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

  b) A single-layer neural network has the weights w = [0.2 0.5 0.66 0.45] with bias b=0.3. **5**
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)

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

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

  e) Let us consider the discrete fuzzy set $A = \left\{ \dfrac{1}{a} + \dfrac{0.9}{b} + \dfrac{0.6}{c} + \dfrac{0.3}{d} + \dfrac{0.01}{e} + \dfrac{0}{f} \right\}$ using **5**
Zadeh's notation, defined on universe $X = \{a, b, c, d, e, f\}$.
Compute/Infer λ cut for**:** a) $\lambda = 0.9$ b) $\lambda = 0.3$

Qu-2 a) Using Mamdani fuzzy model design a fuzzy logic controller to determine the wash **10**
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.

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

Qu-3 a) Determine the weights after one iteration for Hebbian learning of a single neuron **10**
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.

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

Qu-4 a) What is Linear Separability? Explain with example why single layer perceptron is not **10**
capable of solving Linearly Inseparable problems.

  b) Using the binary input/output row matrix shown in table-1 train a hetero-associative **10**
network to store the input row vectors s = {s1, s2, s3, s4} to the output row vector t
= {t1, t2}. Obtain/predict the final weight matrix

Table-1: Input row vectors {s1, s2, s3, s4} and output row vector {t1, t2}.

	s1	s2	s3	s4	t1	t2
1st	1	0	0	0	1	0
2nd	1	1	0	0	1	0
3rd	0	0	0	1	0	1
4th	0	0	1	1	0	1

Qu-5 Consider a 2-2-2 three-layer network as shown in figure-1. Perform calculations (upto 4 decimal places) assuming back-propagation learning for one iteration on the input, and desired output patterns given in Table-2.   **20**
a) Learning rate $\eta = 0.8$, Momentum $\alpha = 0.8$ and Sigmoidal activation function.

Table-2: Input-Output pattern.

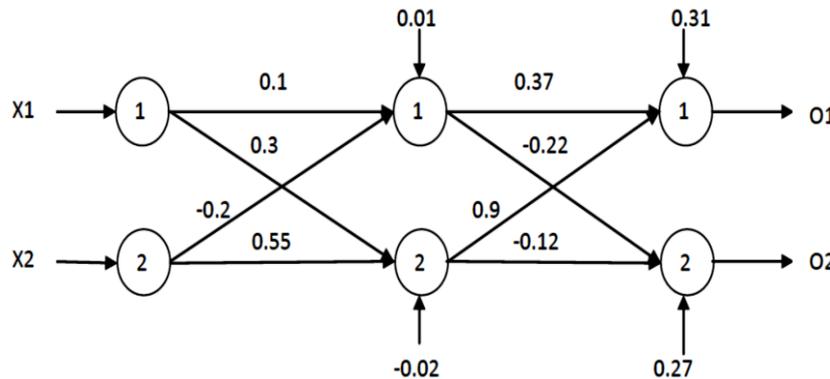| Pattern Index	Input		Output/desired	
	X1	X2	O1	O2
1	0.5	-0.5	0.9	0.1

Figure-1: The MLP with initial weights

Qu-6 a) Describe Genetic Algorithms considering: Encoding, Selection, Crossover, Mutation, and Stopping Condition for Genetic Algorithms.   **10**

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

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

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

_____