

2125  
M.E. (Electronics and Communication Engineering)  
Third Semester  
ECE-1301: Neural Network and Fuzzy Logic  
(For UIET)

Time allowed: 3 Hours

Max. Marks: 50

**NOTE:** Attempt five questions in all, including Question No. 1 which is compulsory and selecting two questions from each Section.

x-x-x

- Q 1(a) Describe the perceptron learning rule. (2)
- (b) What are different tasks done after completion of an epoch? (2)
- (c) What is the primary purpose of an activation function in a neural network? (2)
- (d) According to the Delta Learning Rule's weight update formula,  $w = w + \alpha(y-t)x \cdot d(a)$ , what does the term  $d(a)$  represent? (2)
- (e) Describe the Centroid defuzzification method (2)

**Section - A**

- Q2 (a) Explain how the error correction mechanism differs between Adaline and Perceptron learning rule and why Adaline can converge where the Perceptron fails. (5)
- (b) Derive the gradient update rule for a three-layer feedforward neural network. Describe the step-by-step calculation of partial derivatives with respect to weights and biases. (5)
- Q3 (a) Compare sigmoid, tanh, ReLU, and softmax in terms of mathematical properties, their derivatives advantages, and limitations. (5)
- (b) How does a feedforward neural network with a single hidden layer can approximate any continuous function, and what are the practical limitations of this theorem? (5)
- Q 4 (a) Discuss the role of Gaussian functions in RBF networks and how the distance metric influences hidden layer activation. Compare supervised and unsupervised methods for determining centers in RBF networks. (5)
- (b) Design an RBF network for function approximation of a nonlinear system. Analyze the limitations of RBF networks in high-dimensional spaces using an example. (5)

**Section -B**

- Q5 (a) Explain the stability in Adaptive Resonance Theory (ART). What is the role of the vigilance parameter? (5)
- (b) Describe the training process of a Self-Organizing Map (SOM) by highlighting the role of neighborhood functions and their impact on topological preservation. (5)
- Q6 (a) Differentiate between hetero-associative and auto-associative memory models. Provide examples of each and explain their applications in pattern recognition (5)
- (b) Analyze the energy function of a Hopfield network. How does it ensure convergence to stable states, and what limitations arise in large-scale networks. (5)
- Q7 (a) Discuss the role of fuzzification in a fuzzy inference system. Describe the process of converting crisp inputs into fuzzy sets, and illustrate with a real-world example (5)
- (b) Using your own intuition, develop fuzzy membership functions on the real line for the fuzzy number "approximately 2 to approximately 8", using the following function shapes: (5)
- (a) Symmetric triangles (b) Trapezoids. (c) Gaussian functions.

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