

COURSE TITLE	MACHINE LEARNING FOR PATTERN ANALYSIS
COURSE CODE	01AL0505
COURSE CREDITS	4

Objective:

- 1 The course aims to provide a foundational understanding of pattern analysis using machine learning techniques, enabling students to apply algorithms for classification and clustering, perform feature engineering and dimensional reduction, and evaluate model performance to solve real-world data-driven problems effectively.

Course Outcomes: After completion of this course, student will be able to:

- 1 Understand pattern representation and similarity measures used in machine learning.
- 2 Apply classification and clustering algorithms to analyze data patterns.
- 3 Analyze feature selection and dimensionality reduction techniques.
- 4 Evaluate machine learning models using appropriate performance metrics.
- 5 Develop solutions for real-world problems using pattern analysis techniques.

Pre-requisite of course: Basic Python, Linear Algebra, Basic Statistics & Probability

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	Introduction to Pattern Analysis Pattern recognition vs machine learning, Pattern representation and feature vectors, Types of data (structured, unstructured), Similarity & distance measures such as Euclidean, Manhattan, Cosine, Data preprocessing and normalization	8
2	Supervised Learning for Pattern Analysis Classification concepts, k-NN algorithm, Logistic Regression, Support Vector Machines (SVM), Decision Trees basics, Overfitting & underfitting	8
3	Unsupervised Learning & Clustering Clustering fundamentals, K-means clustering, Hierarchical clustering, DBSCAN, Cluster evaluation methods	8
4	Feature Engineering & Dimensionality Reduction Feature extraction techniques, Feature selection methods, Principal Component Analysis (PCA), Linear Discriminant Analysis (LDA), Curse of dimensionality	8

Contents : Unit	Topics	Contact Hours
5	Model Evaluation & Applications Confusion matrix, Accuracy, Precision, Recall, F1-score, Cross-validation Bias-variance tradeoff, Applications: Image classification, Text classification Healthcare / anomaly detection	8
Total Hours		40

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	Practical 1 Perform data preprocessing and normalization using Python. Handle missing values and apply scaling concept	2
2	Practical 2 Compute distance measures Euclidean, Manhattan, Cosine on sample data	2
3	Practical 3 Implement k-NN classification using Scikit-learn	2
4	Practical 4 Apply Logistic Regression on a small dataset	2
5	Practical 5 Apply SVM using a pre-defined dataset (no tuning)	2
6	Practical 6 Implement Decision Tree classifier and visualize results	2
7	Practical 7 Perform K-means clustering and plot clusters	2
8	Practical 8 Apply hierarchical clustering and visualize dendrogram	2
9	Practical 9 Perform PCA for dimensionality reduction using 2D visualization	2
10	Practical 10 Apply basic feature selection methods SelectKBest / correlation method	2
11	Practical 11 Evaluate model using confusion matrix, accuracy, precision, recall	2
12	Practical 12 Build a simple ML pipeline (preprocessing + model + evaluation)	2
Total Hours		24

Textbook :

- 1 Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer, 2006
- 2 Machine Learning, Tom M. Mitchell, McGraw Hill, 1997
- 3 Introduction to Machine Learning, Ethem Alpaydin, MIT Press, 2020
- 4 Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, MIT Press, 2012

Textbook :

- 5 Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, Aurélien Géron, O'Reilly Media, 2022

References:

- 1 Pattern Classification, Pattern Classification, Richard O. Duda, Peter E. Hart, David G. Stork, Wiley-Interscience, 2000
- 2 The Elements of Statistical Learning, The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, Springer, 2009
- 3 Deep Learning, Deep Learning, Ian Goodfellow, MIT Press, 2016
- 4 Introduction to Data Mining, Introduction to Data Mining, Pang-Ning Tan, Pearson, 2018
- 5 Neural Networks for Pattern Recognition, Neural Networks for Pattern Recognition, Christopher M. Bishop, Oxford University Press, 1995

Suggested Theory Distribution:

The suggested theory distribution as per Bloom’s taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	Understand	Apply	Analyze	Evaluate	Higher order Thinking / Creative
10.00	20.00	30.00	20.00	10.00	10.00

Instructional Method:

- 1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, PPTs may also use any of tools such as demonstration, role play, Quiz, brainstorming, Case studies, Kaggle datasets / real-world problems, Flipped learning & MOOCs etc.
- 2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.
- 3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.
- 4 Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory