

SOFT COMPUTING

(MCA1231)

Time Allotted : 2½ hrs

Full Marks : 60

Figures out of the right margin indicate full marks

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group

Candidates are required to give answer in their own words as far as practicable.

Group - A

1. Answer any twelve:

$$12 \times 1 = 12$$

Choose the correct alternative for the following

(i) In a genetic algorithm, what does mutation refer to?

- (a) Randomly selecting individuals from the population
- (b) Swapping genetic material between individuals
- (c) Introducing random changes to individuals' genetic material
- (d) Selecting the fittest individuals for reproduction

(ii) In the Partially-Mapped Crossover (PMX) technique of genetic algorithms within soft computing, if we have two parents with chromosomes represented as [1, 3, 5, 7, 2, 4, 6, 8] and [8, 4, 7, 3, 6, 2, 5, 1], and the crossover points are selected as 3 and 6, what will be the resulting offspring after applying the PMX crossover?

- (a) [1, 4, 7, 3, 2, 6, 5, 8] and [8, 3, 5, 7, 6, 2, 4, 1]
- (b) [1, 3, 7, 2, 6, 4, 5, 8] and [8, 4, 5, 3, 6, 2, 7, 1]
- (c) [8, 3, 5, 7, 6, 2, 4, 1] and [1, 4, 7, 3, 2, 6, 5, 8]
- (d) [8, 4, 7, 3, 6, 2, 5, 1] and [1, 3, 5, 7, 2, 4, 6, 8]

(iii) In Hebbian learning, if the input neuron fires with an output of 0.5, and the synaptic weight between them is initially set to 0.2, what will be the updated weight after one iteration if the learning rate is 0.3?

- (a) 0.65
- (b) 0.35
- (c) 0.23
- (d) 0.41

(iv) Which of the following is the primary function of an activation function in an artificial neural network?

- (a) To adjust the learning rate during training
- (b) To introduce non-linearity into the network
- (c) To normalize the input data
- (d) To initialize the weights

(v) Consider a simple feedforward neural network with one hidden layer. The input layer has 3 neurons, the hidden layer has 2 neurons, and the output layer has 1 neuron. If the weights between the input and hidden layer and the bias for the hidden neurons are respectively:

$$W = \begin{bmatrix} 0.2 & 0.4 & 0.6 \\ 0.1 & 0.3 & 0.5 \end{bmatrix}, B = \begin{bmatrix} 0.1 \\ 0.2 \end{bmatrix}$$

What is the output of the hidden layer for an input vector $X = [1, 0.5, 0.8]$ using the ReLU activation function?

(a) [0.5, 0.7] (b) [0.7, 1.0]
(c) [0.6, 0.9] (d) [0.4, 0.6]

(vi) Which of the following best describes the core and support of a fuzzy relation in fuzzy logic?

- (a) The core represents the strongest degree of membership in the relation, while the support indicates the range of values over which the relation is defined
- (b) The core represents the range of values over which the relation is defined, while the support indicates the strongest degree of membership in the relation
- (c) The core and support are synonymous terms referring to the same concept in fuzzy logic
- (d) The core represents the weakest degree of membership in the relation, while the support indicates the range of values over which the relation is defined

(vii) Consider a fuzzy set Old as defined below $Old=\{(20,0), (30,0.2), (40,0.4), (50,0.6), (60,0.8), (70,1), (80,1)\}$. The alpha-cut of Old i.e. Old_α for $\alpha = 0.4$ will be

- (a) $\{(20,0), (30,0), (40,0.4), (50,0.6), (60,0.8), (70,1), (80,1)\}$
- (b) $\{(20,0), (30,0), (40,0), (50,0.6), (60,0.8), (70,1), (80,1)\}$
- (c) $\{40, 50, 60, 70, 80\}$
- (d) $\{50, 60, 70, 80\}$

(x) In PSO, what is the primary purpose of the 'personal best' (pbest) position for each particle
 (a) To help the particle avoid getting stuck in local minima
 (b) To guide the particle towards the global best solution by maintaining the best fitness value found so far
 (c) To adjust the particle's velocity during each iteration
 (d) To store the best solution for the entire swarm

Fill in the blanks with the correct word

(xi) In fuzzy set operations, the _____ operator combines membership values from different fuzzy sets to determine the degree of overlap or similarity between them.

(xii) The core concept of ant colony optimization lies in the _____ mechanism, where pheromone trails are updated based on the quality of solutions found by individual ants.

(xiii) Soft computing approaches are often employed in situations where traditional methods fail to provide accurate solutions due to the presence of ambiguity, complexity, and _____.

(xiv) In rough set theory, the concept of _____ is used to identify objects or elements that cannot be distinguished based on available information, leading to the creation of rough approximations of sets.

(xv) The process of adjusting the weights of a neural network based on the error is called _____.

Group - B

2. (a) With a suitable example explain 'Hamming cliff problem'. [(CO2)(Understand/LOCQ)]
 (b) Two parent chromosomes in order GA are given in the following figure:

$P_1:$	8	4	7	3	6	2	5	1	9	0
$P_2:$	0	1	2	3	4	5	6	7	8	9

(c) Apply "Partially mapped crossover (PMX)" technique to obtain the two offspring chromosomes. [(CO2)(Apply/IOCQ)]
 Consider the following chromosome in order GA encoding scheme.

Offspring:	B	H	F	G	C	E	A	D
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Explain how such a chromosome can be mutated. Consider the least change in chromosomes between the offspring and the mutated offspring. [(CO2)(Analyse/IOCQ)]

4 + 4 + 4 = 12

3. (a) Evaluate the potential impact of soft computing techniques on the future of artificial intelligence and automation. [(CO1)(Evaluate/HOCQ)]
 (b) Consider the following table with individuals and their fitness values:

Individual :	1	2	3	4	5	6	7	8
Fitness Value :	1.01	2.11	3.11	4.01	4.66	1.91	1.93	4.51

(c) Explain the selection process using Roulette-Wheel selection scheme. [(CO2)(Apply/IOCQ)]
 Consider the following two parents in binary-coded GA. Find out the offspring(s) using two-point crossover technique (crossover points may be selected randomly).

Parent 1: 0 1 1 0 0 0 1 0

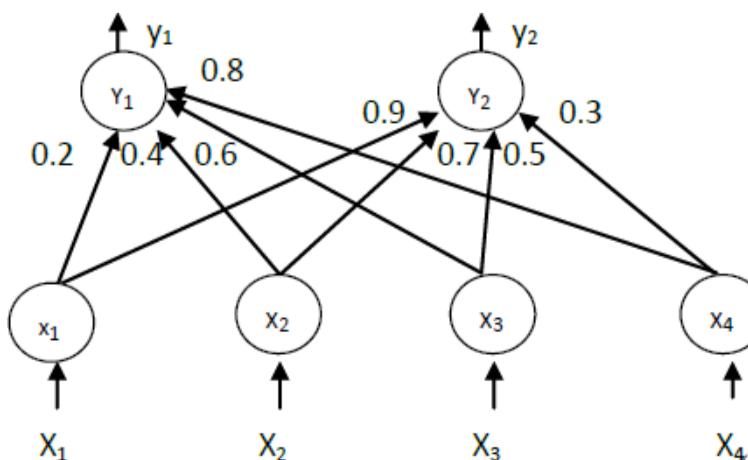
Parent 2: 1 0 1 0 1 1 0 0

[(CO2)(Apply/IOCQ)]

4 + 4 + 4 = 12

Group - C

4. (a) Build a ANDNOT function using McCulloch-Pitts neuron. Use suitable data representation. [(CO3)(Apply/IOCQ)]
 (b) Consider a Kohonen self-organizing net with two cluster units and four input units. The weight vectors for the cluster units are given by,
 $w1 = [0.2 \ 0.4 \ 0.6 \ 0.8]$, $w2 = [0.9 \ 0.7 \ 0.5 \ 0.3]$.
 Use the square of the Euclidean distance to generate the winning cluster unit for the input pattern [1 0 1 1] using a learning rate of 0.3. Find the new weights for the winning unit.



[(CO3)(Apply/IOCQ)]

6 + 6 = 12

5. (a) Implement OR function using McCulloch-Pitts neuron. Use binary data representation.
 (b) What is supervised learning and how is it different from unsupervised learning?
 (c) Indicate the difference between excitatory and inhibitory weighted interconnections.

[(C03)(Apply/IOCQ)]

[(C03)(Remember/LOCQ)]

[(C03)(Apply/IOCQ)]

6 + 2 + 4 = 12

Group - D

6. (a) How can the concept of fuzzy set operations, such as union, intersection, and complement, be applied to effectively handle uncertainties in decision-making processes within complex systems?
 (b) What are the key steps involved in the defuzzification process within fuzzy logic, and how does each step contribute to converting fuzzy sets into crisp values for decision-making or control systems?

[(C04)(Evaluate/HOCQ)]

[(C04)(Understand/LOCQ)]

6 + 6 = 12

7. (a) Consider $\tilde{A}(x)$ and $\tilde{B}(x)$ are two fuzzy sets define below:

$$\tilde{A}(x) = \{(x_1, 0.5), (x_2, 0.6), (x_3, 0.4), (x_4, 0.7)\}$$

$$\tilde{B}(x) = \{(x_1, 0.8), (x_2, 0.7), (x_3, 0.6), (x_4, 0.9)\}$$

Find out the value of following fuzzy sets

(i) $(\tilde{A} \cap \tilde{B})(x)$, (ii) $\tilde{A}(x) \ominus \tilde{B}(x)$.

[(C04)(Apply/IOCQ)]

(b) Consider two fuzzy sets A and B, defined on the universe of discourse $X = \{1, 2, 3, 4, 5\}$, where the membership functions are given as follows:

$$\mu_A(1) = 0.8, \mu_A(2) = 0.6, \mu_A(3) = 0.4, \mu_A(4) = 0.2, \mu_A(5) = 0.1$$

$$\mu_B(1) = 0.7, \mu_B(2) = 0.5, \mu_B(3) = 0.3, \mu_B(4) = 0.1, \mu_B(5) = 0.6$$

Calculate the value of the fuzzy set relation operator $R(A, B)$ using the max-min and max-product composition.

[(C04)(Apply/IOCQ)]

6 + 6 = 12

Group - E

8. (a) Consider the information system presented bellow represents data related to the shopping habits of a number of customers to a shopping mall. Generate the reducts of the information system as well as the minimal reducts from the set of reducts obtained.

#	Customer Name	Gender (GD)	Food (F)	Garment (GM)	Cosmetics (C)	Toys (D)	Amount (A)	Payment Mode (P)
1	Mili	F	Yes	Yes	Yes	Yes	High	CC
2	Bill	M	Yes	No	No	No	Low	Cash
3	Rita	F	Yes	Yes	Yes	Yes	High	CC
4	Pam	F	Yes	Yes	Yes	Yes	High	CC
5	Maya	F	No	No	Yes	No	Medium	Cash
6	Bob	M	Yes	No	No	No	Medium	CC
7	Tony	M	Yes	No	No	No	Low	Cash
8	Gaga	F	Yes	Yes	Yes	Yes	High	CC
9	Sam	M	Yes	No	No	No	Low	Cash
10	Abu	M	Yes	No	No	No	Low	Cash

[(C05)(Apply/IOCQ)]

(b) Also, extract the rules on the basis of one of the minimal reducts and assuming modes of payment (P) to be the decision attribute.

[(C05)(Apply/IOCQ)]

6 + 6 = 12

9. (a) Discuss the behaviour of real ants and compare it with artificial ants.
 (b) Consider similarity (\approx) relation of triangles i.e., two triangles are similar if they have the same set of angles. Prove that similarity relation of triangles is an equivalence relation.
 (c) Summarize the advantages and disadvantages of PSO.

[(C06)(Evaluate/HOCQ)]

[(C05)(Apply/IOCQ)]

[(C06)(Evaluate/HOCQ)]

4 + 4 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	12.5	68	19.5

