Deep Learning

Course Code	Credit Hours
CS-405	3+1

Course Description

Since their resurgence in 2012, Deep Neural Networks have revolutionised computer vision, speech and object recognition, language translation, and many other application areas. This course covers the fundamental principles, practical applications, and advanced techniques of Deep Learning. Through a combination of lectures, hands-on exercises, and real-world case studies, students will gain a solid understanding of neural networks, convolutional neural networks (CNNs), recurrent neural networks (RNNs), and other deep learning architectures with a particular focus on supervised Deep Learning and reasonable coverage of unsupervised methods. Lectures are supplemented by assignments and lab tasks using Python programming language. Emphasising theoretical concepts and practical implementation, this course aims to equip students with the knowledge and skills to tackle complex problems in artificial intelligence and data analysis using deep learning.

Text Book:

1. Deep Learning by Ian Goodfellow, Yoshua Benjio, and Aaron Courville

Reference Book:

1. Any material (papers, notes, slides, video) on the web from credible sources.

Prerequisites

None

ASSESSMENT SYSTEM FOR THEORY

Quizzes	15%
Assignments	10%
Mid Terms	30%
ESE	45%

ASSESSMENT SYSTEM FOR LAB

Lab Work and Report	70-80%
Lab ESE/Viva	20-30%

Teaching Plan

Week No.	Topic	Learning Outcomes
1	Introduction to Deep Learning	Course Outline, objectives, teaching plan, assessment method, concepts review
2	Artificial Neural Networks: Perceptron and Multi-Layer Perceptron	Understand structure and limitations of single-layer perceptrons, explain the architecture and functionality of multi-layer perceptrons (MLPs)
3	Artificial Neural Networks: Backpropagation, Optimisation, and Implementation	Discover activation functions, Implement MLP using backpropagation.
4	Training Neural Networks: Hyperparameter Selection, Optimization Algorithms	Select various hyperparameters to avoid overfitting. Understand the working of different optimisation algorithms.
5	Convolutional Neural Networks	Components of CNN, Dilated Convolution, Transposed Convolution
6	Common CNN Architectures	VGG, Inception, Residual Networks, Dense Networks (Transfer Learning)
7	Computer Vision - I: Object Detection	
8	Computer Vision - II: Semantic Segmentation	
9	**Mid Term Break**	
10	Natural Language Processing-I	Sequence Modelling using RNN, GRU, LSTM
11	Natural Language Processing-II	Machine Translation using seq2seq models and Cross Attention
12	Natural Language Processing-II	Transformers and self-attention
13	Generative Models:	Autoencoders, VAEs, GANs, Diffusion Models
14	Reinforcement Learning	Introduction to Reinforcement Learning and Q-Learning, epsilon-greedy policy
15	Bias in AI	Identifying and mitigating biases in data and deep models.
16	Advanced Topics in Deep Learning	
17	Project Presentations	
18	**End Term Exam**	

Lab Experiments

Week No.	Description
1	Introduction to Python
2	Basics of Neural Networks using python
3	Implementation of multilayer perceptron
4	Backpropagation
5	Optimization
6	Hyper parameters Tuning
7	Implementation of CNNs
8	Transfer Learning using common CNNs
9	**Mid Semester Break**
10	Image Segmentation using neural networks
11	**Open-Ended Lab**
12	Implementation of RNNs
13	Introduction to NLP: Preprocessing raw text data
14	Machine translation using Transformers
15	**Open-Ended Lab**
16	Reinforcement Learning
17	Project Demo/Viva
18	**End Semester Break**