(Time: 3 Hrs) **Marks: 80**

N.B. : 1. Question no. 1 is **compulsory**.
2. Solve any **Three** questions out of remaining **Five** questions.

Qu-1 Attempt any **FOUR** of the following.

a) How do genetic Algorithms differ from conventional optimization algorithms? **5**

b) **Demonstrate/Outline** the excluded middle axioms, extended for fuzzy sets. **5**

c) Demonstrate/outline the working of Roulette-wheel selection. **5**

d) Consider a fuzzy set and use Zadeh's notation to represent the same defined on universe X = {a, b, c, d, e, f}. Then compute/Infer λ cut for**:** a) $\lambda = 0.9$ b) $\lambda = 0.3$ **5**

e) A single-layer neural network has the weights w = [0.2 0.5 0.66 0.45] with bias b=0.3. It is given an input of I = [0.5 0.8 0.1 0.36]. **Find/estimate** the output if the sigmoidal activation function is used (slope = 0.3) **5**

Qu-2 a) Determine the weights after one iteration for Hebbian learning of a single neuron network starting with initial weights w = [1 -1]. The inputs are X_1 = [1 -2], X2 = [2 3], X_3 = [1, -1] and learning rate c=1.
a) Use Bipolar Binary activation function.
b) Use Bipolar continuous activation function. **10**

b) What are Neuro-Fuzzy Systems? Explain the steps in Neuro-Fuzzy Hybrid System. **10**

Qu-3 a) Using Mamdani fuzzy model design a fuzzy logic controller to determine the wash time of a domestic washing machine. Assume that the inputs are dirt and grease on cloths. Use three descriptors for each input variables and five descriptors for the output variable. Derive a set of rules for control action and defuzzification. The design should be supported by figures wherever possible. Show/Defend that if the clothes are soiled to a larger degree the wash time will be more and vice-versa. **10**

b) Explain McCulloch Pitts neuron model with example. **10**

Qu-4 a) Describe Genetic Algorithms considering: Encoding, Selection, Crossover, Mutation, and Stopping Condition for Genetic Algorithms. **10**

b) Consider a suitable set of the binary input/output row matrix to train a hetero-associative network. Demonstrate the working of hetero-associative network and compute the final weight matrix. **10**

Qu-5 a) Explain the Backpropagation Algorithm with flowchart. **10**

b) List the variety of Genetic algorithms and explain the Hybrid GA. **10**

Qu-6 a) What is Linear Separability? Explain with example why single layer perceptron is not capable of solving Linearly Inseparable problems. **10**

b) Let R and S be two fuzzy relations defined as: **10**

$$R = \begin{array}{c} \\ x1 \\ x2 \end{array} \begin{pmatrix} y1 & y2 & y3 \\ 0.0 & 0.2 & 0.8 \\ 0.3 & 0.6 & 1.0 \end{pmatrix} \qquad S = \begin{array}{c} \\ y1 \\ y2 \\ y3 \end{array} \begin{pmatrix} z1 & z2 & z3 \\ 0.3 & 0.7 & 1.0 \\ 0.5 & 1.0 & 0.6 \\ 1.0 & 0.2 & 0.0 \end{pmatrix}$$

a) Compute/Infer the result of R°S using max-min composition**.**
b) Compute/Infer the result of R⋆S using max-product composition.
