## DISCIPLINE SPECIFIC ELECTIVES (DSE) COURSES OFFERED BY THE DEPARTMENT

## DISCIPLINE SPECIFIC ELECTIVES (DSE-1)

### CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

| Course title & Code | Credits | Credit distribution of the course | | | Eligibility criteria | Pre-requisite of the course (if any) |
|---|---|---|---|---|---|---|
| | | Lecture | Tutorial | Practical/ Practice | | |
| **Advanced Machine Learning ELDSE7A** | **4** | **3** | **-** | **1** | **Class XII passed with Physics + Mathematics/Applied Mathematics + Chemistry OR Physics + Mathematics/Applied Mathematics + Computer Science/Informatics Practices** | **-** |

### Learning Objectives

Machine Learning (ML) has emerged as one of the most dominant fields under AI, which has produced a significant impact in almost all the other sectors of science and technology including consumer electronics, robotics, Internet of Things and preventive health care to name a few. The primary focus of this course is to provide a comprehensive understanding of various advanced machine learning algorithms which can be used to design efficient automated systems and learning agents which are able to self-adapt and reprogram themselves according to their changing surroundings. These intelligent agents designed using ML algorithms have the ability to self-learn from the consequences of their past actions such that they can make improved decisions in the future.

## Learning outcomes

After successful completion of this course, student will be able to

CO1 Develop a good understanding of machine learning concepts

CO2 Formulate a machine learning problem

CO3 Develop a model using supervised and unsupervised machine learning algorithms for classification, regression and clustering

CO4 Evaluate performance of various machine learning algorithms on various data sets of a chosen domain.

## SYLLABUS OF ELDSE-7A Total Hours- Theory: 45 Hours, Practicals: 30 Hours

**Unit I: (12 Hours)**

**A Brief overview of Machine Learning:** Supervised Learning, Unsupervised Learning and Reinforcement Learning. Supervised Learning Vs. Unsupervised Learning. Classification Vs. Regression Analysis. Criteria for selecting training data and test data, concept of over-fitting and under fitting.

**Supervised Learning :** Regression Analysis in Supervised Learning- Linear Regression: Simple Linear Regression, Multiple Linear Regression, Polynomial Regression, Feature selection algorithms.

**Classification algorithms in Supervised Learning -** Linear models for classification, Logistic Regression, K-NN Algorithm, Decision Tree Classification Algorithm, Random Forest Algorithm, Support Vector Machine Classifier

**Unit II : (11 Hours)**

**Unsupervised Learning:** Clustering, K-Means Clustering Algorithm, Agglomerative Clustering, DBSCAN (density-based spatial clustering of applications with noise), Comparing and Evaluating Clustering Algorithms, Generating Association Rule, Principal Component Analysis (PCA), Non-Negative Matrix Factorization (NMF), Manifold Learning with t-SNE Clustering.

**Unit III: (12 Hours)**

**Probabilistic Reasoning Models and Bayesian Learning:**

Bayesian Networks- representation, construction and inference, Temporal model: concept of Transition probability. Naïve Bayes algorithm.

**Markov Decision Process (MDP) Model:** Simple Markov Model and Hidden Markov model, MDP formulation, utility theory, utility functions, value iteration, policy iteration and Q- Learning. Elements of MDP Model, Concept of Sequential Decision Processing, Example of MDP Problem: Agent in a grid world.

**Reinforcement Learning:** Passive Reinforcement learning and Active Reinforcement Learning.

**Unit IV: (10 Hours)**
**Computational Learning Theory:**
Probably Approximately Correct (PAC) learning model, Sample Complexity for finite hypothesis spaces, Sample Complexity for infinite hypothesis spaces, Mistake bound model of learning.
**Instance Based Learning:** Distance Weighted Nearest Neighbor algorithm.

**Practical component (if any) – Advanced Machine Learning Lab**
***(Algorithms to be implemented in Python or any other suitable programming language)***

## Learning outcomes

At the end of this course, Students will be able to

CO1 Effectively use various machine learning tools
CO2 Understand and implement the procedures for machine learning algorithms
CO3 Design Python programs for various machine learning algorithms
CO4 Apply appropriate datasets to machine learning algorithms
CO5 Analyze the graphical outcomes of learning algorithms with specific datasets

## LIST OF PRACTICALS ( Total Practical Hours- 30 Hours)

1. Perform Simple Linear Regression and Multiple Linear Regression.
2. Write a program to implement Logistic Regression.
3. Write a program to implement the following algorithms
    a. K-NN Classifier
    b. Decision Tree Classification Algorithm
    c. Support Vector Machine Classifier
4. Write a program to implement K-Means Clustering Algorithm
5. Write a program to demonstrate Agglomerative Hierarchical Clustering
6. Write a program for construction and inference of a Bayesian network
7. Write a program to implement Naïve Bayes classifier.
8. Write a program to implement Simple Markov and Hidden Markov Model
9. Write a program to demonstrate sequential decision processing in Markov Decision Process model by considering the problem of an agent in a grid world

Note: Students shall sincerely work towards completing all the above listed practicals for this course. In any circumstance, the completed number of practicals shall not be less than eight.

**Essential/recommended readings**


1. Introduction to Machine Learning with Python, by Andreas C. Müller, Sarah Guido, O'Reilly Media, Inc., 2016.
2. Machine Learning by Tom. M. Mitchell, Tata McGraw Hill, 1st ed (reprint) 2017.
3. Introduction to Machine Learning by Nils. J. Nilsson, 1998.
4. Introduction to Machine Learning by E. Alpaydin, PHI, 2005.


**Suggestive readings**


1. Machine Learning: A Probabilistic Perspective by Kevin P. Murphy, MIT Press, 2012.
2. Pattern recognition and Machine Learning by Christopher M. Bishop, Springer, 2006.


**Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**