EC314: Machine Learning

Details of course: -

Course Title	Course Structure			Pre-Requisite
	L	T	P	
Machine Learning	3	0	2	Probability theory, linear algebra, and programming language (C, Python, MATLAB)

Course Objective: To provide theoretical basis of machine learning and a set of concrete algorithms with programming.

Course Outcomes:

CO1: Describe the fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.

CO2: Explain the underlying mathematical relationships within and across Machine Learning algorithms.

CO3: Compare and contrast different paradigms for learning (supervised, unsupervised, etc.).

CO4: Analyze the concept of neural networks and design the same.

CO5: Design the appropriate machine learning techniques for different real-world problems.

S. No.	Content	Contact Hours
Unit 1	**Introduction to machine learning, Basic concepts**: Definition of learning systems, Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. Types of Learning: Supervised learning and unsupervised learning. Overview of classification: setup, training, test, validation dataset, overfitting. Machine Learning Fundamentals: Bias and Variance, Cross-validation, Confusion matrix, Sensitivity and Specificity, ROC and AUC.	10
Unit 2	**Supervised Learning**: Linear Regression, Multivariate Regression, Maximum Likelihood Estimation, Logistic regression, Discriminant Analysis, Naive Bayes, Support vector machines: Optimal hyperplane, Kernels. **Regularization Techniques**: Ridge Regression (L2 Norm), Lasso Regression (L1 Norm), Elastic-Net Regression. Classification	8

	Families: Linear Discriminative, Non-linear Discriminative, Decision Trees, Probabilistic (conditional and generative), Nearest Neighbor	
Unit 3	**Unsupervised Learning:** Clustering, K-means, EM Algorithm, Gaussian Mixture Models, PCA (Principal components analysis), ICA (Independent components analysis), latent semantic indexing. Spectral clustering, Markov models Hidden Markov models (HMMs). **Ensemble Methods**: Random Forest, Combining Classifiers: Bagging, boosting (The Ada boost algorithm), Classification errors, Model selection, and Feature selection.	10
Unit 4	**Reinforcement Learning and Control**: MDPs. Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR). LQG. Q-learning. Value function approximation, Policy search. Reinforce. POMDPs.	6
Unit 5	**Introduction to Deep Learning**: History of Deep Learning, Types of errors, Bias-variance trade-off, Overfitting-underfitting, Brief review of concepts from Vector Calculus and Optimization, Gradient Descent, Variants of Gradient Descent, Momentum, Computation graph, Vectorization and Broadcasting, Perceptron, Neural Networks, Generative learning algorithms.	8
	Total	42

Books: -

S. No	Name of Books/Authors/Publisher
1	Machine Learning/Tom.M.Mitchell/McGraw Hill International Edition, 2017.
2	Introduction to Machine Learning/Ethern Alpaydin/Eastern Economy Edition, Prentice Hall ofIndia, 2005.
3	Deep Learning/Ian Goodfellow, Yoshoua Bengio, and Aaron Courville/MIT Press Ltd, Illustrated edition, 2016.
4	Pattern Recognition and Machine Learning/Christopher M. Bishop/Springer, 2nd edition, 2009.