

Branch Name:	Artificial Intelligence & Data Science
Program Code:	108
Course Name:	Advanced Machine Learning
Course Code:	1ET1080504
Pre-requisite Course:	Basic Machine Learning knowledge

Course Objectives:

Upon completion of this course, the students will be able to

1. Implement a neural network for an application.
2. Implement probabilistic discriminative and generative algorithms for an application and analyze the results.
3. Implement typical clustering algorithms for different types of applications.
4. Design and implement an HMM for a sequence model type of application.
5. Identify applications suitable for different types of machine learning with suitable justification.

Teaching and Examination Scheme:

Teaching Scheme (Hours per week)				Evaluation Scheme (Marks)				
Lecture (L)	Tutorial (T)	Practical (P)	Credit	Theory (Marks)		Practical (Marks)		Total (Marks)
				University Assessment	Continuous Assessment	University Assessment	Continuous Assessment	
03	-	02	04	70	30	30	20	150

Subject Contents:

Sr. No	Topic	Total Hours	Weightage (%)
1	Introduction Introduction to Machine Learning, Types of Machine learning, Basic Concepts in Machine Learning, Examples of Machine Learning Applications, Linear Models for Regression, Linear Basis Function Models, The Bias-Variance Decomposition, Bayesian Linear Regression, Bayesian Model Comparison.	09	10
2	Supervised Learning Linear Models for Classification: Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models, Bayesian Logistic Regression. Neural Networks: Feedforward Network Functions, Error Backpropagation, Regularization in Neural Networks, Mixture Density	09	15

	Networks, Bayesian Neural Networks. Kernel Methods, Dual Representations, Radial Basis Function Networks, Ensemble learning: Boosting, Bagging.		
3	Unsupervised Learning Clustering, K-means, K-NN classifier Dimensionality, Mixtures of Gaussians, The EM Algorithm in General, Model Selection for Latent Variable Models, High-Dimensional Spaces. Dimensionality Reduction: Techniques, Factor analysis, Principal Component Analysis, Probabilistic PCA, Independent components analysis.	09	15
4	Preparing to Model, Exploring Structure of Data, Modelling and Evaluation, Selecting a Model, Training a Model, Basics of Feature Engineering	05	10
5	Probabilistic Graphical Models Directed Graphical Models: Introduction, Bayesian Networks, Examples, Naive Bayes classifiers, Markov Models, Hidden Markov Models, Inference, Learning, Conditional independence properties of DGMs. Undirected graphical models: Markov random fields, Conditional independence properties, Parameterization of MRFs, Examples of MRF, Learning, Conditional random fields (CRFs), Structural SVMs.	03	15
6	Advanced Learning Sampling, Basic Sampling Methods, Monte Carlo. Reinforcement Learning: K-Armed Bandit, Elements of Reinforcement Learning, Model-Based Learning. Temporal Difference Learning, Exploration Strategies, Deterministic and Non-deterministic Rewards and Actions, Eligibility Traces, Generalization, Partially Observable States, The Setting, Example. Computational Learning Theory, Mistake bound analysis, sample complexity analysis, VC dimension. Occam learning, accuracy and confidence boosting.	04	20
7	Neural Networks And Deep Learning Neural Networks, Biological Motivation, Perceptron, Multi-layer Perceptron, Feed Forward Network, Back Propagation, Activation and Loss Functions, Limitations of Machine Learning, Deep Learning, Convolution Neural Networks, Recurrent Neural Networks	03	15

Text Books:

1. Kevin Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012.
2. Jeeva Jose, Introduction to Machine Learning, Khanna Book Publishing Company, 2020

Reference Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, The Elements of Statistical Learning, Springer 2009.
2. Christopher Bishop, Pattern Recognition and Machine Learning, Springer, 2007.

LAB/Practical

1. Introduction about basic machine learning techniques.
2. Implement Bayesian Neural Networks for Supervised Learning.
3. Implement Classification
 - a. K-Nearest Neighbors (KNN)

- b. Support Vector Machine (SVM)
- c. Decision Tree Classification
- d. Random Forest Classification
- 4. Implement Simple Linear Regression
- 5. Implement Multiple Linear Regression
- 6. Implement K-Means Clustering
- 7. Implement reinforcement Algorithm

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Understand the concepts of computational intelligence like machine learning	2 UNDERSTAND
CLO2	Explore the skills to apply machine learning techniques to address the real time problems in different areas	4 ANALYZE
CLO3	Understand the concept of learning and candidate elimination algorithms	2 UNDERSTAND
CLO4	Explore on tree based decision tree learning algorithm and its applications	4 ANALYZE
CLO5	Understand the Artificial Neural Networks and its usage in machine learning application.	2 UNDERSTAND
CLO6	Understand the concepts of Bayesian learning, computational learning and instance-based learning and their usage in machine learning application.	2 UNDERSTAND

Mapping of CLOs with POs & PSOs

Course	Program Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CLO1	H	L	L										M	M		
CLO2	H	H	M	M									M	M		
CLO3	M	M	M	M									M	L		

CLO4	H	H	H	H	H									L	M		
CLO5	M	M	M	M	M									M	M		
CLO6	M	M	M	M	M									L	M		

H:High, M:Medium, L:Low