SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology

Year: B. Tech IV (Semester VII)

Subject Name: Deep Learning **Subject Code:** BTAI13701
Type of course: Professional Core Course
Prerequisite (if any): Basics of Machine Learning, Python programming

Rationale: The course of Deep Learning is a branch of machine learning concerned with the development and application of modern neural networks. Deep learning algorithms extract layered high-level representations of data in a way that maximizes performance on a given task. In this course, students will learn the fundamental principles, underlying mathematics, and implementation details of deep learning.

Teaching and Examination Scheme:

Teaching Scheme				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	2	4	60	25	15	30	20	150

CA1: Continuous Assessment (assignments / projects / open book tests / closed book tests) CA2: Sincerity in attending classes / class tests / timely submissions of assignments / self-learning attitude / solving advanced problems TEE: Term End Examination TEP: Term End Practical Exam (Performance and viva on practical skills learned in course) CA3: Regular submission of Lab work / Quality of work submitted / Active participation in lab sessions / viva on practical skills learned in course.

Contents:

Sr. No.	Contents	Total Hours
1.	**Basics of Artificial Neural networks** Biological Neuron, Artificial Neurons, Computational Models Of Neurons, Structure Of Neural Networks, Boolean Functions Using Mcculloch-Pitts Neuron, Non-Linear Separability, Perceptron, Perceptron Learning Algorithm, Multilayer Perceptron, Feed Forward Neural Networks, Activation Functions, Empirical Risk Minimization, Stochastic Gradient Descent, Loss Functions, Back Propagation Learning, Regularization, Early Stopping	12
2.	**Introduction to Deep Learning** Deep Feed forward Network(DNN), Difficulty of training DNNs, Greedy layer wise training, Optimization for training DNNs, Second order methods for training, saddle point problem in neural networks, Regularization methods (dropout, drop connect, batch normalization), Newer optimization methods for neural networks-AdaGrad, RMSProp, Adam;	08

3.	**Convolution Neural Networks (CNNs)** Introduction to CNNs – convolution, pooling, Deep CNNs, Different deep CNN architectures – LeNet, AlexNet, Training a CNNs: weights initialization, batch normalization, Hyper parameter optimization, Understanding and visualizing CNNs	10
4.	**Recurrent Neural Networks (RNNs)** Sequence Modelling using RNNs, Back propagation Through Time, Long Short Term Memory (LSTM), Bidirectional LSTMs, Bidirectional RNNs	08
5.	**Recent trends and Applications** Auto Encoders (Standard, Sparse, De-Noising, Contractive), Variational Auto Encoders, Generative Adversarial Networks, Applications in Computer Vision, Speech Recognitions And Natural Language Processing	07

Suggested Specification table with Marks (Theory): (For B. Tech only)

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**30**	**10**	**5**	**0**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (Revised Bloom's Taxonomy)

Reference Books:

Sr no	**Title of book /article**	**Author(s)**	**Publisher and details like ISBN**	**Year of publication**	**Publication Edition**
1.	Deep Learning	Ian Goodfellow, Yoshua Bengio and Aaron Courville	MIT Press	2016	-
2.	Neural Networks - A Class Room approach	Satish Kumar	Tata McGraw-Hill	2013	2nd Edition
3.	Neural Networks and Learning Machines	Simon Haykin	Prentice Hall of India	2010	3rd Edition
4.	Pattern Recognition and Machine Learning	Christopher M. Bishop	Springer	2006	-
5.	Neural networks and Deep learning	Aurélien Géron	O'Reilly Media, Inc.	2018	-

Course Outcomes (CO):

Sr. No.	CO statements	Marks % weightage
CO-1	Understand and describe the mathematical formulation of different types of deep learning models	20%
CO-2	Analyze and Apply various optimization techniques in deep neural network.	20%
CO-3	Discuss the use of Convolution Neural networks and Recurrent neural networks in solving various applications.	40%
CO-4	Demonstrate deep learning algorithms and solve real-world problems.	20%

List of Open learning website:

- NPTEL: Deep Learning- https://nptel.ac.in/courses/106105215
- NPTEL:Introduction to Artificial Neural Networks- https://nptel.ac.in/courses/117105084

List of Open Source Software:

- Tensorflow
- Pytorch
- OpenCV

List of Experiments:

1. Write python codes for demonstrating basic math operations on scalar, vectors and matrix: Addition, multiplications, transpose, diagonal matrix, triangular matrix, orthogonal matrix, finding Eigenvalues and Eigenvectors.
2. Write a program to generate various logic functions (AND,OR,NOT, NOR, XOR) using McCulloch-Pitts neuron and appropriate values for weights, bias and threshold.
3. Provide a brief overview of three Python libraries along with their methods/functions commonly used in Deep Learning and create a document based on a case study.
4. Design a feed-forward neural network (NN) model with one hidden layer for classification problems using Numpy.(Use any suitable data set)
5. Creating a Multilayer Perceptron (MLP) Classifier Model. (Use any suitable data set)

6. Implement and compare different activation functions (e.g., sigmoid, tanh, ReLU) on a simple dataset.
7. Implement and compare different loss functions (e.g., mean squared error, cross-entropy) for classification and regression tasks.
8. Construct a Convolutional Neural Network (CNN) of your own design, featuring convolutional layers, pooling layers, and fully connected layers. Assess its performance and compare it to established models.
9. Implement dropout and L2 regularization in a neural network and observe the impact on overfitting.
10. Implement computer vision fundamentals with MNIST dataset.
11. Install OpenCv package on your system and perform following operations on images.
    a. Image Sharpening b. Edge Detection & Image Gradients c. Cropping d. Blurring