Course Type	Course Code	Name of the Course	L	Т	Р	Credits
DE	CSD411	Introduction to Deep Learning		0	0	9

## **Course Objective**

This course is designed to cover the fundamentals of deep learning and its application in various domains.

## **Learning Outcomes**

On successful completion of this course, the students would be able to:

- Understand the basic concepts of neural networks and deep learning methods
- Learn the basic model types used in deep learning
- Apply strategies for modifying state-of-the-art deep learning architectures for a new dataset/task
- Identify suitable deep learning methods for solving real-world problems in various domains

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	<b>Introduction:</b> Course overview, Motivation, Mathematical foundations, Basic concepts of learning, Concept of model, model capacity, Generalization, Cost function, Optimization, Explaining learning with respect to the task of regression and classification (introducing linear regression and logistic regression models)	9	This unit will help the students to get motivation regarding this course and to acquire sufficient background to learn the topics in the subsequent units
2	Neural Network Basics: Biological Neuron and Artificial Neurons, Concept of Linear Perceptron, Perceptron Learning Algorithm, Linear separability, Convergence theorem for Perceptron Learning Algorithm, Multilayer Perceptron, Activation functions	4	This unit will introduce the students with the basic concepts of artificial neurons and artificial neural network
3	<b>Training Feed-Forward Neural Networks</b> : Backpropagation, Empirical Risk Minimization, Regularization, Difficulty of training deep neural networks, Dropout, Batch norm, Layer norm, Momentum and Acceleration, Adaptive gradient methods	4	In this unit, the students will learn how to train a neural network model and the various tricks to train a deep network
4	<b>Convolutional Neural Networks:</b> Basic concept of convolution, stride, padding, pooling etc., modern architectures: LeNet, AlexNet, VGGNet, GoogLeNet, ResNet, MobileNet/v2	8	This unit will help the students to gain the fundamental concepts of convolutional neural network and to become familiar with its various popular architectures
5	<b>Recurrent Neural Networks:</b> Basic concepts of recurrent neural network and its various architectures, concept of back propagation through time, Special architectures: Long Short Term Memory (LSTM), Gated Recurrent Units (GRU), Bidirectional LSTMs	7	In this unit, the students will learn about the fundamental concepts of recurrent neural network and also will become familiar with its various special/gated architectures
6	<b>Deep Unsupervised Learning:</b> Autoencoders and its variants, Concept of generative models, Restricted Boltzmann Machines, Variational Autoencoders, Recent trends	6	This unit will introduce the students with the concepts of deep unsupervised learning. The students will also become familiar with the idea of generative learning and its recent trends
7	<b>Applications:</b> Applications of the convolutional neural networks, recurrent neural networks and autoencoders in the domains of computer vision and natural language processing	4	This unit will help the students to learn how to apply suitable deep network models to solve various real- world problems

## **Text Book:**

• Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016. **Reference Books:** 

- Pattern Recognition and Machine Learning, Christopher Bishop, 2007
- Neural Networks for Pattern Recognition Christopher Bishop Clarendon Press 1st Edition 1996
- Neural Networks and Learning Machines Simon Haykin, Pearson Education; 3rd Edition 2016