INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

MACHINE LEARNING TECHNIQUES AND PRACTICES								
VI Semester: CSE (AI&ML)								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
ACAD20	**Elective**	3	0	0	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisites: Matrices and Calculus								

I. COURSE OVERVIEW:

Machine Learning Techniques and Practices course explores major types of machine learning such as supervised learning, classification models, decision trees, SVMs, KNN, neural networks, and ensemble methods. Students will learn key linear models for regression and classification, covering maximum likelihood estimation, regularization, Bayesian learning, and discriminant functions. The course also provides a deep understanding of unsupervised learning techniques such as clustering, Gaussian mixtures, EM algorithms, and dimensionality reduction methods like PCA and LDA. Finally, it covers graphical models, inference techniques, reinforcement learning fundamentals, and an introduction to deep learning, preparing students for applications in Machine Learning (ML).

II. COURSE OBJECTIVES:

The students will try to learn:

1. The ML and learn the methods of solving problems.
2. The range of ML algorithms and techniques for optimization, classification, clustering, and probabilistic reasoning, while understanding key concepts and distinctions in ML methodologies.
3. The methods of searching techniques problems in ML.
4. Applications in various domains using ML techniques in areas of core engineering.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO1	Explain the fundamental concepts of Machine Learning and evaluate supervised learning models using metrics such as entropy, Gini index, and information gain.
CO2	Apply basic ML algorithms such as SVM, KNN, MLP, CART, and ensemble methods to solve classification and prediction problems.
CO3	Derive and implement linear regression models using least squares, regularization, and Bayesian approaches, and analyze the bias–variance trade-off.
CO4	Build and compare probabilistic generative and discriminative models using Bayes theorem, discriminant functions, and Bayesian logistic regression.
CO5	Perform clustering and dimensionality reduction using K-Means, hierarchical clustering, Gaussian mixtures, EM algorithm, PCA, and LDA.
CO6	Apply graphical models (HMMs, Monte Carlo sampling) and apply reinforcement learning frameworks for sequential decision-making tasks.

IV. COURSE CONTENT:

MODULE – I: INTRODUCTION (10)

Introduction to Machine Learning, Types of Machine Learning - Supervised Learning - Classification models - Naïve Bayes Classifier - Decision trees - Entropy computation using GINI - Information Gain.

MODULE – II: PROBLEM SOLVING METHODS: BASIC ALGORITHMS (09)

Support Vector Machines - KNN model - MLP - CART - Ensemble Methods: Bagging - Boosting - Gradient boosting.

MODULE – III: LINEAR MODELS FOR CLASSIFICATION AND REGRESSION (10)

Maximum Likelihood Estimation (MLS) - least squares - regularized least squares - The Bias-Variance Decomposition - Bayesian Linear Regression.

Linear models for classification - Discriminant functions - Fisher's linear discriminant - Probabilistic generative models - Probabilistic discriminative models - Bayes theorem - Bayesian logistic regression - Bayesian learning

MODULE – IV: CLUSTURING (09)

Clustering - K-Means clustering - Hierarchical Clustering - Mixture of Gaussians - Expectation maximization for mixture models (EM) - Dimensionality Reduction - Principal Component Analysis (PCA) - Linear Discriminant Analysis (LDA).

MODULE – V: GRAPHICAL MODELS AND REINFORCEMENT LEARNING (10)

Graphical models - Hidden Markov Models - Representation - learning - Decoding - Inference in graphical models - Monte Carlo models - Sampling. Reinforcement Learning.

V. TEXTBOOKS:

1. Tom Mitchell, "Machine Learning", McGraw Hill, 1997.
2. E. Alpaydin, "Introduction to Machine Learning", Second Edition, Prentice-Hall of India, 2010.

VI. REFERENCE BOOKS:

1. Simon Haykin, "Neural Networks and Learning Machines", Pearson, 2008.
2. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning from Theory to Algorithms", Cambridge University Press, 2014.
3. R.O. Duda, P.E. Hart, D.G. Stork, "Pattern Classification", Second Edition, Wiley Inderscience, 2000.
4. T. Hastie, R. Tibshirani, J. Friedman, "The Elements of Statistical Learning", Springer, 2011.

VII. WEB REFERENCES

1. https://bpbonline.com/products/applied-machine-learning-solutions-with-python
2. NPTEL: Machine Learning and Deep Learning, Machine Learning And Deep Learning - Fundamentals And Applications - Course
3. Machine Learning: https://www.ibm.com/think/topics/machine-learning
4. http://www.library.thinkquest.org/2705/
5. http://www.ai.eecs.umich.edu/
6. Machine Learning Algorithms and Applications: A guide to the types of machine learning algorithms | SAS UK.

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper – II
9. Lecture notes
10. PowerPoint presentation
11. E-Learning Readiness Videos (ELRV)