Program Booklet

Department of Computer Science and Engineering

Birla Institute of Technology, Mesra,

Ranchi, Jharkhand

M.Tech in Artificial Intelligence & Machine Learning

Department of Computer Science & Engineering

Birla Institute of Technology, Mesra, Ranchi - 835215 (India)

M.Tech in Artificial Intelligence & Machine Learning

Institute Vision

To become a Globally Recognized Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research and technological service to the National needs.

Institute Mission

- To educate students at Undergraduate, Postgraduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D. programmes and research projects.
- To develop effective teaching and learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision

The department strives to be recognized globally for outstanding education and research, leading to excellent professionals and innovators in the field of Computer Science and Engineering, who can positively contribute to the society.

Department Mission

- To impart quality education and equip the students with strong foundation that could make them capable of handling challenges of the new century.

- To maintain state of the art research facilities and facilitate interaction with world's leading universities, industries and research organization for constant improvement in the quality of education and research.

Program Educational Objectives (PEOs) – M.Tech (AIML)

The program aims:

PEO1: To train the students in such a way that makes them capable of exploiting and enhancing theoretical and practical knowledge in the domain of machine learning and artificial intelligence.

PEO2: To impart students with a strong base of knowledge that makes them suitable for both industry teaching and research.

PEO3: To train the students to develop practical and efficient solutions to the research challenges in the growing field of artificial intelligence to gain leadership positions in the organization and/or teams.

PEO4: To inculcate students with the sensitivity towards ethics, public policies and their responsibilities towards the society to gain trust and respect of others as ethical team members.

Program Outcomes (POs) For M.Tech (AIML)

PO1: An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program.

BIRLA INSTITUTE OF TECHNOLOGY- MESRA, RANCHI NEW COURSE STRUCTURE - To be effective from academic session 2024-25 Based on NEP Recommended scheme of study for M.Tech. (AIML)								
SEMESTER/ Session of Study (Recommended)	**Course Level**	**Category of Course**	**Course Code**	**Courses**	**Mode of delivery & credits** ***L- Lecture; T-Tutorial; P-Practicals***			**Total Credits** ***C-Credits***
					L (*Periods/ week*)	T (*Periods /week*)	P (*Periods /week*)	C
	THEORY							
FIRST / Monsoon	Fifth	Programme Core (PC)	AI26501	Modern Artificial Intelligence	3	0	0	3
			AI26503	Advanced Concepts of Supervised Learning	3	0	0	3
			AI26505	Advanced Concepts of Unsupervised Learning	3	0	0	3
			AI26507	Linear Algebra	3	0	0	3
			CS26501	Advanced Data Structures and Algorithm	3	0	0	3
								15
		LABORATORIES						
	Fifth	Programme Core (PC) Lab	CS26502	Advanced Data Structures and Algorithm Lab	0	0	3	1.5
			AI26510	Machine Learning Lab	0	0	3	1.5
			AI26512	Skill Development course – I	0	0	4	2
								5
		TOTAL						**15+5=20**
SECOND/ Spring	Fifth	Programme Core (PC)	AI26513	Deep Learning	3	0	0	3

		Programme Elective (PE)		PE I (Pool 1)	3	0	0	3
				PE II (Pool 2)	3	0	0	3
				PE III (Pool 2)	3	0	0	3
				PE IV (Pool 2)	3	0	0	3
								15
		LABORATORIES						
	Fifth	Programme Core (PC) Lab	AI26514	Deep Learning Lab	0	0	3	1.5
		Programme Elective (PE) Lab		PE I Lab (Pool 1)	0	0	3	1.5
			AI26516	Skill Development course – II	0	0	4	2
		TOTAL						**15+5=20**
TOTAL FOR FIFTH LEVEL								**20+20=40**
THIRD /Monsoon	Sixth	Programme Core (PC)	AI26517	Thesis Part I				14
		Open Elective (OE)	*	OE 1/MOOC-I	3	0	0	3
		Open Elective (OE)	*	OE 2/MOOC-II	3	0	0	3
		TOTAL						**14+6=20**
FOURTH/ Spring	Sixth	Programme Core (PC)	AI26519	Thesis Part II				20
		TOTAL						**20**
TOTAL FOR SIXTH LEVEL								**20+20=40**
GRAND TOTAL FOR M.TECH. PROGRAMME								**80**

List of Electives

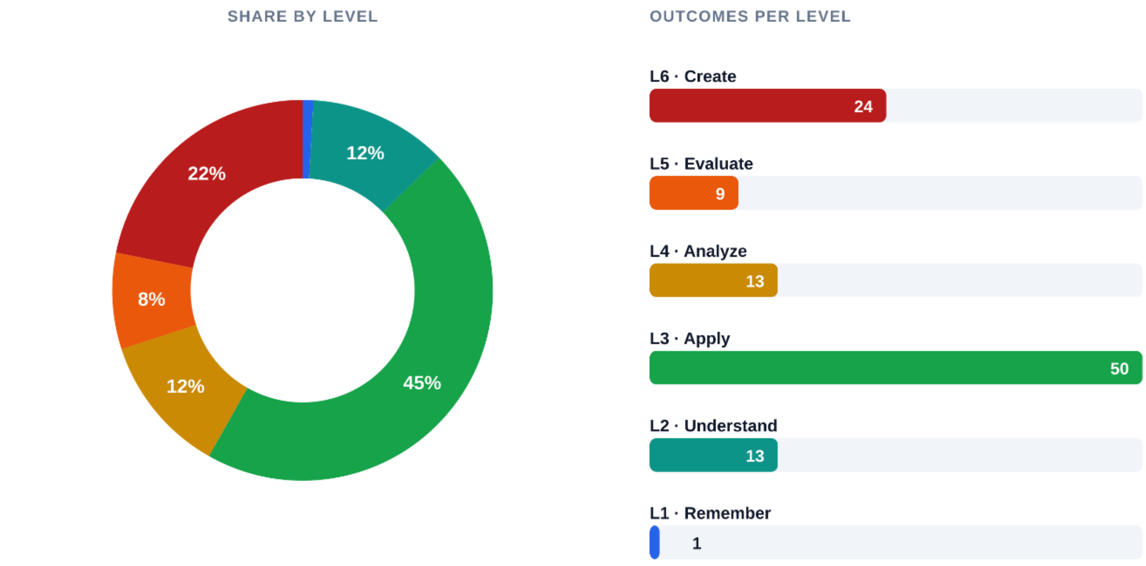
Course Code	Courses	Mode of delivery & credits *L- Lecture; T- Tutorial; P- Practical*			Total Credits *C -Credits*
Theory with Lab- Pool 1					
AI26521	Data Analysis and Interpretation	3	0	0	3
AI26523	Evolutionary Computing	3	0	0	3
CS26523	Computer Vision	3	0	0	3
AI26522	Data Analysis and Interpretation Lab	0	0	3	1.5
AI26524	Evolutionary Computing Lab	0	0	3	1.5
CS26524	Computer Vision Lab	0	0	3	1.5
Theory- Pool 2					
AI26525	Large Language Models	3	0	0	3
AI26527	Agentic AI Systems	3	0	0	3
AI26529	Concepts of Reinforcement Learning	3	0	0	3
CS26531	Quantum Computing	3	0	0	3
AI26531	Network Analysis	3	0	0	3
AI26533	Mining Massive Datasets	3	0	0	3
AI26535	Time Series Analysis	3	0	0	3
AI26537	Outlier Analysis	3	0	0	3
AI26539	Generative AI	3	0	0	3
AI26541	Multimedia Databases	3	0	0	3

M. Tech AIML COURSE MAPPING WITH BLOOM’S LEVELS

Level	Cognitive level	Description
L1	Remember	Recall facts, terms and basic concepts.
L2	Understand	Explain ideas or concepts in one’s own words.
L3	Apply	Use knowledge to solve problems in new situations.
L4	Analyze	Break information into parts and examine how they relate.
L5	Evaluate	Judge or justify a decision based on criteria.
L6	Create	Combine elements to produce new ideas or solutions.

Overall Programme Bloom's Distribution — M.Tech (AI & ML)

All 110 course outcomes across 22 courses, classified into Bloom's six cognitive levels.



Higher-order thinking (Analyze + Evaluate + Create)
46 (42%)

Lower-order thinking (Remember + Understand + Apply)
64 (58%)

Assessment Tool→ Bloom's level mapping

Legend: L1 Remember L2 Understand L3 Apply L4 Analyze L5 Evaluate L6 Create

Semesters I & II

Evaluation method	Type	L1	L2	L3	L4	L5	L6
		Remember	Understand	Apply	Analyze	Evaluate	Create
Quizzes	Theory	✓	✓	✓			
Assignments	Theory		✓	✓	✓		
Seminar (before committee)	Theory		✓		✓	✓	✓
Semester-End Examination	Theory	✓	✓	✓	✓		
Day-to-day lab evaluation	Lab			✓	✓		
Lab Viva	Lab		✓	✓	✓	✓	
Lab Quiz	Lab	✓	✓	✓			
End-Sem performance	Lab			✓	✓		✓

Semester III — Thesis Part I + MOOC / Open Elective

Evaluation method	Scope	L1	L2	L3	L4	L5	L6
		Remember	Understand	Apply	Analyze	Evaluate	Create
Progressive Evaluation	Thesis Part I				✓	✓	✓
End Semester Presentation	Thesis Part I				✓	✓	✓
MOOC / Open-Elective assessment	MOOC / OE		✓	✓	✓	✓	

Semester IV — Thesis Part II

Evaluation method	Scope	L1	L2	L3	L4	L5	L6
		Remember	Understand	Apply	Analyze	Evaluate	Create
Progressive Evaluation	Thesis Part II				✓	✓	✓
End Semester Presentation	Thesis Part II				✓	✓	✓

Course Code: AI26501

Course Title: Modern Artificial Intelligence
Pre-requisite(s): Basic Artificial Intelligence, Machine Learning
Co-requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: M. Tech
Semester / Level: FIRST/Fifth
Branch: AIML

Course Objectives
This course enables the students to:

1.	Provide a comprehensive understanding of the fundamental concepts, principles, and applications of Artificial Intelligence and Generative AI.
2.	Introduce intelligent search techniques, heuristic methods, and adversarial search algorithms used in AI-based problem solving.
3.	Develop knowledge of Natural Language Processing (NLP), language models, and deep learning techniques for text understanding and generation.
4.	Explain modern deep learning architectures, generative models, robotics, and automation for designing intelligent systems.
5.	Familiarize students with contemporary computer vision techniques, multimodal AI, and vision-language models for solving real-world AI applications and Promote awareness of responsible AI practices, ethical issues, and emerging trends in modern Artificial Intelligence.

Course Outcomes (COs)
After the completion of this course, students will be able to:

CO1	Understand the fundamental concepts of Artificial Intelligence, Generative AI, ethical AI, and intelligent search techniques, and apply search algorithms to solve AI problems.
CO2	Apply Natural Language Processing techniques, language models, word embeddings, and recurrent neural networks to analyze and solve text processing and language understanding problems.
CO3	Understand and analyze the principles of AI-enabled robotics, including robot perception, motion planning, navigation, and automation in intelligent systems.
CO4	Analyze and evaluate deep learning architectures, including ANN, CNN, RNN, LSTM, and generative models such as Autoencoders, Variational Autoencoders (VAE), GANs, and Diffusion Models for AI applications.
CO5	Apply computer vision techniques, including image classification, object detection, image segmentation, Vision Transformers (ViT), vision-language models, and multimodal AI to design and develop intelligent vision-based applications.

SYLLABUS

MODULE	NO. OF LECTURE HOURS

Module 1: Introduction To Artificial Intelligence, Generative AI, Agents and Search Techniques What is Artificial Intelligence? Foundations of AI, Characteristics, Benefits and Risks of AI (covers hallucinations), Narrow AI vs General AI, Introduction to Generative AI, what is Generative AI? Discriminative vs Generative AI , AI Applications across domains, Responsible and Ethical AI , Introduction to the concept of Foundation Models, Large Language Models (LLMs), Synthetic data Generation (examples from image/text), Popular Generative AI Tools (such as ChatGPT, Gemini, Claude), Impact of prompts, Search Techniques: Problem Solving using Search, State Space Representation, Heuristic Search-Hill Climbing, Simulated Annealing, A* Search, Introduction to Adversarial Search-Mini-Max Algorithm, Alpha-Beta Pruning.	8
Module 2: Natural Language Processing and Implementation Natural Language Processing: Introduction to NLP, Language Models, Grammar and Parsing, Morphological Analysis, Syntactic Processing, Semantic Analysis, Discourse and Pragmatic Processing, Ambiguity in NLP, NLP Applications: Text Representation, TF-IDF, Word Embeddings, examples of modern natural language feature extractors.	8
Module 3: Robotics and Automation Introduction to Robotics, Robot Hardware and Software, Robot Architectures, Robotic Perception, Motion Planning, Navigation and Control, Robotics in Certain and Uncertain Environments, AI-enabled Robotics Applications.	8
Module 4: Deep Learning and Generative Models Deep Learning: Artificial Neural Networks, Multilayer Networks, Introduction to CNN Architecture, Introduction to RNN, Time-Series Prediction, Introduction to Generative Deep Learning: Autoencoders (Basic), Variational Autoencoders (Overview), Introduction to Generative Adversarial Networks (GANs).	8
Module 5: Computer Vision Introduction to Computer Vision, Digital Image Representation, Image Features and Feature Extraction, Fundamentals of Image Classification. Convolutional Neural Networks (CNNs) for Vision-ResNet18 as an example. Advanced Computer Vision: Vision Transformers (ViT) (Introduction), Vision-Language Models (Introduction), Comparative Study: Image Processing vs. Computer Vision vs. Computer Graphics.	8

Text Books:

1. Artificial Intelligence: A Modern Approach, Authors: Stuart Russell & Peter Norvig, Publisher: Pearson

Reference Books:

1. Deep Learning, Authors: Ian Goodfellow, Yoshua Bengio, Aaron Courville, Publisher: MIT Press.
2. Computer Vision: Algorithms and Applications, Author: Richard Szeliski, Publisher: Springer.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	30
Assignment(s)	10

Continuous Internal Assessment	% Distribution
Seminar before a committee	10
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Interactive Classroom Lectures/ Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars/ Case Studies/ Project-Based Learning
CD3	Laboratory experiments/ Hands-on Laboratory Sessions/ Generative AI Tool Demonstrations
CD4	Industry Applications based lecture/guest lecture/ Expert Talks
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Continuous Assessment and Practical Evaluation/ Theoretical understanding /Practical implementation/ Collaborative learning/ Real-world exposure.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes
Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65 100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	3
CO2	2	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4, CD6, CD7
CO2	CD1, CD2, CD3, CD4, CD6, CD7
CO3	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO4	CD1, CD2, CD3, CD4, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD6, CD7

Course Code: AI26503

Course Title: Advanced Concepts of Supervised Learning
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: 0 T: 0 P: 3
Class schedule per week: 3
Class: MTech
Semester / Level: First/Fifth
Branch: AIML

Course Objectives

This course envisions to impart to students to:

1.	Familiarize with the core concepts of supervised learning.
2.	Understand the working of Decision trees, and the technique of SVMs and decide the proper kernel for a task.
3.	Understand the working of neural networks with backpropagation.
4.	Understand the learning with less labels.
5.	Learn how Ensemble works.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Demonstrate with examples the core concepts of supervised learning.
CO2	Perform classification using SVMs and to build tree-based classifiers and demonstrate the splitting criteria.
CO3	Articulate the working of a simple neural network with backpropagation.
CO4	Apply semi-supervised learning techniques to learn with less labeled data.
CO5	Demonstrate how Ensemble learning helps improve classifier performance.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module –I Preliminaries Machine Learning – what and why? Regression, Confusion Matrix, Gradient Descent, Naïve Bayes Classifier, KNN Classifier**.**	6
Module – II Learning with Decision Trees and Support Vector machines Basics of Feature Selection and Evaluation, Decision Tree, Overfitting and Pruning, Logistic Regression. Support Vector Machine and Kernel; Noise, bias-variance trade-off, under-fitting and over-fitting concepts.	10
Module – III Neural Networks Gradient Descent and Perceptron/Delta Learning, Loss functions, Multilayer Perceptron, Feed forward networks and backpropagation, Overfitting and regularization.	10
Module – IV Semi Supervised Learning Learning from less labels. Self-training, co-training, Mean Teacher learning using labelled and unlabeled data.	8
Module – V Ensemble learning Bagging, Boosting, Random Forest, Different ways to combine classifiers	6

Text book:

1. Marsland S., "Machine Learning: An Algorithmic Perspective", CRC Press, 2nd Edition, 2015

Reference Book:

1. Han J., Kamber M., Pei J., "Data Mining: Concepts and Techniques", Morgan Kaufman, 3rd Edition, 2012
2. Tom M. Mitchell, "Machine Learning ", Tata McGraw Hill, New Delhi, 2017

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	30
Assignment(s)	10
Seminar before a committee	10
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- **Student Feedback on Course Outcome**

Course Delivery Methods

Code	Course Delivery Method
CD1	Interactive Classroom Lectures/ Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars/ Case Studies/ Project-Based Learning
CD3	Laboratory experiments/ Hands-on Laboratory Sessions/ Generative AI Tool Demonstrations
CD4	Industry Applications based lecture/guest lecture/ Expert Talks
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Continuous Assessment and Practical Evaluation/ Theoretical understanding /Practical implementation/ Collaborative learning/ Real-world exposure.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes
Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65 100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	3
CO2	2	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4, CD6, CD7
CO2	CD1, CD2, CD3, CD4, CD6, CD7
CO3	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO4	CD1, CD2, CD3, CD4, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD6, CD7

Course Code: AI26505

Course Title: Advanced Concepts of Unsupervised Learning
Pre-requisite(s): Mathematics for Computing, Data Structures
Co-requisite(s): Machine Learning Lab
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: MTech
Semester/ Level: First/ Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Introduce the fundamental concepts of clustering, data representation, similarity measures, and outlier analysis.
2.	Develop an understanding of partitioning clustering techniques and their applications.
3.	Familiarize with hierarchical clustering approaches for uncovering data structures and relationships.
4.	Provide knowledge of advanced clustering methods for handling complex and large-scale datasets.
5.	Evaluate clustering results using validation measures and apply clustering techniques to real-world problems.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Analyze data characteristics, similarity measures, attribute types in the context of clustering technique.
CO2	Apply partitional clustering techniques such as K-Means, Kernel K-Means, and K-Medoid to segregate datasets.
CO3	Examine hierarchical clustering methods and interpret dendrograms for discovering data structures.
CO4	Implement advanced clustering algorithms for identifying complex data patterns.
CO5	Evaluate clustering outcomes to measure the purity of clusters for real-world applications.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Concepts of Clustering, Data Matrix, Dissimilarity Matrices, Types of Attributes, Concept of Outliers.	6
Module 2: Representative-based Clustering: K-Means Algorithm, Kernel K-Means, K-Medoid, Other Variations of Partitional Clustering.	10

Module 3: Concepts of Hierarchical Clustering, Single Linkage, Complete Linkage, Agglomerative Clustering, Divisive Clustering, Dendrogram.	8
Module 4: Density Based Clustering, DBSCAN Algorithm, DENCLUE Algorithm, Grid Based Clustering, STING, Fuzzy C-Means Clustering.	10
Module 5: Cluster Validation, Measuring Clustering Quality, External Measures, Internal Measures, Relative Measures, Application of Clustering.	6

Text Books:

2. Mohammed J. Zaki, Wagner Meira Jr. Data Mining and Machine Learning: fundamental Concepts and Algorithms, 2nd Edition, 2020, Cambridge University Press.

Reference Books:

1. Charu C. Aggarwal, Chadan C. Reddy, Data Clustering Algorithms and Applications, 2014, CRC Press, Taylor & Francis.
2. Jiawei Han, and Micheline Kamber, Data Mining Concepts & Techniques, 3rd Edition, Publisher Elsevier India Private Limited, 2015.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50%
End Semester Examination	50%

Continuous Internal Assessment	**% Distribution**
3 Quizzes (Best two Quizzes)	30%
Assignment(s)	10%
Seminar before a committee	10%
Total	50%

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	**Course Delivery Method**
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Concept based Assignments

Code	Course Delivery Method
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Interactive Lectures, Flipped Classroom Activities
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Case Studies via Research Papers

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	2	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD5
CO2	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO3	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO4	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO5	CD1, CD3, CD5, CD7

Course Code: AI26507

Course Title: Linear Algebra
Pre-requisite(s): Discrete Mathematics
Co-requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: M.Tech
Semester / Level: First/Fifth
Branch: AIML

Course Objectives
This course enables the students to:

1.	Present basic concepts and techniques of linear algebra.
2.	Use the concept of linear algebra to formulate problems and solve those.
3.	Develop mathematical thinking and problem-solving skill.
4.	Provide the foundations of probabilistic and statistical analysis.
5.	Apply the concept of number theory in Cryptography.

Course Outcomes

After the completion of this course, students will be able to:

CO1	Demonstrate skills in solving mathematical problems
CO2	Analyze problems and identify the computing requirements appropriate to its solution
CO3	Understand basic concepts in probability theory and statistical analysis
CO4	Attain sufficient knowledge for studying the courses of Computer science such as Machine learning, Data Science, Computational problems (like solving set of linear equations), Networking (graph representation using matrix), etc.
CO5	Apply linear algebra concepts to model, solve and analyse real-world situations

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Set, Relation, Function, Sequences, Counting techniques, Group, Ring, Field, Field polynomial.	6
Module 2: Matrices, Various types of matrices, Sparse and dense matrix, Row reduction and echelon forms, Determinants and their properties, Operations on matrices including inverse, Linear transformation on matrices, Block matrices, Rank of matrix, Systems of linear equations (homogenous and non-homogenous),	8

Solving linear equations, Cramer's Rule.	
Module 3: Vectors, Vector operations (sum and product), Linear dependence and independence, Vector space and dimension and subspace, Basis vectors and dimension, Orthogonality, Norms, Metric spaces, Gram-Schmidt process.	8
Module 4: Eigenvalues and eigenvectors, Diagonalization of a matrix, characterizations of eigenvalues, Eigen Value Decomposition, Singular Value Decomposition. Elementary number theory: Prime numbers, Divisibility, Congruences.	8
Module 5: Basic Probability: Experiment, definition of probability, conditional probability, independent events, Bayes' rule, Bernoulli trials, Random variables, discrete random variable, entropy calculation, probability mass function, continuous random variable, probability density function, cumulative distribution function, properties of cumulative distribution function, Two dimensional random variables and their distribution functions, Independent random variables Some special Probability Distributions: Binomial distribution, Poisson distribution, Normal distributions. Basic Statistics: Measure of central tendency: Moments, Expectation, dispersion, skewness, expected value of two-dimensional random variable, Linear Correlation, correlation coefficient, rank correlation coefficient, Regression Applied Statistics: Formation of Hypothesis, Test of significance: Sampling, parameter and statistic, data transformation, Confidence interval, Critical region, Testing of hypothesis, Likelihood ratio, testing, examples. Chi-square test of goodness of fit, large sample test for single proportion, Test of significance for Small samples: t- Test for single mean, difference of means, t-test for correlation coefficients, F- test for ratio of variances, Chi-square test for goodness of fit and independence of attribute.	10

Text Books:

1. Introduction to Linear Algebra, Gilbert Strang, Wellesley-Cambridge Press, Fifth Edition (2016).

Reference Books:

1. Schaum's Outline of Linear Algebra, Seymour Lipschutz and Marc Lars Lipson, McGraw-Hill Education, Sixth Edition (2018)

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50%
End Semester Examination	50%

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	30%
Assignment(s)	10%
Seminar before a committee	10%
Total	50%

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Concept based Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Interactive Lectures, Flipped Classroom Activities
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Case Studies via Research Papers

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	3
CO2	3	3	3
CO3	3	3	3
CO4	3	3	3
CO5	2	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD5
CO2	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO3	CD1, CD2, CD3, CD4, CD5, CD6, CD7

Course Outcomes	Course Delivery Method
CO4	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO5	CD1, CD3, CD5, CD7

Course Code: CS26501

Course Title: Advanced Data Structures & Algorithms
Pre-requisite(s):
Co-requisite(s): CS26502 Advanced Data Structures & Algorithms Lab
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: MTech
Semester / Level: First/Fifth
Branch: CSE/AIML

Course Objectives

This course enables the students to:

1	Understand the fundamentals of data structures and algorithm analysis, including asymptotic notations and complexity analysis.
2.	Learn the implementation and applications of linear data structures such as arrays, linked lists, stacks, queues, and hashing.
3.	Develop proficiency in non-linear data structures including trees, binary search trees, heaps, tries, skip lists, B-trees, graphs, and union-find structures.
4.	Analyze, design, and implement efficient algorithms using paradigms such as divide-and-conquer, greedy methods, and dynamic programming.
5.	5Apply appropriate data structures and algorithms to solve computational problems while evaluating their correctness, efficiency, and computational complexity.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Analyze algorithms, solve recurrence, and implement fundamental linear data structures.
CO2	Design and implement hashing techniques and graph traversal algorithms (BFS and DFS) for solving practical computational problems.
CO3	Construct, traverse, and manipulate binary tree and heap.
CO4	Apply searching, indexing, and connectivity operations with skip lists, B-trees, and union-find structures, respectively.
CO5	Apply various algorithm design techniques and evaluate computational complexity.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction Algorithm and its properties, time and space complexities, O, Ω and Θ notations, solving recurrence; Multidimensional arrays, memory representation of multidimensional arrays; Various operations on singly linked lists, concepts of doubly and circular linked lists; Stack implementations with array and linked-list, applications of stack; Queue implementations with array and linked-list,	10

circular queue (with array)	
Module 2: Hashing and Graphs Hashing, hash functions, open addressing (linear probing, quadratic probing, double hashing), and chaining; Graph representation, traversal (BFS and DFS), and their applications	6
Module 3: Trees Tree, Binary Tree, Traversal (inorder, preorder, postorder), reconstruction of tree from its traversals; Binary Search Tree (BST), height-balanced BST; Heaps, building heap in linear time, applications of heap	8
Module 4: Advance Data Structures Trie and its applications; Skip-list, operations on skip-list; B-Tree, insertion and deletion operations; Application of Union-Find (disjoint set) data structure;	8
Module 5: Algorithm Design Divide and conquer paradigm, common examples, Strassen's Algorithm; Greedy algorithm design paradigm, Huffman coding; Dynamic Programming algorithm design paradigm, Longest Common Subsequence; Efficient string matching (KMP algorithm); Overview of complexity classes, polynomial reduction, computational hardness, list of NP-complete problems	8

Text Books:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, Introduction to Algorithms.
2. Ellis Horowitz, Sartaj Sahni, and Susan Anderson-Freed, Fundamentals of Data Structures in C.
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++.
4. Jeff Erickson, Algorithms (https://jeffe.cs.illinois.edu/teaching/algorithms/)
5. Tim Roughgarden, Algorithms Illuminated (https://www.algorithmsilluminated.org/)

Reference Books:

1. Reema Thareja, Data Structures Using C.
2. Narasimha Karumanchi, Data Structures and Algorithms Made Easy.
3. Jon Kleinberg and Éva Tardos, Algorithm Design.
4. Sanjoy Dasgupta, Christos H. Papadimitriou, and Umesh V. Vazirani, Algorithms.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	30
Assignment(s)	10
Seminar before a committee	10
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Classroom Lectures
CD2	Interactive Discussions and Question–Answer Sessions
CD3	Demonstration of Django Concepts and Case Studies
CD4	Laboratory Demonstrations and Hands-on Practice
CD5	Tutorials and Problem-Solving Sessions
CD6	Assignments, Quizzes, and Self-Learning Activities
CD7	Seminar Presentations and Project-Based Learning

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	3
CO2	3	3	3
CO3	3	2	3
CO4	3	2	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4, CD5, CD6
CO2	CD1, CD3, CD4, CD5, CD6
CO3	CD1, CD3, CD4, CD5, CD6
CO4	CD1, CD3, CD4, CD5, CD6, CD7
CO5	CD1, CD2, CD3, CD5, CD6, CD7

Course Code: CS26502

Course Title: Advanced Data Structures & Algorithms Lab
Pre-requisite(s):
Co-requisite(s): CS26501 Advanced Data Structures & Algorithms
Credits: 1.5 L: 0 T: 0 P: 1.5
Class Schedule per Week: 1
Class: MTech
Semester / Level: First/Fifth
Branch: CSE/AIML

Course Objectives

This course enables the students to:

1.	Develop a strong understanding of fundamental and advanced data structures.
2.	Enable students to design, implement, and analyze efficient data structures and algorithms for solving computational problems.
3.	Provide practical knowledge of searching, sorting, graph traversal, tree operations, and algorithmic techniques through implementation and performance analysis.
4.	Introduce advanced data structures such as Trie, Skip List, and B-Tree and understand their applications in real-world computing systems.
5.	Develop skills in algorithm design techniques including pattern matching, compression algorithms, and optimization approaches for solving complex problems.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Implement and analyze basic data structures for solving computational problems. Evaluate the performance of an algorithm through experimental comparison on large datasets.
CO2	Design and implement hashing and graph algorithms for solving various computational problems.
CO3	Implement and analyze tree-based data structures for efficient data organization and retrieval.
CO4	Apply advanced data structures for efficient searching, indexing, and storage applications.
CO5	Implement and analyze pattern matching, data compression techniques on large datasets. Implement various algorithm design paradigms to solve complex computational problems.

SYLLABUS (A model list of programs to be implemented with C/C++ like programming language)

MODULE	NO. OF LECTURE HOURS
Module 1: Basic Data Structures and Programming 1. Implement Static, dynamic and multidimensional arrays.	9

2. Menu based operations/applications on arrays. 3. Running time comparison of various searching and sorting algorithms on large random input. 4. Operations on linked-lists and its application. 5. Implementation of Stack with arrays and linked-list. 6. Implementation of Queue with arrays and linked-list. 7. Application of Stacks and Queues.	
Module 2: Hashing and Graphs 8. Implement Hash data structure with chaining and its application. 9. Implement various graphs with adjacency matrix and adjacency list. 10. Implement BFS and DFS graph traversal and their application.	6
Module 3: Trees 11. Implement Binary Search Tree and its operations. 12. Implement height balanced tree and its operations. 13. Implement Heap and its applications.	9
Module 4: Advance Data Structures 14. Implement Trie and its operations. 15. Implement Skip List and its operations. 16. Implement B-Tree and its operations.	9
Module 5: Algorithm Design 17. Implement KMP Algorithm and analyze its performance on random input. 18. Implement Huffman Coding and analyze its performance on random input. 19. Applications of different algorithm design techniques.	6

Text Books:

2. Ellis Horowitz, Sartaj Sahni, and Susan Anderson-Freed, Fundamentals of Data Structures in C.
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++.
4. Reema Thareja, Data Structures Using C.
5. Narasimha Karumanchi, Data Structures and Algorithms Made Easy.
6. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. Stein, Introduction to Algorithms.

Reference Books:

1. Jeff Erickson, Algorithms (https://jeffe.cs.illinois.edu/teaching/algorithms/)
2. Tim Roughgarden, Algorithms Illuminated (https://www.algorithmsilluminated.org/)
3. Jon Kleinberg and Éva Tardos, Algorithm Design.
4. Sanjoy Dasgupta, Christos H. Papadimitriou, and Umesh V. Vazirani, Algorithms.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

<u>Direct Assessment</u>

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
Day-to-day progressive evaluation	30
Lab Quiz 1	10
Lab Viva	20
End Semester Examination	**% Distribution**
End Sem Performance	30
Lab Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars/ Quiz (s)
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Online Materials
CD7	Video Lectures for Self-Studies

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	2	3
CO2	2	2	3

CO	PO1	PO2	PO3
CO3	2	2	3
CO4	3	2	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD4, CD5, CD6, CD7
CO2	CD1, CD2, CD4, CD5, CD6, CD7
CO3	CD1, CD2, CD4, CD5, CD6, CD7
CO4	CD1, CD2, CD4, CD5, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD6, CD7

Course Code: AI26510

Course Title: Machine Learning Lab
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0 T: 0 P: 1.5
Class schedule per week: 3
Class: M. Tech
Semester / Level: First/Fifth
Branch: CSE

Course Objectives

This course envisions to impart to students to:

1.	Understand the foundational concepts and types of Machine Learning including supervised and unsupervised learning.
2.	Develop regression models using linear and regularized approaches and evaluate them using suitable metrics.
3.	Explore and implement various classification algorithms and understand their theoretical foundations.
4.	Apply clustering techniques and dimensionality reduction methods to analyze unlabeled data.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Preprocess and visualize data for machine learning tasks
CO2	Understand and implement basic supervised learning algorithms
CO3	Explore dimensionality reduction techniques
CO4	Design and apply unsupervised learning techniques
CO5	Analyze performance metrics of supervised and unsupervised models

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module – I Introduction to Machine Learning Programs based on Linear Regression, Gradient Descent, and implementation of different evaluation metrics like MSE, RMSE, MAE, R^2 Score. Programs on K-Nearest Neighbor technique.	6
Module – II Supervised Learning Programs based on Logistic Regression. Programs on Support Vector Machines (SVMs) using linear different kernel approaches. Programs based on implementing Decision Trees.	9
Module – III Neural Networks Programs based on understanding the concept of linear separability. Programs based on Multilayer Perceptron (MLP) and Back Propagation Algorithm.	9
Module – IV Unsupervised Learning Programs based on K-Means Clustering. Programs based on Hierarchical clustering methods	6
Module – V Ensemble learning Programs based on Bagging and Boosting. Mini project on real data set.	9

Text Books:

1. Aurelien Géron - Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd September 21019, O'Reilly Media, Inc., ISBN: 9781492032649.

Reference Books:

1. Tom M. Mitchell, "Machine Learning ", Tata McGraw Hill, New Delhi, 2017
2. Shalev-Shwartz Shai and Ben-David Shai, Understanding Machine Learning, Cambridge University Press, 2017.
3. Christopher Bishop, Pattern Recognition and Machine Learning, Springer.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	% Distribution
Day-to-day progressive evaluation	30
Lab Quiz 1	10
Lab Viva	20
End Semester Examination	**% Distribution**

Continuous Internal Assessment	% Distribution
End Sem Performance	30
Lab Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Concept based Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Interactive Lectures, Flipped Classroom Activities
CD6	Self- learning through NPTEL materials and internets
CD7	Case Studies via Research Papers

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	2	3
CO2	2	2	3
CO3	2	2	3
CO4	3	3	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD5, CD6

CO2	CD1, CD2, CD3, CD5, CD6
CO3	CD1, CD2, CD3, CD4, CD5, CD6
CO4	CD1, CD2, CD3, CD4, CD5 CD6, CD7
CO5	CD1, CD2, CD5, CD6, CD7

Course Code: CS26510/ AI26512

COURSE OPTIONS

1.
Course Title: Skill Development I- Python programming
Pre-requisite(s): Data Structure, Basic concepts of any Programming language.
Co-requisite(s): None
Credits: 2 L: 0 T:0 P: 4
Class Schedule per Week: 3
Class: M.Tech
Semester / Level: First/Fifth
Branch: CSE/ AIML

Course Objectives

This course enables the students to:

1.	Understand the fundamentals of Python programming, including syntax, data types, operators, and control structures.
2.	Develop Python programs using functions, modules, and object-oriented programming concepts.
3.	Apply appropriate data structures such as lists, tuples, dictionaries, and sets to solve computational problems.
4.	Utilize NumPy and other Python libraries for numerical computation, data manipulation, and scientific computing.
5.	Analyse, manipulate, clean, and transform data using Pandas Data Frames and related data structures. Visualize and interpret data using Matplotlib and Pandas plotting tools to support data analysis and decision-making.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Demonstrate proficiency in Python programming fundamentals, including variables, expressions, control structures, functions, strings, lists, tuples, and dictionaries.
CO2	Develop Python applications involving file handling, data processing, and web-based data access using appropriate programming techniques.
CO3	Design and implement object-oriented solutions using classes, objects, attributes, methods, and other OOP concepts in Python.
CO4	Apply NumPy for numerical computing and efficient manipulation of multidimensional arrays through indexing, slicing, and array operations.
CO5	Perform data analysis, transformation, and visualization using Pandas and Matplotlib to extract insights from structured datasets and present them effectively.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Variables, Expressions and Statements, Iteration, Functions with arguments and return values, Strings, Tuples, Lists, Objects and references, Aliasing, cloning lists, Lists and for loops, List parameters.	10
Module 2: Dictionaries: Dictionary operations, dictionary methods, aliasing and copying. files, writing our first file, reading a file line-at-a-time, turning a file into a list of lines, Reading the whole file at once, working with binary files, Directories, fetching something from the Web.	10
Module 3: Object oriented programming: Classes and Objects — The Basics, Attributes, Adding methods to our class, Instances as arguments and parameters, Converting an instance to a string, Instances as return values.	10
Module 4: Array manipulation using Numpy: **Numpy array:** Creating Numpy arrays; various data types of Numpy arrays, indexing and slicing, swapping axes, transposing arrays, data processing using Numpy arrays.	10
Module 5: Data Manipulation using Pandas: **Data Structures in Pandas:** Series, DataFrame, Index objects, Loading data into Pandas data frame, Working with DataFrames: Arithmetics, Statistics, Binning, Indexing, Filtering, Handling missing data, Hierarchical indexing, Data cleaning, transforming, merging and reshaping, Using Matplotlib to plot data: figures, subplots, markings, color and line styles, labels and legends, Plotting functions in Pandas: Line, bar, Scatter plots, histograms, stacked bars, Heatmap, 3D Plotting	12

Text Books:

1. Peter Wentworth, Jeffrey Elkner, Allen B. Downey and Chris Meyers- How to think like a computer scientist: learning with python 3. Green Tea Press, Wellesley, Massachusetts,2020 https://media.readthedocs.org/pdf/howtothink/latest/howtothink.pdf.

2. McKinney W. Python for Data Analysis: Data Wrangling with Pandas, NumPy and IPython, 2nd edition, O'Reilly Media, 2018.

3. Molin S. Hands-On Data Analysis with Pandas, Packt Publishing, 2019. 3. Gupta S.C., Kapoor V.K. Fundamentals of Mathematical Statistics,12 th edition, Sultan Chand & Sons, 2020.

Reference Books:

1.Al Sweigart, "Automate the Boring Stuff with Python, 2nd Edition: Practical Programming for Total Beginners",2nd Edition, No Starch Press, 2022. (Available under CC-BY-NC-SA license at https://automatetheboringstuff.com/)

2. Kyla McMullen, Elizabeth Matthews and June Jamrich Parsons, Programming with Python, Cengage, 2023.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	**% Distribution**
Day-to-day progressive evaluation	30
Lab Quiz 1	10
Lab Viva	20
End Semester Examination	**% Distribution**
End Sem Performance	30
Lab Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Lab Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Seminars
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	3	2	2
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4, CD7
CO2	CD1, CD2, CD3, CD4, CD6, CD7
CO3	CD2, CD3, CD4, CD6, CD7
CO4	CD2, CD3, CD4, CD7
CO5	CD2, CD3, CD4, CD5, CD7

2.
Course Title: Skill Development I- Latex and Slide Preparation
Pre-requisite(s): None
Co-requisite(s): None
Credits: 2 L: 0 T:0 P: 4
Class Schedule per Week: 3
Class: M.Tech
Semester / Level: First/Fifth
Branch: CSE/ AIML

Course Objectives

This course enables the students to:

1.	Understand the fundamentals of LaTeX for professional scientific and technical document preparation.
2.	Develop skills in formatting mathematical equations, tables, figures, references, and bibliographies.
3.	Learn advanced document structuring techniques for research papers, reports, theses, and dissertations.
4.	Create professional presentation slides using the Beamer class in LaTeX.
5.	Design and deliver high-quality academic and research presentations using Beamer templates and visualization tools.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Create professionally formatted technical documents using LaTeX.
CO2	Develop scientific documents incorporating equations, figures, tables, and references.
CO3	Prepare research papers, technical reports, and thesis documents using standard publication templates.
CO4	Apply skills to design academic and professional presentations using Beamer.
CO5	Create scientific documents into effective presentation formats and communicate technical content efficiently.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Overview of TeX and LaTeX ecosystem, Installation and setup of TeX distributions and editors, Structure of a LaTeX document, Document classes, Basic text formatting, Compiling LaTeX documents.	10
Module 2: Mathematical equations and symbols, Tables and figures, Cross-referencing, Hyperlinks, Bibliography management using BibTeX, Citation styles and reference formatting.	10
Module 3: IEEE, ACM and Springer templates, Formatting research papers, Reports and thesis preparation, Algorithm and code insertion, Multi-file document management, Best practices in scientific writing.	10
Module 4: Beamer document class, Themes and templates, Frame structure, Title pages, Lists and blocks, Mathematical content in slides, Navigation and overlays.	10
Module 5: Figures, tables, charts and multimedia in Beamer, Animations and overlays, Custom themes and branding, Conference and seminar presentations, Converting LaTeX reports into Beamer presentations, Presentation design best practices.	12

Text Books:

1. Stefan Kottwitz, *LaTeX Beginner's Guide*, Packt Publishing, 2022.
2. Till Tantau, *The Beamer Class User Guide*, Version 3.76.

Reference Books:

1. https://www.latex-project.org/

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	% Distribution
Day-to-day progressive evaluation	30
Lab Quiz 1	10
Lab Viva	20
End Semester Examination	**% Distribution**
End Sem Performance	30
Lab Quiz 2	10

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Lab Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Seminars
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	3	1	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4, CD7
CO2	CD1, CD2, CD3, CD4, CD6, CD7
CO3	CD2, CD3, CD4, CD6, CD7
CO4	CD2, CD3, CD4, CD7
CO5	CD2, CD3, CD4, CD5, CD7

3.

Course Title: Skill Development I- Introduction to Power BI
Pre-requisite(s): Data Mining
Co-requisite(s):
Credits: 2 L: 0 T: 0 P: 4
Class Schedule per Week: 3

Class: MTech
Semester / Level: First/Fifth
Branch: CSE/ AIML

Course Objectives

This course enables the students to:

1.	Understand the architecture, interface, and workflow of Microsoft Power BI for business intelligence applications.
2.	Import, clean, transform, and model data from multiple sources using Power Query.
3.	Develop interactive dashboards and visualizations using Power BI's charts and reporting tools.
4.	Apply DAX functions, calculated columns, calculated tables, and measures for business data analysis.
5.	Design advanced business intelligence reports using AI-powered visuals, what-if analysis, and storytelling features.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Explain the architecture, interface, and workflow of Microsoft Power BI for business intelligence applications.
CO2	Import, transform, and model data from multiple sources using Power Query and establish relationships among datasets.
CO3	Create interactive dashboards and visualizations using Power BI charts, reports, and analytical tools.
CO4	Apply DAX functions, calculated columns, calculated tables, and measures for business data analysis.
CO5	Develop advanced business intelligence reports using AI-powered visuals, what-if analysis, and reporting features.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to Power BI and the Power BI interface, Report and Data Views, Importing and modelling data, basic data manipulation	10
Module 2: Data visualization in Power BI, Different plots and charts in Power BI	10
Module 3: Aggregation, measures and introduction to DAX, Calculated columns and Calculated Tables, Implicit and explicit measures, DAX syntax and applications	10
Module 4: Importing data from multiple files, Transformations in Power Query, Building Relationships between tables	10
Module 5: Advanced reporting, AI powered Visuals, Key influencers, Decomposition tree, smart narratives, What If analysis	12

Text Books:

1. Arnold J., Learning Microsoft Power BI – Transforming Data into Insights, 1st Edition, O'Reilly, 2025

Reference Books:

1. Deckler G., Powell B., Microsoft Power BI Cookbook, 3rd Edition, Packt Publishing, 2024

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	**% Distribution**
Day-to-day progressive evaluation	30
Lab Quiz 1	10
Lab Viva	20
End Semester Examination	**% Distribution**
End Sem Performance	30
Lab Quiz 2	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars/ Quiz (s)
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Online Materials
CD7	Video Lectures for Self-Studies

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	2
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6, CD7
CO2	CD1, CD2, CD5, CD6
CO3	CD1, CD2, CD3, CD5, CD6
CO4	CD2, CD4, CD5, CD6
CO5	CD3, CD4, CD5, CD6, CD7

4.
Course Title: Skill Development I- MATLAB Programming
Pre-requisite(s): None
Co-requisite(s): None
Credits: 2 L: 0 T:0 P: 4
Class Schedule per Week: 3
Class: M.Tech
Semester / Level: First/Fifth
Branch: CSE/ AIML

Course Objectives

This course enables the students to:

1.	Understand the MATLAB programming environment and develop programs using fundamental programming constructs, data structures, and built-in functions.
2.	Apply control structures, user-defined functions, and file handling techniques for solving computational and engineering problems.
3.	Develop data visualization skills using MATLAB graphical tools for effective analysis and interpretation of data.
4.	Utilize MATLAB toolboxes for data preprocessing, statistical analysis, machine learning, and predictive modeling.
5.	Design and implement MATLAB-based solutions for engineering, scientific, artificial intelligence, and machine learning applications.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Apply MATLAB programming fundamentals, including variables, matrices, operators, control structures, and built-in functions to solve computational problems.
CO2	Develop modular MATLAB programs using user-defined functions, file operations, and debugging techniques for efficient software development.
CO3	Analyze and visualize data using 2D/3D graphical tools and perform basic data processing and interpretation tasks.
CO4	Apply MATLAB-based data analytics and machine learning techniques, including preprocessing, feature engineering, classification, regression, clustering, and model evaluation.
CO5	Design and implement MATLAB solutions for engineering and AI/ML applications involving signal processing, image analysis, optimization, and simulation.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: MATLAB environment, command window, workspace, help system. Variables, constants, data types, operators. Input/output functions (input, disp, fprintf). Vectors, matrices, indexing, slicing. Built-in mathematical functions. Script files and live scripts. Relational and logical operations. Simple engineering computations.	10
Module 2: Control Structures and User-Defined Functions: if, if-else, nested conditions. switch-case statements. for loops. while loops. Break, continue, and loop optimization. User-defined functions. Function arguments, return values, scope of variables. Recursive functions and debugging basics.	10
Module 3: Data Visualization and File Handling: 2D plotting: plot, fplot. Plot formatting: titles, labels, legends, grids. Multiple plots and subplots. 3D plotting: mesh, surf, contour. Import/export of data files. Text file handling. CSV and spreadsheet operations. Basic data analysis and visualization.	10
Module 4: Data Analytics and Machine Learning using MATLAB: Introduction to MATLAB Toolboxes for Data Analytics. Data Preprocessing and Data Cleaning. Descriptive Statistics and Data Visualization. Feature Extraction and Feature Selection. Classification using MATLAB Classification Learner App. Regression Analysis using MATLAB. Clustering using K-Means Clustering. Model Evaluation and Performance Metrics	10
Module 5: MATLAB for Engineering Applications: Signal generation and analysis. Image processing basics (reading, displaying, filtering). Curve fitting and regression. Introduction to Simulink. Optimization using built-in solvers. Performance measurement and code profiling.	12

Text Books:

1. MATLAB Programming for Engineers, Stephen J. Chapman | 7th Edition, 2025
2. Basics of MATLAB Programming, R. Balaji, 2020

Reference Books:

1. Mastering MATLAB: A Practical Guide for Engineers, Scientists, and Programmers to Learn Programming, Simulation, and Data Analysis with Hands-On Examples, 2025

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	% Distribution
Day-to-day progressive evaluation	30
Lab Quiz 1	10
Lab Viva	20
End Semester Examination	**% Distribution**
End Sem Performance	30
Lab Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Lab Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini Projects
CD5	Seminars
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	3	2	2
CO2	3	3	3

CO	PO1	PO2	PO3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4, CD7
CO2	CD1, CD2, CD3, CD4, CD6, CD7
CO3	CD2, CD3, CD4, CD6, CD7
CO4	CD2, CD3, CD4, CD7
CO5	CD2, CD3, CD4, CD5, CD7

Course Code: AI26513

Course Title: Deep Learning
Pre-requisite(s):
Co-requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week:3
Class: M.Tech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives
This course enables the students to:

1.	Understand the mathematical foundations, architectures, and learning mechanisms of deep neural networks.
2.	Apply deep learning algorithms and frameworks to solve complex classification, prediction, and representation-learning problems.
3.	Analyze the performance of deep learning models using appropriate optimization, regularization, and evaluation techniques.
4.	Evaluate advanced deep learning architectures such as CNNs, RNNs, LSTMs, Transformers, and Attention-based models for domain-specific applications.
5.	Design and develop intelligent AI systems using deep learning, generative AI, and large language models for solving real-world problems.

Course Outcomes (COs)
After the completion of this course, students will be able to:

CO1	Explain the mathematical foundations, neural network architectures, activation functions, loss functions, and optimization techniques used in deep learning.
CO2	Apply feedforward neural networks, backpropagation algorithms, and modern deep learning frameworks to solve supervised learning problems.
CO3	Analyze the behavior, performance, and limitations of deep learning models using suitable evaluation metrics and optimization strategies.
CO4	Evaluate advanced architectures such as CNNs, RNNs, LSTMs, Attention Models, Transformers, and their applicability to different problem domains.
CO5	Design and develop intelligent systems using deep learning, generative AI, and large language models for real-world applications.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Foundations of Deep Learning: Introduction to Artificial Intelligence, Machine Learning, and Deep Learning, Biological Neurons and Artificial Neurons, Perceptron and Multi-Layer Perceptron, Feedforward Neural Networks, Activation Functions, Loss Functions, Gradient Descent Optimization, Backpropagation Algorithm, Vanishing and Exploding Gradient Problems, Universal Approximation Theorem	8
Module 2: Deep Neural Networks and Optimization: Deep Feedforward Networks Weight Initialization Strategies, Hyperparameter Tuning, Regularization Techniques Dropout, Batch Normalization, Optimization Algorithms: SGD, Momentum, Nesterov Momentum,	8

RMSProp, Adam, Model Evaluation and Performance Metrics, Bias-Variance Trade-off	
Module 3: Convolutional Neural Networks and Computer Vision: Digital Image Representation, Convolution Operations, Pooling Techniques, CNN Architecture, LeNet, AlexNet, VGGNet, GoogLeNet, ResNet, DenseNet, Transfer Learning, Fine-Tuning Techniques, Introduction to Object Detection and Image Segmentation.	6
Module 4: Sequence Models and Transformer Architectures: Sequential Data Processing, Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Encoder–Decoder Models, Attention Mechanisms, Self-Attention, Transformer Architecture, Positional Encoding, Bidirectional Encoder Representations from Transformers (BERT), Generative Pre-trained Transformer (GPT), Applications in Natural Language Processing	9
Module 5: Generative AI, Large Language Models, and Advanced Deep Learning Applications: Autoencoders and Variational Autoencoders (VAE), Generative Adversarial Networks (GANs), Diffusion Models (Introduction), Self-Supervised Learning, Introduction to Foundation Models, Large Language Models (LLMs), Evolution of LLMs, Transformer-based LLM Architecture, Pre-training and Fine-Tuning, Prompt Engineering Fundamentals, Retrieval-Augmented Generation (RAG) Concepts, Hallucinations and LLM Limitations, Responsible and Ethical AI Considerations, Explainable AI (XAI), Deep Reinforcement Learning (Overview), Applications of Deep Learning and LLMs in: Computer Vision, Natural Language Processing, Healthcare, Cybersecurity, Autonomous Systems, Recommendation Systems, Smart Manufacturing, Emerging Trends and Research Directions	9

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, MIT Press, 2016
2. Charu C. Aggarwal, *Neural Networks and Deep Learning*, Springer, 2018.

Reference Books:

1. Francois Chollet, *Deep Learning with Python*, 3rd Edition, Manning Publications, 2025.
2. Aston Zhang, Zachary Lipton, Mu Li, Alexander Smola, *Dive into Deep Learning*, Cambridge University Press, 2023.
3. Nikhil Buduma and Nicholas Locascio, *Fundamentals of Deep Learning*, O'Reilly Media.
4. Jay Alammar and Maarten Grootendorst, *Hands-On Large Language Models*, O'Reilly Media, 2024.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	**% Distribution**
3 Quizzes (Best two Quizzes)	30
Assignment(s)	10
Seminar before a committee	10

Continuous Internal Assessment	% Distribution
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Interactive Classroom Lectures
CD2	NPTEL Video-Based Learning
CD3	Flipped Classroom Sessions
CD4	Hands-on Laboratory Experiments using TensorFlow and PyTorch
CD5	Case Study and Research Paper Analysis
CD6	Project-Based Learning and Mini Projects
CD7	Seminars, Technical Presentations, and LLM Demonstrations

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes
Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	2	2
CO2	2	2	3
CO3	2	2	3
CO4	3	2	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2, CD3
CO3	CD3, CD4
CO4	CD5, CD6
CO5	CD5, CD6, CD7

Course Code: AI26514

Course Title: Deep Learning Lab
Pre-requisite(s): Python, Basic ML, Algebra,
Co-requisite(s): Probability and Statistics, Advanced ML, Research Methodology
Credits: 1.5 L: 0 T:0 P: 1.5
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Understand and implement deep neural network architectures, learning algorithms, and optimization techniques using modern deep learning frameworks such as TensorFlow and PyTorch.
2.	Develop practical skills in designing, training, validating, and fine-tuning deep learning models for classification, prediction, and representation learning tasks.
3.	Experiment with and analyze the impact of various hyperparameters, regularization methods, optimization algorithms, and evaluation metrics on model performance.
4.	Apply advanced deep learning architectures, including CNNs, RNNs, LSTMs, Attention Mechanisms, and Transformers, to solve computer vision and natural language processing problems.
5.	Design and deploy intelligent AI solutions using Generative AI, Large Language Models (LLMs), Prompt Engineering, and Explainable AI techniques while considering ethical and responsible AI practices.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Implement and train feedforward neural networks using TensorFlow/PyTorch for solving classification and regression problems through appropriate data preprocessing, model design, and performance evaluation.
CO2	Analyze the impact of hyperparameter tuning, optimization algorithms, regularization methods, and performance metrics on the effectiveness of deep learning models.
CO3	Develop and evaluate Convolutional Neural Network (CNN) models for image classification and computer vision applications using transfer learning and fine-tuning techniques.
CO4	Assess the suitability and performance of sequence models, including RNNs, LSTMs, GRUs, Attention mechanisms, and Transformer architectures, for natural language processing and sequential data analysis tasks.
CO5	Design and develop intelligent AI solutions using Generative AI, Large Language Models (LLMs), Prompt Engineering, Retrieval-Augmented Generation (RAG), and Explainable AI techniques for real-world applications while considering ethical AI principles.

SYLLABUS

<table>
<tr><th>MODULE</th><th>NO. OF LECTURE HOURS</th></tr>
<tr><td>Assignment 1: Neural Network Development and Optimization Mapped COs-CO1, CO2, Bloom's Levels-Apply (L3), Analyze (L4)
Problem Statement: Develop a Feedforward Neural Network (FNN) using TensorFlow/PyTorch for a multiclass classification problem.
Tasks:
Select a dataset (Iris, Wine Quality, MNIST, etc.).
1. Perform data preprocessing and feature scaling.
2. Implement MLP with varying:
o Number of hidden layers
o Activation functions
o Learning rates
3. Compare SGD, RMSProp, and Adam optimizers.
4. Plot:
o Training Loss
o Validation Loss
o Accuracy Curves
5. Analyze overfitting and underfitting scenarios.
Deliverables
• Source Code
• Experimental Report
• Performance Comparison Table
Practical Outcome- Students understand how neural networks learn and how optimization affects performance.</td><td>6</td></tr>
<tr><td>Assignment 2: Hyperparameter Tuning and Model Evaluation Framework
Mapped COs-CO2
Bloom's Levels- Analyze (L4), Evaluate (L5)
Problem Statement: Build a model evaluation framework for deep learning systems.
Tasks:
1. Use a benchmark dataset.
2. Perform:
o Grid Search
o Random Search</td><td>6</td></tr>
</table>

3. Experiment with: ○ Batch Size ○ Learning Rate ○ Dropout ○ Number of Epochs 4. Evaluate using: ○ Accuracy ○ Precision ○ Recall ○ F1 Score ○ ROC Curve Deliverables • Automated Hyperparameter Tuning Script • Comparative Analysis Report Practical Outcome- Students learn systematic model optimization used in industrial AI projects.	
Assignment 3: Computer Vision System using CNN and Transfer Learning Mapped COs- CO3 Bloom's Levels- Apply (L3), Analyze (L4), Evaluate (L5) Problem Statement- Develop an image classification system using CNN and Transfer Learning. Tasks 1. Select a real-world dataset: ○ Medical Images ○ Plant Disease Dataset ○ Waste Classification ○ Face Mask Detection 2. Design a CNN from scratch. 3. Implement Transfer Learning using: ○ VGG16 ○ ResNet50 ○ EfficientNet 4. Compare model performances. 5. Generate confusion matrix and explain misclassifications. Deliverables • Trained Model	6

• Experimental Report • Deployment Demo Practical Outcome- Students gain experience in developing industrial-grade computer vision solutions.	
Assignment 4: NLP System using Transformers Mapped COs- CO4 Bloom's Levels- Analyze (L4), Evaluate (L5) Problem Statement- Build a Transformer-based NLP application. Tasks Choose any one: • Sentiment Analysis • News Classification • Fake News Detection • Question Answering Implement: 1. RNN/LSTM baseline. 2. BERT-based model. 3. Compare: o Accuracy o Training Time o Inference Time 4. Visualize attention weights. Deliverables • Source Code • Comparative Study • Presentation Practical Outcome- Students learn why Transformer architectures dominate modern AI systems.	6
Assignment 5: Prompt Engineering and LLM Evaluation Mapped COs- CO4, CO5 Bloom's Levels- Evaluate (L5), Create (L6) Problem Statement- Design and evaluate prompts for a Large Language Model. Tasks 1. Use ChatGPT, Gemini, Claude, or Llama. 2. Create prompts for: o Summarization o Code Generation o Information Extraction o Report Writing	6

3. Evaluate: o Accuracy o Hallucination Rate o Prompt Robustness 4. Document prompt engineering strategies. Deliverables • Prompt Repository • Evaluation Report Practical Outcome- Students learn how to effectively utilize LLMs in practical applications.	
Assignment 6: Retrieval-Augmented Generation (RAG) System Mapped COs- CO5 Bloom's Levels- Create (L6) Problem Statement- Develop a domain-specific AI assistant using RAG. Tasks 1. Select a domain: o Healthcare o Education o Legal o Cybersecurity 2. Create a knowledge base. 3. Use: o LangChain/LlamaIndex o Vector Database (FAISS/Chroma) 4. Integrate with an LLM. 5. Evaluate response quality. Deliverables • Functional RAG System • Architecture Diagram • Demonstration Practical Outcome- Students develop enterprise-grade AI assistants. Assignment 7: Explainable AI for Deep Learning Models Mapped COs- CO5 Bloom's Levels- Analyze (L4), Evaluate (L5) Problem Statement- Explain predictions made by a deep learning model. Tasks 1. Train CNN or Transformer model.	6

2. Apply: ○ SHAP ○ LIME ○ Grad-CAM 3. Compare explanations. 4. Analyze model biases. Deliverables • Visualization Report • Bias Analysis Report Practical Outcome- Students learn trustworthy and responsible AI development.	
Assignment 8 (Capstone Mini Project): End-to-End Intelligent AI System Mapped COs- CO1–CO5 Bloom's Levels- Create (L6) Problem Statement- Design and implement a complete AI system addressing a real-world problem. Suggested Projects 1. AI Research Assistant using RAG 2. Medical Image Diagnosis System 3. Smart Attendance System 4. AI-powered Resume Screening Tool 5. Cyber Threat Detection System 6. AI Academic Advisor 7. Legal Document Summarization Assistant 8. Agricultural Disease Detection System Deliverables • Working Prototype • Research Paper Style Report • Source Code Repository • Technical Presentation Practical Outcome- Students integrate Deep Learning, Transformers, LLMs, RAG, XAI, and Responsible AI concepts into a deployable AI solution.	3

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, *Deep Learning*, MIT Press, 2016
2. Charu C. Aggarwal, *Neural Networks and Deep Learning*, Springer, 2018.

Reference Books:

1. Francois Chollet, *Deep Learning with Python*, 3rd Edition, Manning Publications, 2025.
2. Aston Zhang, Zachary Lipton, Mu Li, Alexander Smola, *Dive into Deep Learning*,

Cambridge University Press, 2023.
3. Nikhil Buduma and Nicholas Locascio, *Fundamentals of Deep Learning*, O'Reilly Media.
4. Jay Alammar and Maarten Grootendorst, *Hands-On Large Language Models*, O'Reilly Media, 2024.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	**% Distribution**
Day-to-day progressive evaluation	30
Lab Quiz 1	10
Lab Viva	20
End Semester Examination	**% Distribution**
End Sem Performance	30
Lab Quiz 2	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	**Course Delivery Method**
CD1	Guided Hands-on Laboratory Sessions using Python, TensorFlow, and PyTorch
CD2	Experiment-Based Learning through Implementation of Deep Learning Algorithms
CD3	Dataset-Centric Learning involving Data Preprocessing, Feature Engineering, and Model Training
CD4	Project-Based Learning (PBL) through Development of Real-World AI Applications
CD5	Case Study Analysis of State-of-the-Art Deep Learning and Generative AI Systems
CD6	Research Paper Review and Reproducibility Experiments on Recent Deep Learning Models
CD7	Collaborative Learning through Team-Based AI System Development and Peer Evaluation
CD8	Model Evaluation and Performance Analysis using Visualization and Explainability Tools
CD9	Industry-Oriented Development using Transfer Learning, LLMs, RAG Frameworks, and AI Deployment Tools
CD10	Seminar, Technical Demonstration, and Project Presentation on Emerging AI Technologies

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	**PO1**	**PO2**	**PO3**
CO1	2	1	3
CO2	2	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD2, CD3
CO2	CD2, CD3, CD8
CO3	CD1, CD4, CD8, CD9
CO4	CD4, CD5, CD6, CD9
CO5	CD4, CD6, CD7, CD9, CD10

Course Code: CS26514/ AI26516

Course Title: Skill Development course – II
Pre-requisite(s):
Co-requisite(s):
Credits: 2 L: 0 T: 0 P: 4
Class Schedule per Week: 4
Class: MTech
Semester / Level: Second/Fifth
Branch: CSE/AIML

Course Objectives

This course enables the students to:

1.	Inculcate professional ethics, legal compliance and quality-assurance practices essential for responsible and accountable engineering practice.
2.	Expose students to management models, production systems and holistic-technology case studies that connect computing solutions with real organisational and societal contexts.
3.	Nurture an entrepreneurial mindset that enables students to identify opportunities and select problems worth solving through design thinking.
4.	Enable students to translate CSE research and technology into a market-validated, sellable product or application supported by a sound business model.
5.	Develop teamwork, communication, pitching and commercial-documentation competencies required to take an idea from concept to a fundable venture.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Demonstrate ethical judgement and professional responsibility when building and deploying computing solutions.
CO2	Interpret the legal, regulatory and contractual obligations that govern software and data, and uphold recognised assurance and integrity standards.
CO3	Plan, organise and track technical work while managing people, resources, cost and risk, and communicate progress clearly.
CO4	Investigate a real-world need and establish its viability through structured enquiry and evidence from prospective users.
CO5	Transform a technical idea into a workable offering with a sound business case and present it persuasively to stakeholders.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Professional Practices Professional codes of conduct and the engineer's responsibility (IEEE/ACM codes), Ethics in AI and data: privacy, bias and accountability, Self/time management, professional communication and documentation, IT, cyber and data-protection law, Software licensing, contracts, NDAs and IP basics, Software-quality models (ISO 9001, CMMI) and QA/audit processes, Project and product management: Agile, Scrum, Lean, Production/operations systems and resource, cost and risk management.	26
Module 2: Entrepreneurial Skills The entrepreneurial mindset and types of innovation, Creativity and idea-generation techniques, Design thinking, Market validation, Business Model Canvas, pricing and unit economics, Technology readiness and productization, Product roadmap, prototyping and scaling, The startup ecosystem: incubators, accelerators, IPR for startups: patents, copyright, trademarks, Funding pathways and government/support schemes, Team building, roles and communication, The pitch deck, storytelling and investor Q&A.	26

Text Books:

1. The Lean Startup — Eric Ries.
2. Business Model Generation — Osterwalder & Pigneur.
3. Value Proposition Design — Osterwalder et al.
4. Zero to One — Peter Thiel.

Reference Books:

1. Design Thinking resources — Stanford d.school / IDEO.
2. A Guide to the Project Management Body of Knowledge (PMBOK) — PMI.
3. IEEE / ACM Codes of Ethics and relevant ISO/CMMI quality standards.
4. Startup India, MSME and DST/DPIIT scheme documentation and IPR (patent/copyright) guidelines.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment -1 Quiz (10) -2 Group Assignment(s) (50) -Milestone 1- Literature review & problem/opportunity validation -Milestone 2- Proof-of-Concept Review	60
End Semester Examination -Lab-to-Launch Report (10) -Milestone 3- Final product presentation before a committee (30)	40

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Interactive lectures- concept sessions with in-class questioning and discussion.
CD2	Group activities & group performance- collaborative tasks, role-plays and reflective activities.
CD3	Invited expert talks- sessions by entrepreneurs, incubation leads, IPR/legal experts and industry practitioners.
CD4	Project-based (experiential) learning- team building of a product/app under faculty mentorship, with milestone reviews.
CD5	Presentations & investor-style pitching- periodic pitch sessions culminating in a final demo-day pitch.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	0	1	1
CO2	1	1	1
CO3	2	3	3
CO4	3	3	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD3, CD4
CO2	CD1, CD2, CD3
CO3	CD1, CD2, CD3, CD4, CD5
CO4	CD2, CD3, CD4, CD5
CO5	CD1, CD2, CD3, CD4, CD5

Course Code: AI26521

Course Title: Data Analysis and Interpretation
Pre-requisite(s): Linear Algebra
Co-requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Develop a comprehensive understanding of the principles, methodologies, and lifecycle of data analytics for extracting meaningful information from diverse datasets.
2.	Apply statistical and analytical techniques to explore, interpret, and derive actionable insights from complex engineering and scientific data.
3.	Design and evaluate predictive analytics models using classical machine learning algorithms and appropriate feature engineering techniques.
4.	Analyze and interpret analytical models using suitable validation, performance evaluation, and model interpretation techniques for informed decision-making.
5.	Appreciate the role of advanced analytics, decision support systems, and ethical considerations in solving real-world engineering and research problems.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Perform data preparation, preprocessing, exploratory analysis, and visualization for effective data interpretation.
CO2	Apply statistical and inferential techniques to analyze datasets and interpret analytical outcomes.
CO3	Design and assess predictive analytics models using appropriate machine learning techniques and evaluation measures.
CO4	Apply feature engineering and dimensionality reduction techniques to enhance model performance and interpretability.
CO5	Evaluate analytical models and decision-support frameworks by incorporating explainability, uncertainty analysis, and ethical considerations in real-world applications.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to data analytics and its applications; Data analytics lifecycle; Types of analytics—descriptive, diagnostic, predictive, and prescriptive; Types and sources of data; Data acquisition techniques; Data quality assessment; Data preprocessing; Data transformation and integration; Feature scaling, normalization, standardization, discretization, and encoding of categorical variables; Exploratory Data Analysis (EDA); Summary statistics; Data visualization	8

techniques.	
Module 2: Statistical Analysis and Data Interpretation: Probability concepts and probability distributions; Random variables; Descriptive statistics; Measures of central tendency and dispersion; Skewness and kurtosis; Correlation and covariance analysis; Pearson, Spearman, and Kendall correlation coefficients; Sampling techniques; Hypothesis testing; p-value and confidence intervals; Type I and Type II errors; Z-test, t-test, Chi-square test; Analysis of Variance (ANOVA); Linear, multiple, and polynomial regression.	8
Module 3: Predictive Analytics: Dataset partitioning; Model training, validation, and testing; Decision Trees; Information Gain, Gini Index, and tree pruning; Random Forest; Bootstrap aggregation (Bagging); Out-of-Bag (OOB) estimation; Feature importance; k-Nearest Neighbour (k-NN); Distance measures including Euclidean, Manhattan, Minkowski, Cosine Similarity, and Mahalanobis distance; Naïve Bayes classifier; Support Vector Machines; Model evaluation using confusion matrix, cross-validation; Bias-variance trade-off; Overfitting and underfitting.	8
Module 4: Feature Engineering and Advanced Data Analytics: Feature Engineering and Data Representation, Feature Selection and Dimensionality Reduction, Feature Importance and Sensitivity Analysis, Cross Validation and Model Selection Techniques, Explainable Analytics: SHAP, LIME, and Model Interpretability, Comparative Analysis and Interpretation of Analytical Models	8
Module 5: Advanced Analytics: Time Series Analysis and Forecasting, Bayesian Data Analysis, Decision Analytics and Decision Support Systems, Uncertainty Quantification and Sensitivity Analysis, Explainable Data Analytics and Model Interpretability, Scalable Data Analytics and Distributed Computing Concepts, Ethical, Privacy and Fairness Issues in Data Analytics, Recent Advances and Research Trends in Data Analytics	8

Text Books: Data Analysis A Model Comparison Approach to Regression, ANOVA, and Beyond, 4th Edition, By Josh Correll, Abigail M. Folberg, Charles M. Judd, Gary H. McClelland, Carey S. Ryan, 2025.

Reference Books:

1. An Introduction to Statistical Learning with Applications in Python, Springer, 2023, by Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, and Jonathan Taylor.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	**% Distribution**
3 Quizzes (Best two Quizzes)	30
Assignment(s)	10
Seminar before a committee	10
Total	50

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	✓	✓	✓	✓	✓

Assessment Components	CO1	CO2	CO3	CO4	CO5
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Concept based Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Interactive Lectures, Flipped Classroom Activities
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Case Studies via Research Papers

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65- 100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	1	0	2
CO2	1	1	2
CO3	2	1	3
CO4	3	2	3
CO5	3	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD5, CD6, CD7
CO2	CD1, CD2, CD5, CD6, CD7
CO3	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO4	CD1, CD2, CD3, CD4, CD5, CD6
CO5	CD1, CD2, CD3, CD4, CD5, CD6

Course Code: AI26522

Course Title: Data Analysis and Interpretation Lab
Pre-requisite(s): Linear Algebra
Co-requisite(s): Data Analysis and Interpretation
Credits: 1.5 L: 0 T:0 P: 1.5
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Develop proficiency in using contemporary data analytics tools and programming environments for data acquisition, preprocessing, and visualization.
2.	Apply statistical and analytical techniques to explore, analyze, and interpret real-world datasets.
3.	Implement and evaluate predictive analytics models using classical machine learning algorithms and appropriate performance metrics.
4.	Perform feature engineering, feature selection, and dimensionality reduction to enhance the performance and interpretability of analytical models.
5.	Design and execute end-to-end data analytics workflows for solving engineering problems and communicating actionable insights through effective visualization and interpretation.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Apply data preprocessing and exploratory data analysis techniques to prepare datasets for analytics.
CO2	Perform statistical analysis and visualize datasets for extracting meaningful insights.
CO3	Develop predictive analytics models using classical machine learning algorithms and evaluate their performance.
CO4	Apply feature engineering and dimensionality reduction techniques to improve predictive models.
CO5	Design and implement end-to-end data analytics solutions and interpret analytical outcomes for decision support.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: i. Perform data acquisition and import datasets from multiple sources (CSV, Excel, SQL). ii. Perform data preprocessing including handling missing values, duplicate records, outlier detection, normalization, and standardization. iii. Perform Exploratory Data Analysis (EDA) using descriptive statistics and visualization techniques.	6

Module 2: i. Perform correlation analysis, covariance analysis, and hypothesis testing on real-world datasets. ii. Implement linear and multiple regression models and interpret the obtained results. iii. Perform Analysis of Variance (ANOVA) for comparing multiple groups.	6
Module 3: i. Implement Decision Tree and Random Forest algorithms for classification/regression and compare their performance. ii. Implement k-Nearest Neighbour (k-NN) and Support Vector Machine (SVM) classifiers and evaluate their performance. iii. Perform model evaluation using Confusion Matrix, Precision, Recall, F1-score, ROC Curve, and Cross Validation.	9
Module 4: i. Implement feature selection techniques using Information Gain, Chi-square, Mutual Information, and ReliefF. ii. Perform dimensionality reduction using Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA). iii. Compare predictive models before and after feature engineering and interpret the results.	9
Module 5: i. Perform time series analysis and forecasting on temporal datasets. ii. Develop an interactive dashboard for analytical visualization using Power BI/Tableau/Python. iii. Mini Project: End-to-end implementation of a data analytics pipeline involving preprocessing, statistical analysis, predictive modelling, visualization, and interpretation.	9

Text Books:

1. Python for Data Analysis, 3E, 2023 by Wes McKinney, O' Reilly

Reference Books:

1. An Introduction to Statistical Learning with Applications in Python, Springer, 2023, by Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, and Jonathan Taylor.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	% Distribution
Day-to-day progressive evaluation	30
Lab Quiz 1	10
Lab Viva	20
End Semester Examination	**% Distribution**
End Sem Performance	30

Continuous Internal Assessment	% Distribution
Lab Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Board / Slides
CD2	Tutorial / Assignments
CD3	Self-Learning through NPTEL / online materials
CD4	Coding demonstration in class
CD5	Mini projects
CD6	
CD7	

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	1	0	1
CO2	1	2	2
CO3	2	2	2
CO4	2	2	3
CO5	3	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4, CD5

Course Code: AI26523

Course Title: Evolutionary Computing
Pre-requisite(s): None
Co-requisite(s): None
Credits: 3 L: 3 T:0 P: 0
Class Schedule per Week: 3
Class: M. Tech.
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Understand the principles of evolutionary computing.
2.	Familiarize with the mathematical aspect of evolutionary computing.
3.	Analyze how evolutionary computing is used to solve problems.
4.	Develop an understanding of multi-objective evolutionary optimization models.
5.	Apply the use of evolutionary computing for various Optimization Problems

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Differentiate and understand various evolutionary computation techniques.
CO2	Grasp the fundamentals of genetic algorithms.
CO3	Apply advanced techniques for multi-objective optimization.
CO4	Explore different methods for multi-objective evolutionary optimization.
CO5	Develop Problem solving skills using evolutionary algorithms

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to Evolutionary Computation Generic Evolutionary Algorithm, Representation – The Chromosome, Initial Population, Fitness Function, Selection, Reproduction Operators, Stopping Conditions, Evolutionary Computation versus Classical Optimization.	8
Module 2: Genetic Algorithms Canonical Genetic Algorithm, Crossover, Mutation, Control Parameters, Genetic Algorithm Variants: Generation Gap Methods, Messy Genetic Algorithms, Interactive Evolution, Island Genetic Algorithms.	8
Module 3: Advanced Topics on Genetic Algorithms Niching Genetic Algorithms, Constraint Handling, Multi-Objective Optimization, Dynamic Environments, Applications, Coevolution: Competitive Fitness, Generic Competitive Coevolutionary Algorithm.	8
Module 4: Multi-objective Evolutionary Optimization Multi-objective Problems: Linear, Nonlinear, Convex, Nonconvex; Pareto optimality, Multi- objective Optimization, Methods: Weighted Sum Method, e-Constraint Method, Weighted Matrix Method, Benson's Method, Value Function Method.	8
Module 5: Handling Optimization Problems Introduction, Fuzzy Optimization Problems, Multi-objective Reliability Design Problem, Combinatorial Optimization Problem, Scheduling Problems, Transportation Problems.	8

Text Books:

1. A. P. Engelbrecht, Computational Intelligence, Wiley, USA, 2007.
2. Genetic Algorithms in Search, Optimuization and machine Learning, D. E. Goldberg, Addition -Wisley Companay Inc, 1989.
3. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, Wiley, USA,2001.

Reference Books:

1. S.N.Sivanandam & S.N.Deepa, Introduction to Genetic Algorithms, Springer Berlin Heidelberg New York, 2008.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	30
Assignment (s)	10
Seminar before a committee	10

Total	50

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	**Course Delivery Method**
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0**-** No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	**PO1**	**PO2**	**PO3**
CO1	3	0	3
CO2	2	0	2
CO3	2	1	2
CO4	3	0	2
CO5	0	1	1

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

Course Code: CS26523

Course Title: Computer Vision
Pre-requisite(s): Linear Algebra, Vector Calculus
Co-requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: CSE/ AIML

Course Objectives

This course enables the students to:

1.	Understand the fundamentals of image formation, acquisition, and visual representation.
2.	Apply computer vision techniques for image analysis and object recognition.
3.	Develop feature extraction and matching methods for visual understanding.
4.	Analyze motion, alignment, and scene reconstruction from images and videos.
5.	Explore depth estimation and 3D vision techniques for real-world applications.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Explain image formation, filtering, and transformation techniques used in computer vision.
CO2	Apply recognition and classification methods for visual content analysis.
CO3	Implement feature detection, matching, and contour-based image analysis techniques.
CO4	Develop solutions for image alignment, stitching, and motion estimation.
CO5	Construct 3D scene representations using depth estimation and correspondence analysis.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Introduction to Computer Vision Computer Vision What and why? Image Formation, Digital Camera, Linear and Non-Linear Filtering, Fourier and Geometric Transforms, Pyramid and Wavelets.	8
Module 2: Model Fitting and Recognition Scattered data interpolation, Variational methods and regularization, Instance Recognition, Image Classification, Object Detection, Semantic Segmentation, Video Understanding, Vision Language.	8

Module 3: Feature Detection and Matching Points and Patches, Edge and Contours, Contour Tracking, Lines and Vanishing point, Segmentation.	8
Module 4: Image alignment, Stitching and Motion Estimation Pairwise, Global and Translational alignment, Image Stitching, Compositing, Parametric, Optical, Layered Motion	8
Module 5: Depth Estimation and 3D Construction Epi polar Geometry, Sparse and Dense Correspondence, Deep networks, Monocular depth estimation, 3D scanning, Point, Surface, Volumetric Representations	8

Text Books:

1. Computer Vision: Algorithms and Applications by Richard Szeliski, Second Edition, Springer, 2021

Reference Books:

1. Deep Learning, by Goodfellow, Bengio, and Courville., 2018
2. Dictionary of Computer Vision and Image Processing, by Fisher et al., 2015
3. Computer Vision A Modern Approach David A forsyth etc. Pearson Education Second Indian Reprint 2015

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	30
Assignment(s)	10
Seminar before a committee	10
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Board / Slides
CD2	Tutorial / Assignments
CD3	Self-Learning through NPTEL / online materials
CD4	Coding demonstration in class
CD5	Mini projects

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0**-** No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	2
CO2	2	2	3
CO3	2	2	3
CO4	3	2	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD4
CO4	CD1, CD2, CD3, CD4, CD5
CO5	CD1, CD2, CD3, CD4, CD5

Course Code: AI26524

Course Title: Evolutionary Computing Lab
Pre-requisite(s):
Co-requisite(s):
Credits: 1.5 L: 0 T:0 P: 3
Class Schedule per Week: 4
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Understand the practicality of evolutionary computing.
2.	Familiarize with the implementation aspects of evolutionary computing.
3.	Implement evolutionary algorithms to solve some classical problems.
4.	Implement multi-objective evolutionary optimization models.
5.	Implement evolutionary computing for various Optimization Problems

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Differentiate and understand various evolutionary computation techniques.
CO2	Grasp the fundamental of genetic algorithm implementation
CO3	Implement advanced evolutionary algorithms for optimization.
CO4	Implement multi-objective evolutionary optimization models.
CO5	Develop Implementation using evolutionary algorithms.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module I: Programs to implement a Generic Evolutionary Algorithm (EA) and study its major components including chromosome representation, population initialization, fitness evaluation, selection, reproduction operators, and stopping conditions.	9
Module – II: Programs to implement the Canonical Genetic Algorithm, apply crossover and mutation operators, analyze the impact of control parameters on performance, implement various Genetic Algorithm variants**.**	9

Module – III: Programs to implement niching algorithm, constraint handling strategy, multi-objective optimization, adaptation to dynamic environments, and competitive coevolution.	6
Module – IV: Programs based on linear, nonlinear problems, convex, and nonconvex multi-objective problems, identify Pareto-optimal solutions, and apply different multi-objective optimization methods to solve decision-making and optimization problems.	6
Module – V: Programs based on Fuzzy Multi objective Optimization, Reliability Design Problem, Combinatorial Optimization Problem, Scheduling Problems, Transportation Problems	9

Text Books:

1. Eyal Wirsansky , Hands-On Genetic Algorithms With Python: Published by Packt Publishing Ltd. Livery Place 35 Livery Street Birmingham B3 2PB, UK. ISBN 978-1-83855-774-4. www.packt.com.

Reference Books:

1. S.N.Sivanandam & S.N.Deepa, Introduction to Genetic Algorithms, Springer Berlin Heidelberg New York, 2008.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	60%
Semester End Examination	40%

Continuous Internal Assessment	**% Distribution**
Day-to-day progressive evaluation	30
Lab Quiz 1	10
Lab Viva	20
End Semester Examination	**% Distribution**
End Sem Performance	30
Lab Quiz 2	10

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	**Course Delivery Method**
CD1	Lectures by use of boards/LCD projectors/OHP projectors

CD2	Assignments/Seminars
CD3	Laboratory experiments/teaching aids
CD4	Industrial/guest lectures
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0**-** No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	**PO1**	**PO2**	**PO3**
CO1	3	0	3
CO2	2	0	2
CO3	2	1	2
CO4	3	0	2
CO5	1	1	1

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	**Course Delivery Method**
CO1	CD1, CD6
CO2	CD1, CD6, CD7
CO3	CD1, CD2, CD3, CD6, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD7

Course Code: CS26524

Course Title: Computer Vision Lab
Pre-requisite(s): Python, Design and Analysis of Algorithms
Co-requisite(s): Computer Vision
Credits: 1.5 L: 0 T: 0 P: 3
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: CSE / AIML

Course Objectives

This course enables the students to:

1.	Provide hands-on experience with fundamental image processing operations and camera systems.
2.	Enable the development of intelligent visual recognition systems using modern deep learning models.
3.	Introduce feature-based approaches for object localization and scene understanding.
4.	Develop competency in motion analysis and image registration techniques.
5.	Familiarize learners with 3D scene understanding and advanced vision applications.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Implement image acquisition, preprocessing, enhancement, and transformation techniques for computer vision applications.
CO2	Analyze and apply feature extraction, matching, segmentation, and tracking techniques for visual scene understanding.
CO3	Develop visual recognition systems using machine learning, deep learning, and vision-language models for classification, detection, and image captioning tasks.
CO4	Evaluate and implement advanced computer vision techniques for motion analysis, depth estimation, face recognition, image restoration, and human pose estimation.
CO5	Design and develop a real-world computer vision application by integrating appropriate algorithms, tools, and performance evaluation methods.

SYLLABUS

MODULE	NO. OF LECTURE SESSIONS
Module 1: Introduction to Computer Vision Experiment: Image Acquisition and Camera Fundamentals Experiment: Image Filtering Experiment: Fourier Transform Analysis Experiment: Geometric Transformations Experiment: Image Pyramids	9

Module 2: Model Fitting and Recognition Experiment: Image Classification using Transfer Learning Experiment: Object Detection Experiment: Vision-Language Modelling Experiment: Image Caption Generation using Vision-Language Models	9
Module 3: Feature Detection and Matching Experiment: Feature matcher Experiment: Feature Tracker Experiment: Contour matching Experiment: Region segmentation	9
Module 4: Image alignment, Stitching and Motion Estimation Experiment: Feature-based image alignment for flip-book animations Experiment: Featured-based stitching Experiment: Optical Flow Estimation Experiment: Motion Tracking	6
Module 5: Depth Estimation and 3D Construction Experiment: Stereo Vision Experiment: Monocular Depth Estimation Experiment: Face Detection and Face Recognition Experiment: Image Inpainting and Object Removal Experiment: Human Pose Estimation	6

Text Books:

1. Computer Vision: Algorithms and Applications by Richard Szeliski , Second Edition, Springer, 2021

Reference Books:

1. Deep Learning, by Goodfellow, Bengio, and Courville., 2018
2. Dictionary of Computer Vision and Image Processing, by Fisher et al., 2015
3. Computer Vision A Modern Approach David A forsyth etc. Pearson Education Second Indian Reprint 2015

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	60
End Semester Examination	40

Continuous Internal Assessment	**% Distribution**
Day-to-day progressive evaluation	30
Lab Quiz 1	10
Lab Viva	20
End Semester Examination	**% Distribution**
End Sem Performance	30
Lab Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Board / Slides
CD2	Tutorial / Assignments
CD3	Self-Learning through NPTEL / online materials
CD4	Coding demonstration in class
CD5	Mini projects
CD6	
CD7	

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	3	2	2
CO2	3	2	2
CO3	3	3	2
CO4	3	3	2
CO5	3	3	2

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD4
CO2	CD1, CD2, CD3, CD4
CO3	CD1, CD2, CD4
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3, CD4, CD5

Course Code: AI26525

Course Title: Large Language Models
Pre-requisite(s): Machine Learning
Co-requisite(s):
Credits: 3 L: 3 T:0 P:0
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Understand the fundamental concepts of Natural Language Processing, Transformer architectures, and Large Language Models.
2.	Analyze the design principles, training methodologies, and optimization techniques employed in modern LLMs.
3.	Apply Transformer-based models to solve Natural Language Understanding and Generation tasks.
4.	Develop and deploy intelligent applications using prompt engineering, fine-tuning, Retrieval-Augmented Generation (RAG), and agentic AI frameworks.
5.	Evaluate the performance, reliability, ethical implications, and societal impact of Large Language Models for real-world applications.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Explain the architecture and working principles of Transformer-based language models.
CO2	Implement Transformer models for various Natural Language Understanding tasks.
CO3	Develop Transformer-based solutions for text generation and conversational AI applications.
CO4	Fine-tune and optimize large language models using modern frameworks and tools.
CO5	Design, evaluate, and deploy responsible LLM-based systems for real-world applications.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Foundations of LLMs: Sequential Neural Networks for Language Modeling (Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU), Introduction to Natural Language Processing, Evolution of NLP, Word Embeddings, Transformer Architecture, Self-Attention Mechanism, Encoder and Decoder Architectures.	8

Module 2: Transformer Models for Natural Language: Understanding Text Classification using Transformers, Transformer Variants (BERT, GPT, T5), Named Entity Recognition (NER), Token Classification, Sequence Classification, Fine-Tuning Pre-trained Models, Performance Evaluation and Benchmarking.	8
Module 3: Transformer Models for Natural Language Generation: Text Generation Techniques, Autoregressive Models, Beam Search, Sampling Strategies, Summarization, Translation, Tokenizers and Subword Techniques	8
Module 4: Building and Training Transformer Models Conversational AI, Practical Applications using GPT and T5 Models., Training Transformers from Scratch, Fine-Tuning Large Language Models, Parameter-Efficient Fine-Tuning (PEFT), Transfer Learning.	8
Module 5: Advanced LLMs, Deployment and Responsible AI: Retrieval-Augmented Generation (RAG), Embeddings and Semantic Search, Vector Databases, LLM Agents and Tool Usage, Model Compression and Quantization, Recent Advances in Foundation Models and Multimodal LLMs.	8

Text Books:

1. Jay Alammar and Maarten Grootendorst, *Hands-On Large Language Models*, O'Reilly Media, 2024.
2. Lewis Tunstall, Leandro von Werra, and Thomas Wolf, *Natural Language Processing with Transformers: Building Language Applications with Hugging Face*, O'Reilly Media, 2022.
3. Chris Fregly and Antje Barth, *Generative AI on AWS: Building Context-Aware Multimodal Reasoning Applications*, O'Reilly Media, 2024.

Reference Books:

1. Daniel Jurafsky and James H. Martin, *Speech and Language Processing*, 3rd Edition (Draft), Pearson Education.
2. Sebastian Raschka, *Build a Large Language Model (From Scratch)*, Manning Publications, 2024.
3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, *Deep Learning*, MIT Press, 2016.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	**% Distribution**
3 Quizzes (Best two Quizzes)	30
Assignment(s)	10
Seminar before a committee	10
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Interactive Classroom Lectures/ Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments/Seminars/ Case Studies/ Project-Based Learning
CD3	Laboratory experiments/ Hands-on Laboratory Sessions/ Generative AI Tool Demonstrations
CD4	Industry Applications based lecture/guest lecture/ Expert Talks
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Continuous Assessment and Practical Evaluation/ Theoretical understanding /Practical implementation/ Collaborative learning/ Real-world exposure.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	2
CO2	2	2	2
CO3	3	2	3
CO4	3	2	3
CO5	3	2	2

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD4, CD6, CD7
CO2	CD1, CD2, CD3, CD4, CD6, CD7
CO3	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO4	CD1, CD2, CD3, CD4, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD5, CD6, CD7

Course Code: AI26527

Course Title: Agentic AI Systems
Pre-requisite(s): Machine Learning / Modern Artificial Intelligence
Co-requisite(s):
Credits: 3 L: 3 T:0 P:0
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Understand the concept of Agentic AI and gain an understanding of the type of tasks that can be done in an Agentic AI System.
2.	Understand the idea of Generative AI from as it is used in the context of Agentic AI.
3.	Gain an understanding of the core components of Agentic AI including orchestration and planning.
4.	Understand the important of knowledge bases and how they can be used as part of an Agentic AI system to provide enhanced performance.
5.	Gain fundamental understanding of how to build an Agentic AI System.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Determine the type of problems that can utilize Agentic AI systems
CO2	Choose/Build the most appropriate LLM from an available collection to act as the main agent in Agentic AI
CO3	Build planning mechanisms for efficient orchestration in the Agentic AI system, build prompts that can aid in effectively solving a given problem
CO4	Build tools that can be used as peripheral components to provide additional functionality to the Agentic AI system
CO5	Build an Agentic AI framework with appropriate components for a given problem

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: **Introduction:** What is Agentic AI? What is an AI Agent? Agentic AI vs AI Agents, examples of Agentic AI (such as use in logistic management). **Introduction to Components:** The main LLM, Planner, Context Management, Guardrails, Tools, RAG, Prompts, example of component usage	8
Module 2: **Introduction to Generative AI:** What is Generative AI? examples of Generative	8

AI, transformers (architectures, single headed and multiheaded attention, self-attention, cross-attention, masked attention), language models, LLMs (with examples such as GPT), decoder only models, supervised fine tuning, introduction to reinforcement learning from human feedback (RLHF) for training LLMs, Multimodal LLMs, introduction to diffusion models, non-determinism in LLMs	
Module 3: **Knowledge Base:** Introduction to Retrieval Augmented Generation (RAG), knowledge representation (including vectorization), data chunking, chunk scoring, similarity-based retrieval (BM25, KNN, Approximate Nearest Neighbor), re-ranking	8
Module 4: **Planning:** ReAct (Reason + Act), chain of thought, tree of thought, hierarchical planning, self-reflection, re-planning **Context Management:** Why is context management needed? working memory (including active instructions), short-term memory, long-term memory **Tool Orchestration: Why** are tools needed? How are tools accessed? Model Context Protocol (MCP), examples of tools (such as google/ Microsoft suite, project management tools such as Asana, team management tools such as Slack) **Introduction to prompts:** System instructions, user instructions, embedding examples in a prompt. Example prompts for popular LLMs (claude, GPT)	8
Module 5: **Multi-Agent Systems:** Why multi-agent systems? Communication between agents in an Agentic AI system (orchestrator-worker, peer-to-peer) Agent-to-Agent protocol (A2A), agent as a tool available to main agent, example of a multi-agent setup in Agentic AI (such as travel planning) **Large scale Agentic AI frameworks:** Introduction to LangGraph, Microsoft AutoGen, Amazon Quick Suite, smolagents	8

Text Books:

1. "The Agentic AI Handbook: Concepts, Design Patterns, and Future Directions" by Kaushik Brar.

Reference Books:

1. "LLM Engineer's Handbook: Master the art of engineering large language models from concept to production" by Paul Iusztin and Maxime Labonne.
2. "A practical guide to building agents" by OpenAI
3. "Build a Large Language Model (From Scratch" by Sebastian Raschka
4. Chapter 11 of "Speech and Language Processing" by Daniel Jurafsky and James Martin
5. https://platform.claude.com/docs/en/build-with-claude/prompt-engineering/overview
6. https://developers.openai.com/api/docs/guides/prompt-engineering
7. "An Introduction to Multi Agent Systems, 2nd Edition" by Michael Wooldridge
8. https://a2a-protocol.org/latest/announcing-1.0/

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	**% Distribution**
3 Quizzes (Best two Quizzes)	20

Continuous Internal Assessment	% Distribution
Assignment(s)	10
Seminar before a committee	20
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching Aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	3
CO2	2	2	3
CO3	3	2	3
CO4	2	2	3
CO5	3	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD4, CD6
CO3	CD1, CD2, CD3, CD4, CD6
CO4	CD1, CD2, CD3, CD4, CD6
CO5	CD1, CD2, CD3, CD4, CD6, CD7

Course Code: AI26529

Course Title: Concepts of Reinforcement Learning
Pre-requisite(s): Programming in Python, Engg Maths
Co-requisite(s): Probability and Statistics, Research Methodology
Credits: 3 L: 3 T:0 P: 0
Class Schedule per Week:3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Develop a strong foundation in the mathematical and conceptual principles of Reinforcement Learning, including Markov Decision Processes (MDPs), reward structures, value functions, and optimal policies.
2.	Understand and analyze various reinforcement learning algorithms such as Multi-Armed Bandits, Dynamic Programming, Monte Carlo Methods, and Temporal Difference Learning for sequential decision-making problems
3.	Apply value-based and policy-based learning techniques, including Q-Learning, Policy Gradient Methods, Actor-Critic Models, and Deep Q-Networks (DQN), to solve complex AI and machine learning problems.
4.	Design intelligent agents using function approximation, hierarchical reinforcement learning, and advanced reinforcement learning frameworks for real-world applications such as robotics, autonomous systems, and adaptive decision-making
5.	Evaluate and develop reinforcement learning solutions for partially observable and uncertain environments while exploring current research directions and emerging applications in Artificial Intelligence

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Explain the fundamental concepts of Reinforcement Learning, including agents, environments, rewards, Markov Decision Processes (MDPs), and value functions.
CO2	Apply reinforcement learning techniques such as Multi-Armed Bandits, Dynamic Programming, Monte Carlo Methods, and Temporal Difference Learning to solve sequential decision-making problems.
CO3	Analyze the performance of value-based and policy-based reinforcement learning algorithms and determine their suitability for different learning environments.
CO4	Evaluate advanced reinforcement learning approaches, including Deep Reinforcement Learning, Function Approximation, and Actor-Critic methods for complex real-world applications.
CO5	Design and develop intelligent agents using reinforcement learning frameworks to solve real-world problems in robotics, autonomous systems, gaming, and AI-driven decision-making.(L6)

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Foundations of Reinforcement Learning and Bandit Algorithms: Introduction to Reinforcement Learning (RL), RL Framework: Agent, Environment, State, Action, Reward, Applications of RL in AI and Machine Learning, Exploration vs Exploitation, Multi-Armed Bandit Problems, Value Function-Based Methods, Upper Confidence Bound (UCB) Algorithms, PAC Learning , Median Elimination, Thompson Sampling, Contextual Bandits	8
Module 2: Markov Decision Processes and Dynamic Programming: Introduction to Full Reinforcement Learning, Returns and Value Functions, Markov Decision Processes (MDPs), MDP Modeling, Bellman Equation, Bellman Optimality Equation, Convergence Properties, Value Iteration, Policy Iteration, Generalized Policy Iteration, Dynamic Programming Techniques	8
Module 3: Monte Carlo and Temporal Difference Learning: Monte Carlo Prediction and Control, On-Policy and Off-Policy Learning, Importance Sampling, Temporal Difference Learning, TD (0) Prediction, SARSA, Q-Learning, Afterstates, Eligibility Traces, TD (λ), SARSA (λ), Replacing and Accumulating Traces	8
Module 4: Function Approximation and Deep Reinforcement Learning: Need for Function Approximation, Linear Function Approximation, State Aggregation Methods, Least Squares Temporal Difference (LSTD), Least Squares Policy Iteration (LSPI), Fitted Q Iteration, Deep Q Networks (DQN), Policy Gradient Methods, REINFORCE Algorithm, Actor-Critic Architectures, Deep Reinforcement Learning Frameworks	8
Module 5: Advanced Reinforcement Learning and Applications: Hierarchical Reinforcement Learning, Semi-Markov Decision Processes, Options Framework, MAXQ Framework, Hierarchical Abstract Machines (HAM), Option Discovery, Partially Observable Markov Decision Processes (POMDPs), Solving POMDPs, RL in Robotics, Autonomous Systems, Game Playing Agents, Recent Trends in Reinforcement Learning	8

Text Books:

1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, 2018..

2 Dimitri P. Bertsekas, *Reinforcement Learning and Optimal Control*, Athena Scientific, 2019

Reference Books

1. Csaba Szepesvári, *Algorithms for Reinforcement Learning*, Morgan & Claypool Publishers, 2010.

2. Marco Wiering and Martijn van Otterlo (Eds.), *Reinforcement Learning: State-of-the-Art*, Springer, 2012.

3. Aske Plaat, *Deep Reinforcement Learning*, Springer, 2022.

4. Shangtong Zhang and Richard S. Sutton, *Reinforcement Learning: An Introduction (Solutions and Programming Companion)*, MIT Press Resources.

5 Maxim Lapan, *Deep Reinforcement Learning Hands-On*, 3rd Edition, Packt Publishing, 2024.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	30
Assignment(s)	10
Seminar before a committee	10
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	**Interactive Classroom Lectures** – Delivery of core RL concepts such as MDPs, Bellman Equations, Monte Carlo Methods, and Temporal Difference Learning through instructor-led discussions
CD2	**NPTEL Video-Based Learning** – Integration of IIT Madras NPTEL Reinforcement Learning lectures for self-paced and blended learning.
CD3	**Flipped Classroom Sessions** – Students study RL concepts through videos and reading materials before class, while classroom time is used for problem-solving and discussions.
CD4	**Hands-on Laboratory Exercises** – Implementation of RL algorithms using Python, OpenAI Gym, TensorFlow, and PyTorch.
CD5	**Case Study and Research Paper Analysis** – Evaluation of RL applications in robotics, autonomous systems, gaming, recommendation systems, and finance.
CD6	**Project-Based Learning (PBL)** – Design and development of intelligent agents using reinforcement learning techniques to solve real-world problems
CD7	**Seminars, Technical Presentations, and Group Discussions** – Student-led presentations on advanced topics such as Deep RL, Actor-Critic Methods, Hierarchical RL, Multi-Agent RL, and current research trends.

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	2
CO2	2	2	3
CO3	2	2	3
CO4	3	2	3
CO5	3	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3
CO2	CD3, CD4
CO3	CD5, CD6
CO4	CD7
CO5	CD6, CD7

Course Code: CS26531

Course Title: Quantum Computing
Pre-requisite(s): Probability and Statistics, Machine Learning
Co-requisite(s): Discrete Mathematics
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Be familiar with the fundamental principles of quantum mechanics and mathematical foundations that form the basis of quantum computation.
2.	Understand the presentation and manipulation of quantum information through qubits, quantum gates, multi-qubit systems, and quantum circuits.
3.	Design quantum algorithms for solving complex problems.
4.	Develop practical skills in quantum programming, simulation, and implementation of quantum circuits.
5.	Explore emerging applications of quantum computing while understanding current challenges and future research directions.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Understand the fundamental principles of quantum mechanics relevant to quantum computing.
CO2	Explain the concepts of qubits, quantum gates, and quantum circuits.
CO3	Analyze and implement basic quantum algorithms.
CO4	Apply quantum computing frameworks such as Qiskit or Cirq for simple quantum programs.
CO5	Identify emerging applications of quantum computing in optimization, machine learning, and cryptography.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Fundamentals of Quantum Mechanics for Computing: Introduction to Quantum computing, Classical vs quantum computation, Mathematical foundations: vectors, matrices, complex numbers, Linear algebra concepts for quantum systems, Pauli matrices, Hilbert space, Postulates of quantum mechanics, Representation of quantum states, Dirac notation, Measurement postulate, Superposition principle	8
Module 2: Qubits and Quantum Gates: Qubit representation, Bloch sphere representation, Multi-qubit systems, Tensor product and composite systems, Quantum gates: Pauli gates (X, Y, Z), Hadamard gate, Phase gate, T gate, Multi-qubit gates: Controlled-NOT	8

(CNOT), SWAP gate, Universal quantum gates, Quantum circuit representation	
Module 3: Quantum Algorithms: Introduction to quantum algorithms, Quantum parallelism, Deutsch and Deutsch–Jozsa algorithms, Grover's search algorithm, Quantum Fourier Transform, Shor's factoring algorithm (overview), Quantum Phase Estimation, Variational Quantum Eigensolver (VQE), Quantum Approximate Optimization Algorithm (QAOA)	8
Module 4: Quantum Programming and Simulation: Introduction to quantum programming platforms, Quantum circuit design using Qiskit/ Cirq, Quantum simulators, Execution on cloud quantum computers, Implementation of basic quantum algorithms, Noise in quantum systems, NISQ (Noisy Intermediate Scale Quantum) devices	8
Module 5: Quantum Computing and Security: Quantum cryptography and quantum key distribution, Quantum communication and teleportation, Quantum machine learning concept, Optimization problems using quantum computing, Emerging quantum technologies and future directions.	8

Text Books:

1. Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press.
2. Eleanor Rieffel and Wolfgang Polak, Quantum Computing: A Gentle Introduction, MIT Press.

Reference Books:

1. Phillip Kaye, Raymond Laflamme, and Michele Mosca, An Introduction to Quantum Computing, Oxford University Press.
2. Chris Bernhardt, Quantum Computing for Everyone, MIT Press.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	**% Distribution**
3 Quizzes (Best two Quizzes)	20
Assignment(s)	10
Seminar before a committee	20
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching Aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	3
CO2	2	2	3
CO3	3	2	3
CO4	2	2	3
CO5	3	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD4, CD6
CO3	CD1, CD2, CD3, CD4, CD6
CO4	CD1, CD2, CD3, CD4, CD6
CO5	CD1, CD2, CD3, CD4, CD6, CD7

Course Code: AI26531

Course Title: Network Analysis
Pre-requisite(s):
Co-requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Understand the fundamental concepts, mathematical foundations, and topological properties of complex networks and graph theory.
2.	Analyze the structural characteristics of regular, random, small-world, and scale-free networks using quantitative measures.
3.	Apply network science principles and computational techniques to model and investigate real-world systems.
4.	Develop the ability to evaluate and compare different network models for solving practical problems.
5.	Foster analytical thinking and encourage the use of modern computational tools for network analysis and lifelong learning.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Explain the fundamental concepts of network science, graph theory, and various graph representations.
CO2	Analyze the structural characteristics and performance measures of regular and random networks.
CO3	Evaluate the properties, evolution, and applications of small-world and scale-free network models.
CO4	Apply appropriate computational techniques and modern tools to model and analyze complex networks.
CO5	Compare different network models and recommend suitable approaches for analyzing real-world complex systems.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: What is network science? General Principles. Set theoretic definition of a graph. Matrix algebra definition of a graph. The Konigsberg Graph. Spectral properties of graphs. Types of graphs. Topological structures.	6

Module 2: Defining regular networks, Network Characteristics - Diameter, Centrality, and Average Path Length, Binary Tree Network, Toroidal Network, Hypercube Networks,	6
Module 3: Generation of Random Networks, Degree Distribution of Random Networks, Entropy of Random Networks, Properties of Random Networks, Weak Ties in Random Networks, Randomization of Regular Networks, Analysis.	10
Module 4: Generating a Small-World Network, Properties of Small-World Networks, Phase Transition, Navigating Small Worlds, Weak Ties in Small-World Networks, Analysis.	8
Module 5: Generating a Scale-Free Network, Properties of Scale-Free Networks, Navigation in Scale-Free Networks, Analysis	10

Text Books:

1. Lewis, T. G., Network Science: Theory & Practice, 1st Edition, John Wiley & Sons. Inc. Publications, 2009

Reference Books:

1. Newman M., Networks: An Introduction, 1st Edition, Oxford University Press, 2010

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	**% Distribution**
3 Quizzes (Best two Quizzes)	20
Assignment(s)	10
Seminar before a committee	20
Total	50

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment					
Semester End Examination					

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	**Course Delivery Method**
CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments

Code	Course Delivery Method
CD3	Seminars/ Quiz (s)
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Online Materials
CD7	Video Lectures for Self-Studies

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0**-** No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	2
CO2	2	1	3
CO3	3	2	3
CO4	3	2	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6, CD7
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD3, CD6, CD7
CO4	CD2, CD4, CD5, CD6
CO5	CD2, CD3, CD4, CD6, CD7

Course Code: AI26533

Course Title: Mining Massive Datasets
Pre-requisite(s): Data Mining
Co-requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Understand the Map Reduce Paradigm
2.	Develop an understanding of similarity in the context of large datasets.
3.	Understand the complexities of mining streaming data
4.	Understand the page rank algorithm and its variants
5.	Understand the working of a recommendation system

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Analyse the working of Map Reduce and its variants.
CO2	Compute similarity between objects in extremely large datasets.
CO3	Mine data flowing in streams.
CO4	Calculate the trust of websites using Page Rank.
CO5	Perform content and collaborative item recommendations.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Distributed File Systems, Map Reduce, Algorithms Using Map Reduce, Extensions to Map Reduce, The Communication-Cost Model	8
Module 2: Applications of Set Similarity, Shingling of Documents, Similarity-Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Distance Measures, LSH Families for Other Distance Measures, Applications of Locality-Sensitive Hashing, Methods for High Degrees of Similarity	8
Module 3: The Stream Data Model, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Estimating Moments, Counting Ones in a Window, Decaying Windows	8
Module 4: Page Rank, Efficient Computation of Page Rank, Topic-Sensitive Page Rank, Link Spam, Hubs and Authorities	8
Module 5: A Model for Recommendation Systems, Content-Based Recommendations, Collaborative Filtering, Dimensionality Reduction, The Netflix Challenge	8

Text Books:

1. Leskovec J., Rajaraman A., Ullman J. D., Mining of Massive Datasets, Cambridge University Press, 2020.

Reference Books:

1. Mohammed J. Zaki, Wagner Meira Jr. Data Mining and Machine Learning: fundamental Concepts and Algorithms, 2nd Edition, 2020, Cambridge University Press.
2. Jiawei Han, and Micheline Kamber, Data Mining Concepts & Techniques, 3rd Edition, Publisher Elsevier India Private Limited, 2015.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	20
Assignment(s)	10
Seminar before a committee	20
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
Semester End Examination	√	√	√	√	√

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors
CD2	Tutorials/Assignments
CD3	Seminars/ Quiz (s)
CD4	Mini projects/Projects
CD5	Laboratory experiments/teaching aids
CD6	Online Materials
CD7	Video Lectures for Self-Studies

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	2
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6, CD7
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD3, CD4, CD6
CO4	CD1, CD2, CD4, CD6
CO5	CD1, CD2, CD3, CD4, CD6, CD7

Course Code: AI26535

Course Title: Time Series Analysis
Pre-requisite(s): Probability and Statistics, Machine Learning
Co-requisite(s): Linear Algebra
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3 Hours
Class: MTech
Semester / Level: Second/Fifth
Branch: CSE / AIML

Course Objectives

This course enables the students to:

1.	Understand the theoretical foundations of time series data and stochastic processes.
2.	Analyze temporal data using statistical and visualization techniques.
3.	Develop forecasting models using classical time series methods.
4.	Apply machine learning and deep learning approaches for time series prediction.
5.	Design and evaluate forecasting systems for real-world applications.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Explain the characteristics, components and statistical properties of time series data.
CO2	Analyze and preprocess series data using appropriate transformation and stationarity techniques.
CO3	Develop forecasting models using classical statistical approaches such as ARIMA and exponential smoothing.
CO4	Apply machine learning and deep learning methods for time series forecasting.
CO5	Evaluate and design forecasting solutions for real-world temporal prediction problems.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Fundamentals of Time Series Analysis- Introduction to temporal data, Components of time series- Trend, Seasonality, Cyclic variations, Irregular variations, Time series visualization, Autocorrelation Function (ACF), Partial Autocorrelation Function (PACF), Stationarity and non-stationarity.	8
Module 2: Classical Forecasting Models- Moving Average Models, Exponential Smoothing Techniques-Holt's Linear Trend Method, Holt-Winters Method, Autoregressive (AR) Models, Moving Average (MA) Models, ARMA Models, Integrated Forecasting Models- ARIMA Models, Seasonal ARIMA	9

(SARIMA), Model selection and diagnostics -Residual analysis, Forecast Accuracy Measures (MAE, RMSE, MAPE).	
Module 3: Multivariate Time Series Analysis- Introduction to Multivariate Time Series, Vector Autoregression (VAR), Granger Causality, Cointegration (Concepts and Applications), Multivariate Forecasting, State Space Models, Kalman Filtering, Case Studies in Multivariate Forecasting.	8
Module 4: Machine Learning and Deep Learning for Time Series- Feature engineering for time series- Lag Features, Rolling Window Statistics, Sliding window techniques. Machine Learning Based Forecasting- Regression-based forecasting, Random Forest, Gradient Boosting, Prophet forecasting. Deep Learning Based Forecasting- Recurrent Neural Networks (RNN), Long Short-Term Memory Networks (LSTM), Gated Recurrent Units (GRU), Transformer-based forecasting. Model Evaluation and Comparison of Statistical, Machine Learning and Deep Learning Forecasting Methods.	9
Module 5: Applications and Case Studies- Financial forecasting, Energy demand prediction, Traffic forecasting, Predictive maintenance, Healthcare analytics, Ethics and reliability in forecasting systems, Case Studies and Project Discussion	6

Text Books:

1. Robert H. Shumway and David S. Stoffer, *Time Series Analysis and Its Applications*, Springer.
2. Douglas C. Montgomery, Cheryl Jennings and Murat Kulahci, *Introduction to Time Series Analysis and Forecasting*, Wiley.
3. Rob J. Hyndman and George Athanasopoulos, *Forecasting: Principles and Practice*.

Reference Books:

1. Brockwell, P.J. and Davis, R.A., *Introduction to Time Series and Forecasting*, Springer.
2. Tsay, R.S., *Analysis of Financial Time Series*, Wiley.
3. Goodfellow, Bengio and Courville, *Deep Learning*, MIT Press.
4. Géron, A., *Hands-On Machine Learning with Scikit-Learn, Keras and TensorFlow*, O'Reilly.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	20
Assignment(s)	10
Seminar before a committee	20
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching Aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	3
CO2	2	2	3
CO3	3	2	3
CO4	2	2	3
CO5	3	2	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD4, CD6
CO3	CD1, CD2, CD3, CD4, CD6
CO4	CD1, CD2, CD3, CD4, CD6
CO5	CD1, CD2, CD3, CD4, CD6, CD7

Course Code: AI26537

Course Title: Outlier Analysis
Pre-requisite(s):
Co- requisite(s): -
Credits: 3 L: 0 T: 0 P: 3
Class schedule per week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course envisions to impart to students to:

1.	Familiarize with the concepts of outlier analysis.
2.	Understand the Probabilistic models for outlier detection.
3.	Understand the working of proximity-based methods for outlier detection.
4.	Understand the Supervised techniques for outlier detection.
5.	Learn how outlier detection can be applied for spatial data, graphs and networks.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Develop an understanding of the concepts of outlier analysis.
CO2	Apply Probabilistic models for outlier detection.
CO3	Develop an understanding of the proximity-based methods for outlier detection.
CO4	Demonstrate an understanding of the Supervised techniques for outlier detection.
CO5	Design and implement various outlier detection methods for spatial data, graphs and networks.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module I– Preliminaries What Are Outliers? Types of Outliers, Challenges of Outlier Detection, Overview of Outlier Detection Methods, Basic Data types for analysis	**4**
Module II- Probabilistic Models for Outlier Detection Statistical Methods for Extreme-Value Analysis, Statistical-Tail confidence tests, t-value Test, Sum of Squares of Deviations, Visualizing Extreme values with Box Plots, Probabilistic Mixture Modeling for Outlier Analysis, Limitations of Probabilistic Modeling.	**10**
Module – III Proximity- Based Outlier Detection Clusters and Outliers, Distance-Based Outlier Analysis, Density-Based Outlier Detection, Limitations of Proximity-Based outlier detection.	**10**
Module – IV Supervised Outlier Detection Full supervision: Rare class detection, Semi-supervision-based detection, Unsupervised Feature Engineering in Supervised methods, Active Learning, Supervised Models for Unsupervised Outlier Detection.	**10**
Module – V Outlier detection for Spatial data, Graphs and Networks Neighborhood based algorithms for spatial outlier detection, Outlier detection in small and large graphs, Node content in outlier analysis, Change-based outliers in temporal graphs, Applications of outlier analysis.	**6**

Text book:

1. Charu C. Aggrawal “Outlier Analysis”, Springer, 2nd Edition

Reference Book:

1. Han J., Kamber M., Pei J., “Data Mining: Concepts and Techniques”, Morgan Kaufman, 3rd Edition, 2012

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	30
Assignment(s)	10
Seminar before a committee	10
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lectures by use of boards/LCD projectors/OHP projectors
CD2	Concept based Assignments
CD3	Laboratory experiments/Teaching aids/Seminars
CD4	Mini projects
CD5	Interactive Lectures, Flipped Classroom Activities
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Case Studies via Research Papers

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	2
CO2	2	2	3
CO3	2	2	3
CO4	3	2	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD5, CD6, CD7
CO2	CD1, CD2, CD5, CD6, CD7
CO3	CD1, CD2, CD3, CD4, CD5, CD6, CD7
CO4	CD1, CD2, CD3, CD4, CD5, CD6
CO5	CD1, CD2, CD3, CD4, CD5, CD6

Course Code: AI26539

Course Title: Generative AI
Pre-requisite(s): Probability and Statistics, Linear Algebra, Machine Learning, Python Programming
Co-requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: CSE / AIML

Course Objectives

This course enables the students to:

1.	Understand the evolution and foundations of generative AI models.
2.	Explore generative techniques for text, image, audio, video, and multimodal content generation.
3.	Study modern generative architectures including GANs, VAEs, Diffusion Models, and Foundation Models.
4.	Analyze synthetic media generation, deepfakes, and associated detection methodologies.
5.	Understand fairness, robustness, safety, and responsible deployment of generative AI systems.

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Recall the fundamental concepts and evolution of generative AI models.
CO2	Explain the working principles of generative AI systems across different modalities.
CO3	Apply generative AI concepts to analyze synthetic content generation processes.
CO4	Analyze deepfake generation, detection, and evaluation techniques.
CO5	Evaluate generative AI systems with respect to fairness, robustness, trustworthiness, and societal impact.

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: Foundations and Evolution of Generative AI- Introduction to Generative AI, History and evolution of generative models, Explicit and implicit generative models, Probabilistic foundations, Autoregressive models, Variational Autoencoders (VAEs), Generative Adversarial Networks (GANs).	8
Module 2: Diffusion Models and Modern Generative Architectures- Diffusion process, Denoising Diffusion Probabilistic Models (DDPM), Latent Diffusion,	8

Models, Text-to-image generation, Foundation Models, Open-source and proprietary generative systems.	
Module 3: Generative AI Across Modalities- Text generation and Large Language Models, Image generation, Audio synthesis and voice cloning, Video generation, Vision-language and multimodal models, Prompt engineering fundamentals.	8
Module 4: Deepfakes and Synthetic Media- Image deepfakes, Video deepfakes, Audio deepfakes, Face swapping and reenactment, Applications and misuse of synthetic media, Deepfake detection techniques, Benchmark datasets and evaluation metrics.	8
Module 5: Trustworthy Generative AI- Bias and fairness in generative systems, Explainability and interpretability, Robustness and AI safety, Watermarking and content provenance, Responsible AI and governance, Ethical and societal implications of Generative AI.	8

Text Books:

1. Goodfellow, Bengio and Courville, *Deep Learning*, MIT Press.
2. Kevin P. Murphy, *Probabilistic Machine Learning: An Introduction*, MIT Press.

Reference Books:

1. David Foster, *Generative Deep Learning*, O'Reilly.
2. Selected research papers from NeurIPS, ICML, ICLR, CVPR, ICCV and ACM Computing Surveys.
3. Recent surveys on Generative AI, Diffusion Models, Large Language Models and Deepfake Detection.

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	**% Contribution during CO Assessment**
Continuous Internal Assessment	50
Semester End Examination	50

Continuous Internal Assessment	**% Distribution**
3 Quizzes (Best two Quizzes)	30
Assignment (s)	10
Seminar before a committee	10
Total	50

Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

<u>Indirect Assessment</u>

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Classroom Lectures
CD2	Research Paper Discussions
CD3	Case Studies
CD4	Hands-on Demonstrations
CD5	Seminar Presentations
CD6	Project-Based Learning
CD7	Independent Literature Survey

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)**

CO	PO1	PO2	PO3
CO1	2	1	2
CO2	2	2	3
CO3	2	2	3
CO4	3	2	2
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2, CD4
CO3	CD3, CD4, CD6
CO4	CD2, CD3, CD4, CD6
CO5	CD2, CD3, CD5, CD7

Course Code: AI26541

Course Title: Multimedia Databases
Pre-requisite(s):
Co-requisite(s):
Credits: 3 L: 3 T: 0 P: 0
Class Schedule per Week: 3
Class: MTech
Semester / Level: Second/Fifth
Branch: AIML

Course Objectives

This course enables the students to:

1.	Understand the concept of multimedia and common modalities present in it
2.	Gain an understanding of the different common types of data that are used with multimedia databases
3.	Understand the architectural requirements for multimedia databases
4.	Understand the indexing and retrieval needs for a multimedia database.
5.	Gain a fundamental understanding of how to build multimedia databases

Course Outcomes (COs)

After the completion of this course, students will be able to:

CO1	Determine the scenarios where a multimedia database is needed
CO2	Design the architecture of a multimedia database
CO3	Build feature extraction and indexing mechanisms for text, images and videos
CO4	Desing and utilize data structures and search techniques to store and retrieve multimedia
CO5	Design distributed multimedia databases while taking into account the different performance requirements

SYLLABUS

MODULE	NO. OF LECTURE HOURS
Module 1: **Introduction:** What is a multimedia database? Why is multimedia databases needed, multimedia vs traditional (non-multimedia) databases, introduction to DBMS and relational databases, introduction to SQL, introduction to concepts of indexing, retrieval, content representation and vectorization **Types of data:** Introduction to Text (plain, structured), introduction to text compression (Huffman, Run-Length and Lempel-Ziv-Welch coding), Audio (sampling, representation, quantization, quantization, coding), Images (color, grayscale, compression, quantization, subsampling, jpeg), Video (representation,	8

compression, mpeg4/7) **Management Requirements:** Introduction to storage needs, information structure, temporal and spatial relationships between data	
Module 2: **Multimedia Database Design**: MIRS Architecture, Data Model (object layer, media type layer, media format layer), example data model (VYMSYS, video model), feature extraction, similarity measures, QoS guarantee, **Text Indexing and Retrieval:** Text features (bag of words, introduction to NLP feature extractors, BERT), Boolean retrieval, Vector Space retrieval, Probabilistic retrieval, Cluster-Based retrieval, **performance** measurement, introduction to internet search engines.	8
Module 3: **Audio Indexing and Retrieval:** Time domain features, Frequency domain features (sound spectrum, bandwidth, energy distribution, harmonicity, pitch), modern models (introduction to VGGish, Wave2Vec 2.0, WavLM, Speech2Vec), structured music, sound effects, music retrieval, brief introduction to Automatic Speech Recognition (ASR). **Image/Video Indexing and Retrieval :** Text based image retrieval, color based image retrieval (similarity, color distribution, spatial relationship between pixels), shape based retrieval, texture based retrieval, video shot detection and segmentation, indexing and retrieval in video (video frames, motion in the video, objects , metadata, annotation), modern video feature extractors (I3D and R(2+1)D models, SlowFastNetwork, TimeSformer, Video Swin Transformer), concept of storyboard.	8
Module 4: **Integrated Multimedia Indexing and Retrieval:** General architecture for multimedia database management, merging results from indexing individual type of data, joint indexing, joint featurization – CLIP, DALL-E, Gen2 (vision-language), AV-CDiT (audio-visual), VATT (audio-visual-text), ImageBind (combine visuals, audio, text, depth, thermal, inertial measurement) **Data Structures and Search Techniques:** B trees, B^+ trees, multi-dimensional B^+ trees, search (point query, range query, k-nn query), k-d tree, R-tree, clustering, sub-pattern matching, fastmap.	8
Module 5: **Distributed Multimedia Databases:** QoS guarantee and support, storage (capacity, transfer bandwidth, RAID), networking (speed, bandwidth, resource sharing, scalability), Real Time Transfer protocol (RTP), multimedia synchronization **Measuring Performance:** Recall and precision pair (RPP), percentage of weighted hits (PWH), percentage of similarity rankings (PSR), modified RPP, retrieval effectiveness **Example applications:** video-on-demand, search engines, e-learning, introduction to Oracle Multimedia, introduction to Microsoft SQL server, introduction to Binary Large Object (BLOB)	8

Text Books:

1. "Multimedia Database Management Systems" by Guojun Lu.

Reference Books:

1. "Searching Multimedia Databases by Content" by Christos Faloutsos.
2. "Multimedia Database Management Systems" by Prabhakaran Balakrishnan.

3. “Fundamentals of Database Systems”, Seventh Edition by Rames Elmasiri and Shamkant Navathe

COURSE OUTCOME (CO) ATTAINMENT ASSESSMENT TOOLS & EVALUATION PROCEDURE

Direct Assessment

Assessment Tool	% Contribution during CO Assessment
Continuous Internal Assessment	50
End Semester Examination	50

Continuous Internal Assessment	% Distribution
3 Quizzes (Best two Quizzes)	20
Assignment(s)	10
Seminar before a committee	20
Total	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	✓	✓	✓	✓	✓
Semester End Examination	✓	✓	✓	✓	✓

Indirect Assessment

- Student Feedback on Course Outcome

Course Delivery Methods

Code	Course Delivery Method
CD1	Lecture by use of boards/LCD projectors/OHP projectors
CD2	Assignments
CD3	Laboratory experiments/Teaching Aids/Seminars
CD4	Mini projects
CD5	Industrial visits/in-plant training
CD6	Self- learning such as use of NPTEL materials and internets
CD7	Simulation

Mapping of Course Outcomes onto Program Outcomes and Program Specific Outcomes

Grading: 0- No Correlation **(0)**, 0-44.99- Low Correlation **(1)**, 45-64.99 Medium Correlation **(2)**, 65-100 High Correlation **(3)s**

CO	PO1	PO2	PO3
CO1	3	3	3
CO2	3	3	3
CO3	3	3	3

CO	PO1	PO2	PO3
CO4	3	3	3
CO5	3	3	3

Mapping Between Course Outcomes and Course Delivery Method

Course Outcomes	Course Delivery Method
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CO4	CD1, CD2, CD3, CD4, CD6, CD7
CO5	CD1, CD2, CD3, CD4, CD6, CD7