MANIPAL UNIVERSITY
JAIPUR
(University under Section 2(f) of the UGC Act)

MANIPAL UNIVERSITY JAIPUR

Department Artificial Intelligence and Machine Learning
Course Hand-out

A. Basic Details:

Programme Name:	BTech CSE(AI&ML)
Course Name:	Machine Learning
Course Code:	AIM3101
LTPC *(Lecture Tutorial Practical Credits):*	3 1 0 4
Session:	Aug-Nov 2025
Class:	V
Course Coordinator:	Dr. Anamika Dhillon
Course Instructor(s):	Dr Surendra Solanki / Dr. Anamika Dhillon / Dr. Yadvendra Pratap Singh / Dr. Lalit Kumar / Mr. Harish Sharma / Dr. Pranshu Pranjal

B. Introduction This course on Machine Learning provides a comprehensive overview of foundational concepts and techniques in the field. It covers the basics of labeled and unlabeled data, types of learning paradigms (supervised, unsupervised, parametric, and non-parametric models), and essential learning theory, including the bias-variance trade-off and model selection. Students will explore supervised learning methods for regression and classification, delve into ensemble techniques like bagging and boosting, and gain insights into unsupervised learning approaches for clustering and dimensionality reduction. The course also emphasizes performance evaluation metrics to build effective and robust machine learning models.

C. Course Outcomes:

CO Statement	*CO*	*Level*	*Target Attainment %*	*Target Attainment level*
Explain the fundamental concepts of machine learning, including labelled and unlabelled data, types of machine learning, supervised vs. unsupervised learning, parametric vs. non-parametric models, and learning theory.	AIM3101.1	Cognitive: Understand	≥ 80	Level 3
Apply regression techniques such as linear regression, gradient descent, ridge regression, lasso regression, and logistic regression to solve supervised learning problems.	AIM3101.2	Cognitive: Apply	≥ 70% < 80%	Level 2
Analyze and evaluate classification methods, including LDA, k-NN, SVMs, Bayesian networks, naïve Bayes, decision trees, and Gaussian mixture models, using performance metrics like confusion matrix, F1 score, accuracy, and ROC curves.	AIM3101.3	Cognitive: Evaluate	≥ 80	Level 3
Design and implement ensemble learning models such as bagging, boosting (e.g., AdaBoost, XGBoost), and random forests, and validate models using techniques like K-fold cross-validation.	AIM3101.4	Cognitive: Create	≥ 70% < 80%	Level 2
Examine clustering methods (e.g., k-means, hierarchical clustering) and dimensionality reduction techniques (e.g., PCA, factor analysis) for analyzing and interpreting unlabelled data.	AIM3101.5	Cognitive: Analyze	≥ 70% < 80%	Level 2

D. Program Outcomes and Program Specific Outcomes:

[PO.1] Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering zs to the solution of complex engineering problems.

[PO.2] Problem Analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

[PO.3] Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

[PO.4] Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

[PO.5] Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

[PO.6] The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

[PO.7] Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

[PO.8] Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices.

[PO.9] Individual and Teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

[PO.10] Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

[PO.11] Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

[PO.12] Life-long Learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES:

[PSO.1] Graduates will be able to examine the applications of Artificial Intelligence and Machine Learning in real-life problems.

[PSO.2] Graduates will be able to design and implement intelligent systems for multidisciplinary problems.

E. Assessment Plan

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Mid-Term Examination (Close Book)	30
	Attendance- 5 NPTEL Assignment- 10 NPTEL Certificate- 15 (75% and above=15 marks, 60-74%=12 marks, Less than 59%=9 marks)	30
End Term Exam (Summative)	End Term Exam (Close Book)	40
	Total	100
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be eligible to appear for the ETE. The allowance of 25% includes all types of leaves including medical leaves.	

F. Syllabus: Introduction to Machine Learning: Basics, Labelled and unlabelled Data, Types of Machine Learning, Supervised vs. Unsupervised Learning, Parametric vs. non-parametric models. Learning theory, Bias-Variance, trade-off, Model selection.
Regression Techniques and Evaluation: Linear Regression, Gradient descent for Linear Regression, Ridge and Lasso Regression. Logistic Regression. Performance measures for Regression models. Cost functions, Underfitting, Overfitting.
Core Classification Algorithms: k Nearest Neighbours(KNN), Support Vector Machines: kernel functions, Naïve Bayes, Decision Trees. **Performance & Evaluation of Classifiers**: Confusion matrix, F1 score, Accuracy, Recall, Precision, Precision-recall curve, ROC curve.
Advanced Classification and Ensemble Techniques: Ensemble Learning: Concept of weak learners, Bagging and Boosting, Adaptive Boosting, Extreme Gradient

Boosting (XGBoost), Random Forests, Bayesian Networks, Model Validation: K-Fold and Cross-Validation, holdout method, Gaussian Mixture Models(GMM)
Unsupervised learning: Clustering: Partitioning, Hierarchical and Density based methods, Agglomerative Clustering, K-Means, K-Medoids. Association Rule Mining.
Dimensionality Reduction: Feature Extraction and Feature Selection. Principal Component Analysis (PCA), Partial Least Squares, Latent Factors, Factor Analysis.

Textbooks

Machine Learning by Dutt. Published by Pearson. Relevant to Computer Science.

Tom M. Mitchell - "Machine Learning," McGraw-Hill Education, 1997. A foundational textbook introducing the principles and algorithms of machine learning.

Christopher M. Bishop - "Pattern Recognition and Machine Learning," Springer, 2006. Covers both the theoretical and practical aspects of pattern recognition and machine learning.

Reference Books
Ian Goodfellow, Yoshua Bengio, and Aaron Courville - "Deep Learning," MIT Press, 2016. Provides an in-depth understanding of deep learning techniques and their applications.

Ethem Alpaydin - "Introduction to Machine Learning," MIT Press, 4th Edition, 2020. Offers a concise introduction to various machine learning methods and their real-world implementations.

G. Lecture Plan:

Lecture No.	Topic	Session Outcome	Corresponding CO	Mode of delivery	Mode of assessing CO
1	Basics of Machine Learning	Understand the fundamentals of machine learning.	AIM3101.1	Lecture-based teaching-learning	Short Quiz
2	Labelled and Unlabelled Data	Differentiate between labelled and unlabelled data.	AIM3101.1	Technology-based learning	Online Assignment
3	Types of Machine Learning	Learn about supervised, unsupervised, and reinforcement learning.	AIM3101.1	Lecture-based teaching-learning	Quiz

4	Supervised vs. Unsupervised Learning	Compare supervised and unsupervised learning techniques.	AIM3101.1	Lecture-based teaching-learning	Conceptual Questions
5	Parametric vs. Non-Parametric Models	Identify differences between parametric and non-parametric models.	AIM3101.1	Lecture-based teaching-learning	Assignment
6	Learning Theory and Bias-Variance Trade-Off	Explore bias-variance trade-off and its role in performance.	AIM3101.1	Lecture-based teaching-learning	Quiz
7	Model Selection	Understand methods for optimal model selection.	AIM3101.1	Lecture-based teaching-learning	Online Quiz
8	Introduction to Regression Models	Learn the basics of regression in supervised learning.	AIM3101.2	Lecture-based teaching-learning	Short Quiz
9	Linear Regression	Understand linear regression and its applications.	AIM3101.2	Lecture-based teaching-learning	Problem-Solving Assignment
10	Gradient Descent for Linear Regression	Explore gradient descent for optimizing regression models.	AIM3101.2	Learning through problem-solving	Practical Task
11	Ridge and Lasso Regression	Differentiate between Ridge and Lasso regression techniques.	AIM3101.2	Lecture-based teaching-learning	Assignment
12	Logistic Regression	Learn logistic regression for classification problems.	AIM3101.2	Lecture-based teaching-learning	Quiz
13	Performance Measures for Regression Models	Evaluate regression models using MSE, RMSE, etc.	AIM3101.2	Technology-based learning	Conceptual Questions
14	Cost Functions, Underfitting, Overfitting	Analyze cost functions, underfitting, and overfitting.	AIM3101.2	Lecture-based teaching-learning	Quiz
15	Introduction to Classification	Learn classification	AIM3101.3	Lecture-based	Quiz

		basics in supervised learning.		teaching-learning	
16	Linear Discriminant Analysis	Understand LDA for classification.	AIM3101.3	Lecture-based teaching-learning	Assignment
17	k-Nearest Neighbors (k-NN)	Explore k-NN and its applications.	AIM3101.3	Lecture-based teaching-learning	Conceptual Questions
18	Support Vector Machines (SVMs)	Understand SVMs and kernel functions.	AIM3101.3	Technology-based learning	Problem-Solving Assignment
19	Bayesian Networks and Naïve Bayes	Learn Bayesian methods for classification.	AIM3101.3	Lecture-based teaching-learning	Quiz
20	Decision Trees and Gaussian Mixture Models	Explore decision trees and Gaussian mixture models.	AIM3101.3	Lecture-based teaching-learning	Short Quiz
21	Performance & Evaluation of Classifiers	Evaluate classifiers using confusion matrix, F1 score, etc.	AIM3101.3	Technology-based learning	Assignment
22	Introduction to Ensemble Methods	Learn the concept of weak learners and ensemble methods.	AIM3101.4	Flipped Classroom	Quiz
23	Bagging and Random Forests	Understand bagging and random forests.	AIM3101.4	Flipped Classroom	Problem-Solving Assignment
24	Boosting and Adaptive Boosting	Explore boosting techniques.	AIM3101.4	Flipped Classroom	Quiz
25	Extreme Gradient Boosting (XGBoost)	Learn about XGBoost.	AIM3101.4	Flipped Classroom	Conceptual Questions
26	K-Fold Cross-Validation	Understand K-Fold cross-validation in ML.	AIM3101.4	Flipped Classroom	Quiz
27	Introduction to Clustering	Learn the basics of clustering in unsupervised learning.	AIM3101.5	Lecture-based teaching-learning	Assignment
28	K-Means Clustering	Understand K-Means clustering.	AIM3101.5	Flipped Classroom	Practical Task

29	K-Medoids Clustering	Explore K-Medoids clustering techniques.	AIM3101.5	Flipped Classroom	Quiz
30	Hierarchical Clustering	Analyze hierarchical clustering methods.	AIM3101.5	Lecture-based teaching-learning	Conceptual Questions
31	Density-Based Clustering (DBSCAN)	Explore DBSCAN clustering.	AIM3101.5	Technology-based learning	Problem-Solving Assignment
32	Association in Unsupervised Learning	Learn association rules for pattern discovery.	AIM3101.5	Expeditionary Learning	Group Project
33	Introduction to Dimensionality Reduction	Understand dimensionality reduction techniques.	AIM3101.5	Lecture-based teaching-learning	Quiz
34	Principal Component Analysis (PCA)	Analyze PCA for dimensionality reduction.	AIM3101.5	Flipped Classroom	Assignment
35	Partial Least Squares	Understand Partial Least Squares.	AIM3101.5	Lecture-based teaching-learning	Conceptual Questions
36	Factor Analysis and Comparison with PCA	Explore factor analysis and compare with PCA.	AIM3101.5	Lecture-based teaching-learning	Quiz
37	Feature Extraction vs. Feature Selection	Understand differences between feature extraction and selection.	AIM3101.5	Technology-based learning	Assignment
38	Deep Dive into PCA Techniques	Explore advanced techniques in PCA.	AIM3101.5	Flipped Classroom	Problem-Solving Assignment
39	Singular Value Decomposition (SVD)	Understand the SVD and its relation to PCA.	AIM3101.5	Technology-based learning	Quiz
40	Independent Component Analysis (ICA)	Learn about ICA and its applications.	AIM3101.5	Lecture-based teaching-learning	Assignment
41	t-SNE for Dimensionality Reduction	Explore t-SNE for data visualization and dimensionality reduction.	AIM3101.5	Lecture-based teaching-learning	Practical Task

42	Comparison of Dimensionality Reduction Methods	Compare various dimensionality reduction techniques.	AIM3101.5	Expeditionary Learning	Group Project
43	Case Study 1: Predictive Analytics in Healthcare	Apply ML concepts to predict healthcare outcomes.	AIM3101.1, AIM3101.2	Expeditionary Learning	Presentations and Reports
44	Case Study 2: Fraud Detection in Banking	Analyze ML techniques used in fraud detection in banking systems.	AIM3101.2, AIM3101.3	Expeditionary Learning	Presentations and Reports
45	Case Study 3: Image Classification with CNNs	Use Convolutional Neural Networks (CNNs) for image classification.	AIM3101.3, AIM3101.4	Expeditionary Learning	Presentations and Reports
46	Case Study 4: Sentiment Analysis in Social Media	Apply ML to analyze sentiment in social media data.	AIM3101.4, AIM3101.5	Expeditionary Learning	Presentations and Reports
47	Case Study 5: Customer Segmentation in Marketing	Use clustering techniques for customer segmentation in marketing.	AIM3101.5	Expeditionary Learning	Presentations and Reports
48	Case Study 6: Recommendation Systems	Build a recommendation system using collaborative filtering.	AIM3101.5	Expeditionary Learning	Presentations and Reports
End Term Examination					

H. Course Articulation Matrix:

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
AIM3101.1:	Explain fundamental ML concepts (labelled/unlabelled data, types, supervised/unsupervised learning, parametric/non-parametric models, and learning theory.)	3	3	1	1	1	1	1		3			2	2	2
AIM3101.2:	Apply regression techniques (linear regression, gradient descent, ridge, lasso, logistic regression) to solve supervised learning problems.	3	3	3		3	3				3		2	1	2
AIM3101.3:	Analyze and evaluate classification methods (LDA, k-NN, SVMs, Bayesian networks, naïve Bayes, decision trees, Gaussian mixture models) using performance metrics (confusion matrix, F1 score, accuracy, ROC curves).	3	3	3	3	3		3		3	3	3	2	2	2
AIM3101.4:	Design and implement ensemble learning models (bagging, boosting, AdaBoost, XGBoost, random forests) and validate using K-fold cross-validation.	3		3	3	3	3				3	3	3	2	2
AIM3101.5:	Examine clustering methods (k-means, hierarchical) and dimensionality reduction techniques (PCA, factor analysis) for analysing and interpreting unlabelled data.		3	3	3		3	3		3	3	3	3	2	3

1: Low Correlation 2: Moderate Correlation 3: Substantial Correlation