K. K. Wagh Institute of Engineering Education & Research, Nashik

(An Autonomous Institute From A.Y. 2022-23)

InSem Examination-IISummer2025	
Exam Seat No.:	
Academic Year:2024-2025	Semester:IV
Class:SY	Program:B.Tech
Branch Code:ROB	Pattern:2023
Name of Course:Artificial Neural Networks and fuzzy systems	Course Code:2312216
Max. Marks:30	Duration:1.15 Hrs.

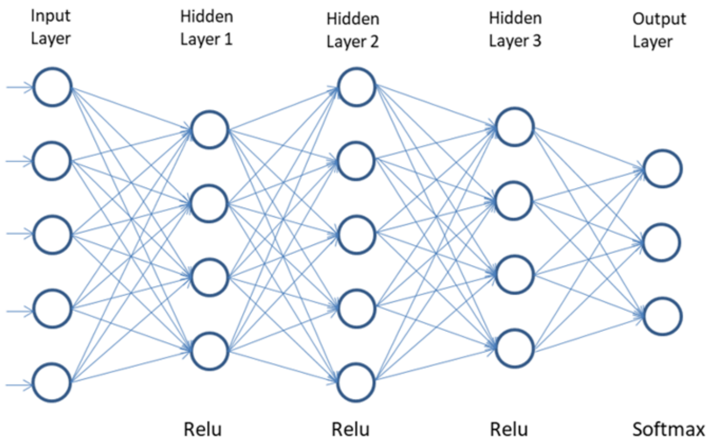
Instructions: Candidates should read carefully the instructions printed on the Question Paper and on the cover page of the Answer Book, which is provided for their use.

1. This question paper contains 4 pages.
2. Answer to each new question is to be started on a new page.
3. Assume suitable data wherever required, but justify it.
4. Draw the neat labelled diagrams, wherever necessary.
5. The last columns indicates the Course Outcome and level of Blooms Taxonomy of the Question/sub-question.

Marks CO

Question No. 1

1 a) A robotic sorting system in an automated warehouse uses a multi-layer neural network to classify objects into three categories based on sensor inputs. The system processes data from five different sensors and determines whether an object should be classified as Type A, Type B, or Type C using following architecture: (7) CO1



Sensor Readings for a new Object:

x1	x2	x3	x4	x5
0.7	0.3	0.9	0.2	0.5

Weights and Biases are given below:

Input → Hidden Layer 1					
Weights 1					Bias 1
0.2	0.3	0.5	0.7	0.1	0.1
0.4	0.6	0.8	0.2	0.5	0.2
0.3	0.9	0.7	0.6	0.4	0.3
0.5	0.1	0.2	0.8	0.3	0.4

Hidden Layer 1 → Hidden Layer 2				
Weights 2				Bias 2
0.3	0.6	0.1	0.5	0.2
0.8	0.2	0.4	0.7	0.1
0.9	0.3	0.6	0.2	0.3
0.4	0.7	0.5	0.8	0.5
0.2	0.9	0.1	0.6	0.4

Hidden Layer 2 → Hidden Layer 3					
Weights 3					Bias 3
0.5	0.7	0.3	0.6	0.8	0.3
0.2	0.9	0.4	0.1	0.5	0.1
0.8	0.2	0.6	0.3	0.7	0.2
0.3	0.5	0.9	0.7	0.1	0.4

Hidden Layer 3 → Output				
Weights 4				Bias 4
0.6	0.8	0.2	0.4	0.2
0.3	0.5	0.7	0.9	0.4
0.1	0.2	0.6	0.8	0.3

Classify the object as Type A, Type B, or Type C

Question No. 2

2 a) A robotic arm needs to decide whether to pick up an object based on two sensor inputs: (8) CO1

1. x_1: Signal indicating if the object's weight is within a safe range (+1 for within range, -1 for out of range).
2. x_2: Signal indicating if the object is within the arm's reach (+1 for within reach, -1 for out of reach).

The decision is given below:

- Pick the object (y = +1) if both conditions are met.
- Do not pick the object (y = -1) otherwise.

Assume the initial weights and bias are 0, and the bias for all inputs is set to 1.

1. Train a Hebb net with bipolar inputs (+1 and -1) and targets (y) to implement this decision function.
2. Determine the weight vector and bias using Hebbian learning.

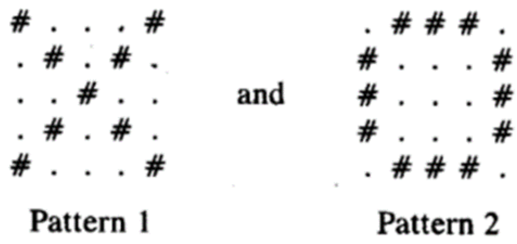
3. Plot the decision boundary on a 2D graph with x_1 on the x-axis and x_2 on the y-axis to visualize how the decision function separates the two classes (pick or do not pick).

OR

2 b) A robot is designed to navigate through different environmental patterns represented as 5×5 grids. The robot needs to classify these patterns to distinguish between navigable paths and obstacles. Two specific patterns, "X" and "O", are provided: (8) CO1

Pattern "X" (Navigable Path, Target Value = 1):

Pattern "O" (Obstacle, Target Value = -1):



Note: Initialize the weights to zero.

1. Using the Hebb rule, determine the weights required for the robot to correctly classify these patterns.

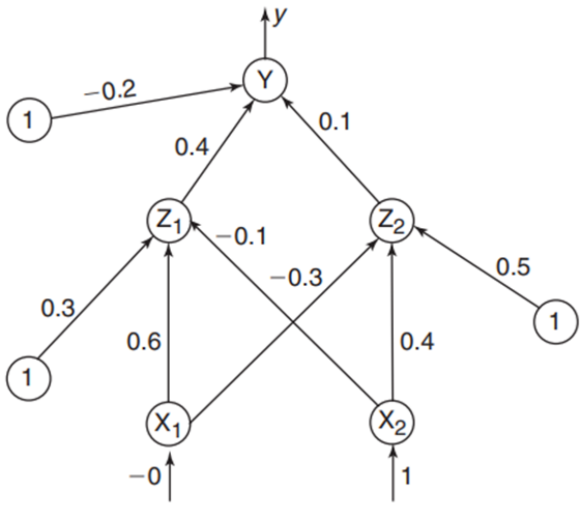
2. Verify if the robot can correctly classify "X" and "O" based on the learned weights.

Question No. 3

3 a) A robotic arm uses a neural network-based controller to adjust its movement based on sensor inputs. The network is trained using back-propagation to refine its weight parameters. (7) CO2

Given Scenario:

- Input Pattern: 0, 1 (Sensor readings)
- Target Output: 1 (Desired arm position)
- Learning Rate (α): 0.25
- Activation Function: Binary Sigmoid



1. Perform one iteration of the back-propagation algorithm.
2. Calculate updated weights for the network.

Question No. 4

4 a) A robotic arm is equipped with two proximity sensors to determine whether to pick up an object. The sensors provide bipolar input signals, and the arm must decide whether to pick up the object (target output = 1) or not (target output = -1) using an Adaline Network. (8) CO2

The truth table for the sensor inputs and target outputs is as follows:

x1 (Sensor 1)	x2 (Sensor 2)	Target t (Decision)
1	1	1
1	-1	1
-1	1	1
-1	-1	-1

Set the initial weights w1 = 0.1, w2 = 0.1 and bias b = 0.1.

Set the learning rate α = 0.1

1. Train the Adaline Network for each input sample.
2. Calculate the total Mean Squared Error (MSE) for Epoch 1.

OR

4 b) Design a Hopfield network to restore missing sensor readings in a robotic navigation system. Given the stored pattern: (8) CO2

$$\mathbf{X = [1, 1, 1, -1]}$$

(1 = obstacle, -1 = no obstacle)

1. Construct the weight matrix using the outer product rule (no self-connections).
2. Simulate sensor failures by setting the first and second readings to zero.
3. Restore missing values using asynchronous updating.
4. Verify convergence to the original pattern.

····· **End of question paper**·····