

Course Code	Course Name	Credit
CSC604	MachineLearning	03

Pre-requisite: Data Structures, Basic Probability and Statistics, Algorithms

Course Objectives: The course aims:

- 1 To introduce Machine learning concepts
- 2 To develop mathematical concepts required for Machine learning algorithms
- 3 To understand various Regression techniques
- 4 To understand Clustering techniques
- 5 To develop Neural Network based learning models

Course Outcomes:

After successful completion of the course students will be able to:

- 1 Comprehend basics of Machine Learning
- 2 Build Mathematical foundation for machine learning
- 3 Understand various Machine learning models
- 4 Select suitable Machine learning models for a given problem
- 5 Build Neural Network based models
- 6 Apply Dimensionality Reduction techniques

Module	Detailed Content	Hours
1	Introduction to Machine Learning	6
1	1.1 Introduction to Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps of developing a Machine Learning Application.	
	Supervised and Unsupervised Learning: Concepts of Classification, Clustering and prediction, Training, Testing and validation dataset, cross validation, overfitting and underfitting of model	
	Performance Measures: Measuring Quality of model- Confusion Matrix, Accuracy, Recall, Precision, Specificity, F1 Score, RMSE	
2	Mathematical Foundation for ML	5
2	2.1 System of Linear equations, Norms, Inner products, Length of Vector, Distance between vectors, Orthogonal vectors	
	2.2 Symmetric Positive Definite Matrices, Determinant, Trace, Eigenvalues and vectors, Orthogonal Projections, Diagonalization, SVD and its applications	
3	Linear Models	7
3	3.1 The least-squares method, Multivariate Linear Regression, Regularized Regression, Using Least-Squares Regression for classification	
	3.2 Support Vector Machines	
4	Clustering	4
	4.1 Hebbian Learning rule	

	4.2	Expectation -Maximization algorithm for clustering	
5		Classification models	10
	5.1	Introduction, Fundamental concept, Evolution of Neural Networks, Biological Neuron, Artificial Neural Networks, NN architecture, McCulloch-Pitts Model. Designing a simple network, Non-separable patterns, Perceptron model with Bias. Activation functions, Binary, Bipolar, continuous, Ramp. Limitations of Perceptron.	
	5.2	Perceptron Learning Rule. Delta Learning Rule (LMS-Widrow Hoff), Multi-layer perceptron network. Adjusting weights of hidden layers. Error back propagation algorithm.	
	5.3	Logistic regression	
6		Dimensionality Reduction	07
	6.1	Curse of Dimensionality.	
	6.2	Feature Selection and Feature Extraction	
	6.3	Dimensionality Reduction Techniques, Principal Component Analysis.	

Textbooks:

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| 1 | Nathalie Japkowicz & Mohak Shah, “Evaluating Learning Algorithms: A Classification Perspective”, Cambridge. |
| 2 | Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, “Mathematics for machine learning”, |
| 3 | Samir Roy and Chakraborty, “Introduction to soft computing”, Pearson Edition. |
| 4 | Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press McGraw-Hill Higher Education |
| 5 | Peter Flach, “Machine Learning”, Cambridge University Press |

References:

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| 1 | Tom M. Mitchell, “Machine Learning”, McGraw Hill |
| 2 | Kevin P. Murphy, “Machine Learning — A Probabilistic Perspective”, MIT Press |
| 3 | Stephen Marsland, “Machine Learning an Algorithmic Perspective”, CRC Press |
| 4 | Shai Shalev-Shwartz, Shai Ben-David, “Understanding Machine Learning”, Cambridge University Press |
| 5 | Peter Harrington, “Machine Learning in Action”, DreamTech Press |

Assessment:

Internal Assessment:

Assessment consists of two class tests of 20 marks each. The first-class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

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| 1 | Question paper will consist of 6 questions, each carrying 20 marks. |
| 2 | The students need to solve a total of 4 questions. |
| 3 | Question No.1 will be compulsory and based on the entire syllabus. |
| 4 | Remaining question (Q.2 to Q.6) will be selected from all the modules. |