GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160315
Semester – VI
Introduction to Artificial Neural Network

Type of course: Open elective - II

Prerequisite: Basic algebra, Matrix operations, Regression, Partial Derivative Equations

Rationale: The main objective of this course is to provide the student with the basic understanding of neural networks and fuzzy logic fundamentals, Program the related algorithms and Design the required and related systems

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Contents	Total Hrs	% Weightage
1	**Introduction to Artificial Neural Network:** Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological Neuron Model, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Potential Applications of ANN.	6	22%
2	**Essentials of Artificial Neural Networks:** Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures (Perceptron, Hebbian, Adaline-Madaline), Classification Taxonomy of ANN – Connectivity, Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules, Types of Application	8	26%
3	**Single Layer Network and Multi-layer Network:** Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications, Generalized Delta Rule, Derivation of Backpropagation (BP) Training, Summary of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements.	8	26%
4	**Associative Memories:** Paradigms of Associative Memory, Pattern Mathematics, Hebbian Learning, General Concepts of Associative Memory (Associative Matrix, Association Rules, Hamming Distance, The Linear Associator, Matrix Memories, Content Addressable Memory), Bidirectional Associative Memory (BAM) Architecture, BAM Training Algorithms: Storage and Recall Algorithm, BAM Energy Function, Proof of BAM Stability	4	13%

5	Theorem Architecture of Hopfield Network: Discrete and Continuous versions, Storage and Recall Algorithm, Stability Analysis, Capacity of the Hopfield Network Summary and Discussion of Instance/Memory Based Learning Algorithms, Applications.	**4**	**13%**
	Total	**30**	**100%**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20%	25%	25%	15%	15%	0%

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

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Introduction to Neural Networks using MATLAB 6.0 - S.N.Sivanandam, S.Sumathi, S.N.Deepa, TMH, 2006
2. Learning and Soft Computing: Support Vector Machines, Neural Network and Fuzzy Logic - Vojislav Kecman, MIT Press, 2001
3. Fuzzy Logic with Engineering Applications - Timothy J. Ross, John Wiley & Sons, 2017
4. Neuro-fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence-Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Prentice Hall, 1997
5. Neural Networks and Artificial Intelligence for Biomedical Engineering by Donna L. Hudson and Maurice E. Cohen, Prentice Hall of India. Pvt. Ltd. New Delhi.
6. Neural Networks and Fuzzy Logic Systems by Simon Haykin, Pearson Education

Course Outcomes:

After learning the course, the students should be able to

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	Understand basics of Biological neural network and extension of it as Artificial Neural Network	22%
CO-2	Implement Different key aspects of Artificial neural network	26%
CO-3	Learn and Implement Perceptron network with performance optimization Algorithms	26%

CO-4	Learn and Implement Memory Storing Network for Bidirectional Associative Memory	13%
CO-5	Learn and Implement Memory Storing Network for Hopfield Network	13%

List of Experiments:

Sr. No.	Name of Experiments	Duration (Hours)
1.	Introduction to MATLAB: Neural Network (NN) Toolbox, NN Simulink Demos	**2**
2.	Implement Learning rules and activation functions in NN	**2**
3.	Development of logic using MP and Hebb neuron model	**2**
4.	Development of supervised learning using NN Toolbox	**2**
5.	Development and testing of perceptron NN algorithm	**2**
6.	Development of ADALINE algorithm with bipolar inputs and outputs	**2**
7.	Development of auto associative network using outer product rule	**2**
8.	Development of fuzzy membership functions and fuzzy set properties	**2**
9.	Implementation of Fuzzy Operations.	**2**
10.	Implementation of Fuzzy Relations (Max-min Composition)	**2**
11.	Design of a fuzzy controller using fuzzy tool of MATLAB	**2**

Major Equipment: Computer (Intel i-5 or above, 8-GB RAM and 500GB Hard disk)

Active Learning Assignments: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding of theory and practical work. The faculty will assign topics from which students can grasp knowledge about the current scenario of the ANN and FL based Biomedical Systems.

List of learning website:

- https://nptel.ac.in/courses/127/105/127105006/
- https://swayam.gov.in/nd1_noc20_ge09/preview