SOFT COMPUTING
(MCA 1231)

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 × 1 = 12**

Choose the correct alternative for the following

(i) What is the primary characteristic that distinguishes soft computing from conventional computing?
(a) Soft computing relies on hard rules and logic
(b) Soft computing is more deterministic and precise
(c) Soft computing deals with approximate reasoning and tolerance for uncertainty
(d) Soft computing is exclusively focused on binary computations.

(ii) What role does selection play in a genetic algorithm?
(a) It determines the probability of each individual being selected for reproduction
(b) It randomly shuffles the population to prevent stagnation
(c) It ensures that only individuals with the highest fitness are allowed to reproduce
(d) It controls the rate at which mutations occur in the population.

(iii) 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

(iv) How does a genetic algorithm evaluate the fitness of individuals in a population?
(a) By assigning a random fitness score to each individual
(b) By measuring how close an individual's traits are to the desired solution
(c) By ranking individuals based on their age in the population
(d) By counting the number of offspring each individual produces.

(v) 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]

(vi) A perceptron can be defined as
(a) A double layer auto-associative neural network
(b) A neural network with feedback
(c) An auto-associative neural network
(d) A single layer feed-forward neural network with pre-processing.

(vii) Which of the following is not the promise of an artificial neural network?
(a) It can survive the failure of some nodes
(b) It can handle noise
(c) It can explain the result
(d) It has inherent parallelism.

(viii) In a fuzzy set representing the membership function of 'moderate temperature' on a scale of 0 to 100, if the core of the set spans from 40 to 70 with a membership value of 1, and the support extends from 20 to 90, what is the width of the support?
(a) 10 (b) 20 (c) 70 (d) 80.

(ix) Let I = (U, A) be an information system and B⊂A and X⊂U. Then which of the following is defined as the B-outside region of X?
(a) $U - \underline{B}(X)$ (b) $U - \overline{B}(X)$
(c) $\overline{B}(X) - \underline{B}(X)$ (d) $\overline{B}(X) \cap X$

(x) What role does the concept of indiscernibility play in rough set theory?
(a) It determines the degree of uncertainty associated with each attribute
(b) It identifies objects that cannot be distinguished based on available information
(c) It quantifies the similarity between different elements in a dataset
(d) It defines the boundaries between rough sets and crisp sets.

Fill in the blanks with the correct word

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

(xii) The crossover operation in genetic algorithms involves combining genetic material from two or more parents to create _____.

(xiii) Activation functions in neural networks introduce _____ to the output of each neuron, allowing the network to model complex, nonlinear relationships in data.

(xiv) In neural networks, the process of adjusting the weights between neurons during training is known as _____.

(xv) 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.

Group - B

2. (a) With a suitable example explain 'Hamming cliff problem'. *[(CO2)(Understand/LOCQ)]*

(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

Explain the selection process using Roulette-Wheel selection scheme.
[(CO2)(Apply/IOCQ)]

(c) 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

3. (a) In what ways, Soft Computing is different from Hard Computing?
[(CO1)(Understand /LOCQ)]

(b) Outline the future scope of soft computing. *[(CO1)(Evaluate/HOCQ)]*

(c) State a few instances of hybrid systems. *[(CO1)(Remember/LOCQ)]*

5 + 5 + 2 = 12

Group - C

4. (a) Design a Hebb net to implement logical AND function (use bipolar inputs and targets). *[(CO3)(Apply/IOCQ)]*

(b) What is the importance of threshold in perceptron network? *[(CO3)(Understand/LOCQ)]*

(c) What is supervised learning and how is it different from unsupervised learning? *[(CO3)(Understand/IOCQ)]*

8 + 2 + 2 = 12

5. (a) Find the weights using perceptron network for ANDNOT function when all the inputs are presented only one time. Use bipolar inputs and targets. *[(CO3)(Apply/IOCQ)]*

(b) Consider a multi-layer perceptron with 3 input neurons, 2 hidden layers each containing 4 neurons, and 2 output neurons. The activation function used in all layers is the ReLU (Rectified Linear Unit) function.
Given an input vector [2, 3, 4]:
1. Calculate the output of the first hidden layer.
2. Calculate the output of the second hidden layer.
3. Calculate the final output of the MLP.

[(CO3)(Apply/IOCQ)]

6 + (2 + 2 + 2) = 12

Group - D

6. (a) Using your own intuition and definitions of the universe of discourse, plot fuzzy membership functions for the linguistic variable 'room temperature'. *[(CO4)(Apply/IOCQ)]*

(b) Consider two fuzzy sets $\tilde{A}$ and $\tilde{B}$, both defined on X, given as follows:

μ	x1	x2	x3	x4	x5
$\tilde{A}$	0.2	0.3	0.4	0.7	0.1
$\tilde{B}$	0.4	0.5	0.6	0.8	0.9

Express the following λ-cut sets using Zadeh's notation:
(i) $\left(\widetilde{A} \cap \widetilde{B}\right)_{0.6}$, (ii) $\left(\widetilde{A} \cup \widetilde{B}\right)_{0.8}$ *[(CO4)(Apply/IOCQ)]*

(c) Consider $\widetilde{A}(x)$ and $\widetilde{B}(x)$ are two fuzzy sets define below:

$$\widetilde{A}(x) = \{(x_1, 0.5), (x_2, 0.6), (x_3, 0.4), (x_4, 0.7)\}$$
$$\widetilde{B}(x) = \{(x_1, 0.8), (x_2, 0.7), (x_3, 0.6), (x_4, 0.9)\}$$

Find out the value of following fuzzy set
(i)$\left(\widetilde{A} \cap \widetilde{B}\right)(x)$, (ii)$\tilde{A}(x) \ominus \tilde{B}(x)$ *[(CO2)(Apply/IOCQ)]*

4 + (2 + 2) + (2 + 2) = 12

7. (a) Consider a fuzzy logic system that uses triangular membership functions for its input variables. The input variable 'Temperature' has three linguistic terms: 'Cold', 'Medium', and 'Hot', with corresponding triangular membership functions defined as follows:
- Cold: (0, 0, 20)
- Medium: (10, 20, 30)
- Hot: (20, 40, 40)

Now, suppose the fuzzy logic system receives a crisp input temperature value of 15. Using the centroid method for defuzzification, calculate the crisp output value. *[(CO4)(Apply/IOCQ)]*

(b) Consider two fuzzy sets A and B defined on the universal set X = {1, 2, 3, 4, 5} as follows:
A = {(1, 0.6), (2, 0.8), (3, 0.5), (4, 0.4), (5, 0.7)}
B = {(1, 0.3), (2, 0.9), (3, 0.6), (4, 0.2), (5, 0.5)}
Using the max-min composition and max-product composition methods, find the resulting fuzzy relation R = A ∘ B.
[(CO4)(Apply/IOCQ)]

6 + 6 = 12

Group - E

8. (a) Explain in brief with a relevant example what you mean by reducts in rough set theory. *[(CO5)(Understand/LOCQ)]*
(b) Consider the following information system:

	a1	a2	a3
X1	2	1	3
X2	3	2	1
X3	2	1	3
X4	2	2	3
X5	1	1	4
X6	1	1	2
X7	3	2	1
X8	1	1	4
X9	2	1	3
X10	3	2	1

If attribute B = {a1, a2, a3} is selected, find out the equivalence classes. Detect the lower approximation, upper approximation, and boundary region of this set. *[(CO5)(Apply/IOCQ)]*

4 + (4 + 4) = 12

9. (a) What do you mean by rough membership? *[(CO5)(Understand/LOCQ)]*
(b) How TSP can be solved using ACO/PSO? Describe operations performed in different phases. *[(CO6)(Evaluate/HOCQ)]*
(c) Explain the artificial Bee Colony algorithm. *[(CO6)(Understand/LOCQ)]*

3 + (3 + 3) + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	23.96	64.58	11.46

Course Outcome (CO):

After the completion of the course students will be able to
CO1: Identify different soft computing concepts and technologies to solve real-time problems.
CO2: Analyze genetic algorithms to solve single and multi-objective optimization problems.
CO3: Identify different neural network architectures, algorithms, applications and their limitations.
CO.4: Relate the partial knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic.
CO5: Substantiate the need for approximate analysis using rough set.
CO6: Compare between various evolutionary algorithms and apply them suitably.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*