Uka Tarsadia University

B. Tech.

Semester V

MACHINE LEARNING
AI5012

EFFECTIVE FROM June-2023

Syllabus version: 1.00

Subject Code	Subject Title	Teaching Scheme			
		Hours		Credits	
		Theory	Practical	Theory	Practical
AI5012	Machine Learning	3	2	3	1

Subject Code	Subject Title	Theory Examination Marks		Practical Examination Marks	Total Marks
		Internal	External	CIE	
AI5012	Machine Learning	40	60	50	150

Objectives of the course:

- To provide breadth and depth of machine learning techniques along with its applications.
- To deliver the knowledge about machine learning techniques and algorithms to draw inferences from the data and solve real-world applications.

Course outcomes:

Upon completion of the course, the student shall be able to,

CO1: Understand the theory of machine learning and its usage.
CO2: Understand and apply the concepts of modeling and model evaluation.
CO3: Understand and apply the probability and feature engineering principles in machine learning.
CO4: Understand and apply the Bayesian concepts and supervised learning algorithms.
CO5: Understand and apply the unsupervised learning algorithms and neural networks.
CO6: Understand the advanced concepts in machine learning.

Sr. No.	Topics	Hours
	Unit – I	
1	**Introduction to Machine Learning:** Human learning, Types of human learning, Machine learning, types of machine learning, applications of machine learning, Model preparation, Exploring structure of data, Data pre-processing.	5
	Unit – II	

2	**Modelling and Evaluation:** Model selection, Model training – Holdout method, k-fold cross-validation, Bootstrap sampling, and Lazy vs. eager learner, Model representation and interpretability, Evaluating performance of a model, Improving model performance.	6
	Unit – III	
3	**Basics of Feature Engineering:** Introduction of features and feature engineering, Feature transformation, Feature subset selection, Understanding issues with higher dimensional data. **Probability in Machine Learning:** Need of statistical tools in machine learning, Concept of probability, Random variables, Discrete distributions, Continuous distribution, Multiple random variables, Central limit theorem, Sampling distributions, Hypothesis testing.	7
	Unit – IV	
4	**Bayesian Concept Learning:** Importance of Bayesian methods in machine learning, Bayes' theorem, Concept learning, Bayesian belief networks. **Supervised Learning:** Classification model, Classification learning steps, Classification algorithms – *k*-nearest neighbour, Decision tree, Random forest, Support Vector Machines (SVMs), Introduction to regression, Regression algorithms – Simple linear regression, Multiple linear regression, Assumptions and problems in linear analysis, Polynomial regression model, Logistic regression, Maximum likelihood estimation.	7
	Unit – V	
5	**Unsupervised Learning:** Comparison with supervised learning, Clustering as a machine learning task, Partition methods in clustering, *k*-Medoids, Hierarchical clustering, Density based clustering, Pattern finding with association rule. **Basics of Neural Networks:** Biological nervous system, Exploring artificial neuron, Activation functions – Identity, Step, ReLu Sigmoid, Softmax and Hyperbolic tangent, MCCulloch-Pitts model, Rosenblatt's perceptron, ADALINE, Single layer feed-forward network, Multi-layer feed-forward network, Competitive network, Recurrent network, Back-propagation, Convolutional network, Transformers.	6

Unit – VI		
6	**Advanced Learning Topics:** Representation learning, Active learning, Instance based learning, Association rule learning algorithm, Ensemble learning algorithm, Regularization algorithm, Generative models, Reinforcement learning.	5

Text book:

1. Saikat Dutt, Subramanian Chandramouli, and Amit Das, "Machine Learning", Pearson.

Reference books:

1. Mitchell Tom, "Machine Learning", Tata McGraw-Hill.
2. R. O. Duda, P. E. Hart, D. G. Stork, "Pattern Classification", Wiley-Blackwell, 2nd Edition.
3. Shalev-Shwartz,S., Ben-David,S., "Understanding Machine Learning: From Theory to Algorithms", Cambridge University Press.
4. Hastie, T., R. Tibshirani, and J. H. Friedman, "The Elements of Statistical Learning: Data Mining, Inference and Prediction", Springer.
5. MacKay, David, "Information Theory, Inference, and Learning Algorithms." Cambridge University Press.
6. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer.

Course objectives and Course outcomes mapping:

- To provide breadth and depth of machine learning techniques along with its applications: CO1, CO2, CO4, CO5, and CO6.
- To deliver the knowledge about machine learning techniques and algorithms to draw inferences from the data and solve real-world applications CO4, CO5, and CO6.

Course units and Course outcomes mapping:

Unit No.	Unit Name	Course Outcomes					
		CO1	CO2	CO3	CO4	CO5	CO6
1	Introduction to Machine Learning	✓					
2	Modelling and Evaluation		✓				
3	Feature Engineering and Probability			✓			
4	Bayesian and Supervised Learning				✓		
5	Unsupervised Learning and Neural Networks					✓	
6	Advanced Learning Topics						✓

Programme outcomes:

PO 1: Engineering knowledge: An ability to apply knowledge of mathematics, science, and engineering.

PO 2: Problem analysis: An ability to identify, formulates, and solves engineering problems.

PO 3: Design/development of solutions: An ability to design a system, component, or process to meet desired needs within realistic constraints.

PO 4: Conduct investigations of complex problems: An ability to use the techniques, skills, and modern engineering tools necessary for solving engineering problems.

PO 5: Modern tool usage: The broad education and understanding of new engineering techniques necessary to solve engineering problems.

PO 6: The engineer and society: Achieve professional success with an understanding and appreciation of ethical behavior, social responsibility, and diversity, both as individuals and in team environments.

PO 7: Environment and sustainability: Articulate a comprehensive world view that integrates diverse approaches to sustainability.

PO 8: Ethics: Identify and demonstrate knowledge of ethical values in non-classroom activities, such as service learning, internships, and field work.

PO 9: Individual and team work: An ability to 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/receive clear instructions.

PO 11: Project management and finance: An ability to 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: recognition of the need for, and an ability to engage in life-long learning.

Programme outcomes and Course outcomes mapping:

Programme Outcomes	Course Outcomes					
	CO1	CO2	CO3	CO4	CO5	CO6

PO1	✓		✓	✓	✓	
PO2	✓	✓	✓	✓	✓	
PO3			✓	✓	✓	
PO4	✓					✓
PO5		✓				
PO6						
PO7						
PO8	✓					
PO9						
PO10						
PO11						
PO12						✓