SOFT COMPUTING
(CSBS 3133)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

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

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Supervised Learning in the soft computing domain, primarily denotes a technique of _____
(a) learning from historic data
(b) learning from a human teacher
(c) learning from action-based reward/penalty experience
(d) none of these.

(ii) Which of the following GA operator do not help in exploring the various parts of the search space?
(a) Selection (b) Crossover (c) Mutation (d) None of these.

(iii) Which of the following selection technique never selects the worst-fit chromosome of a population?
(a) Roulette wheel (b) Tournament selection
(c) Both (a) and (b) (d) None of these.

(iv) The length of chromosomes in binary-coded GAs, is decided by
(a) number of design variables (b) objective functions
(c) constraints (d) all of these.

(v) Which of the following functions cannot be resolved by a single perceptron model?
(a) AND (b) OR (c) XOR (d) None of these.

(vi) How many passes are required in Hebb learning algorithm?
(a) One (b) Two
(c) No fixed number of passes (d) None of these.

(vii) Which of the following is not true about McCulloch-Pitts neurons?
(a) The interconnections are unidirectional
(b) All excitatory interconnections have the same weight
(c) All inhibitory interconnections have the same weight
(d) The activation is bipolar.

(viii) Fuzzy logic is a form of
(a) two-valued logic (b) crisp set logic
(c) multivalued logic (d) one-valued logic.

(ix) 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)}
Then the alpha-cut for alpha=0.6 for the set *old* will be
(a) {(50, 0.6), (60, 0.8), (70, 1), (80, 1)}
(b) {50, 60, 70, 80}
(c) {60, 70, 80}
(d) {(20,0), (30,0), (40,1), (50,1), (60,1), (70,1), (80,1)}

(x) 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) None of these.

Group- B

2. (a) What do you mean by soft computing? Define a few applications of soft computing in engineering. [(CO1)(Understand/LOCQ)]

(b) Consider the population of 5 individuals with fitness values: $f_1 = 4.5$, $f_2 = 2.3$, $f_3 = 1.7$, $f_4 = 1.2$ and $f_5 = 0.3$. Select the two individuals for the mating pool using the *Roulette-Wheel selection* technique and *Rank-based selection* technique. Comments on results. [(CO2)(Analyse/IOCQ)]

(c) What do you mean by *generation gap* in the genetic algorithm? Explain any two strategies that are used to improve the value of *generation gap*. [(CO2)(Understand/LOCQ)]

(1 + 2) + (3 + 2 + 1) + (1 + 2) = 12

3. (a) Explain *Phenotype* and *Genotype* with a proper example. [(CO2)(Understand/LOCQ)]

(b) Consider the parent chromosomes P_1 and P_2 with length 8 in order-coded GA, given below:

P_1:	8	6	1	7	2	3	4	5
P_2:	2	3	4	7	6	5	1	8

Consider the vector V of length 8 randomly filled with elements from the set {1, 2} as {2, 1, 1, 2, 1, 2, 2, 1} Find the offspring(s) using the Precedence-preservation crossover (PPX) technique. [(CO2)(Apply/IOCQ)]

(c) Explain the *Uniform crossover* technique in connection with binary-coded GA, with an appropriate example. [(CO2)(Understand/LOCQ)]

(d) Consider the *Child chromosome* in ordered GA, given below:

Child Chromosome:	7	2	8	3	6	1	5	4

Also, consider two random points 3 and 6. Find out the mutated chromosome by using *scramble mutation* techniques. [(CO2)(Apply/IOCQ)]

2 + 4 + 4 + 2 = 12

Group – C

4. (a) Design an Artificial neural network for following data set with 2 classes having attributes x1 and x2. Consider the threshold is 0.5, learning rate is 0.6, bias is -2 and weigh values (w1, w2) are (0.3, 0.7), compute the value of the output and train using perceptron learning rule for one epoch.

x1	x2	Class
1	1	1
1	0	1
0	1	-1
0	0	1

[(CO3)(Analyse/IOCQ)]

(b) Design a Hebb net to implement OR function considering bipolar inputs and targets. [(CO3)(Analyse/IOCQ)]

7 + 5 = 12

5. (a) Draw the architecture and describe the steps involved in the training of the Back Propagation Neural Network (BPNN). [(CO3)(Understand/LOCQ)]

(b) Discuss the importance of the hidden layer in BPNN. [(CO3)(Understand/LOCQ)]

(c) Distinguish between supervised learning and unsupervised learning. [(CO3)(Understand/LOCQ)]

(2 + 6) + 2 + 2 = 12

Group – D

6. (a) Consider $\tilde{A}(x)$ and $\tilde{B}(x)$ are two fuzzy set in the universe $U = \{x_1, x_2, x_3, x_4, x_5\}$ define below:

$$\tilde{A}(x) = \{(x_1, 0.4), (x_2, 0.3), (x_3, 0.4), (x_4, 0.7)\}$$
$$\tilde{B}(x) = \{(x_1, 0.5), (x_2, 0.8), (x_3, 0.5), (x_5, 0.9)\}$$

Find out the value of the following:

(i) $\left(\bar{\tilde{A}} \cup \tilde{B}\right)(x)$

(ii) $\tilde{A}(x) - \bar{\tilde{B}}(x)$

(iii) $\bar{\tilde{A}}(x) \ominus \bar{\tilde{B}}(x)$. [(CO4)(Apply/IOCQ)]

(b) Consider R = "x is considerable larger than y" and S =" x is very close to y" are two fuzzy relations given below:

$$R = \begin{pmatrix} & y_1 & y_2 & y_3 & y_4 \\ x_1 & 0.8 & 0.1 & 0.1 & 0.7 \\ x_2 & 0.0 & 0.8 & 0.3 & 0.6 \\ x_3 & 0.9 & 1.0 & 0.7 & 0.8 \end{pmatrix} \quad S = \begin{pmatrix} & y_1 & y_2 & y_3 & y_4 \\ x_1 & 0.4 & 0.0 & 0.9 & 0.6 \\ x_2 & 0.9 & 0.4 & 0.5 & 0.7 \\ x_3 & 0.3 & 0.0 & 0.8 & 0.5 \end{pmatrix}$$

Find out the following fuzzy relations

(i) x is considerable larger than y and x is very close to y

(ii) x is considerable larger than y or x is very close to y

(iii) x is not considerable larger than y. [(CO4)(Analyse/LOCQ)]

(3 × 2) + (3 × 2) = 12

7. (a) Consider the following GMP Inferencing process

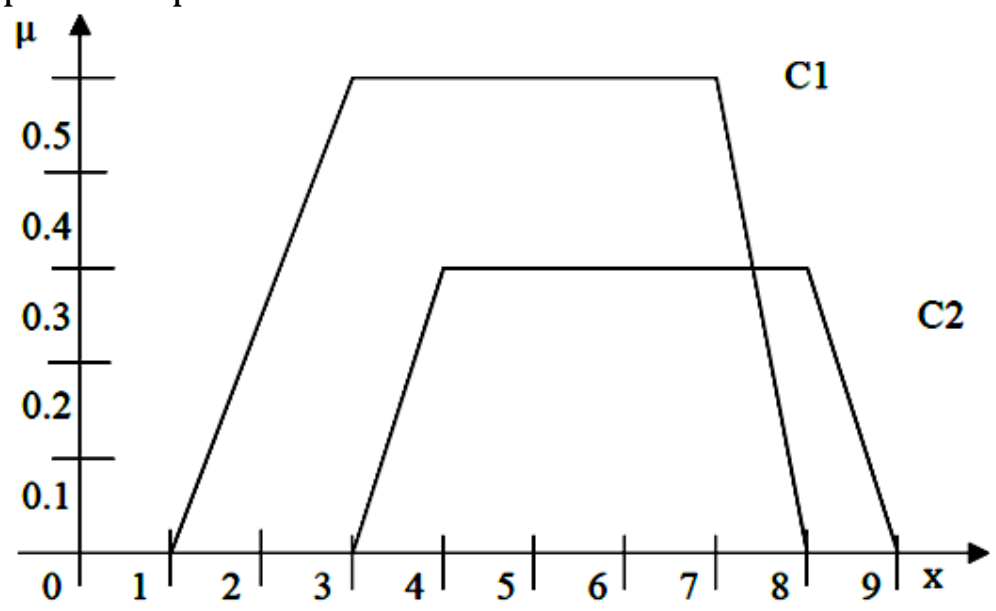
$P: If\ x\ ix\ \tilde{A}\ then\ y\ is\ \tilde{B}$

$Q: x\ is\ \tilde{A}'$

$Therefore\ y\ is\ \tilde{B}'$

Let two set of variables x and y be $x = \{x_1, x_2, x_3\}$ and$y = \{y_1, y_2\}$. Also consider two fuzzy set $\tilde{A}$ and $\tilde{B}$ are $\tilde{A} = \{(x_1, 0.4), (x_2, 0.9), (x_3, 0.5)\}$ and $\tilde{B} = \{(y_1, 1), (y_2, 0.6)\}$. Now apply the above Inferencing rule to find $\tilde{B}'$ when $\tilde{A}' = \{(x_1, 0.6), (x_2, 1), (x_3, 0.7)\}$. [(CO4)(Apply/IOCQ)]

(b) The results of two implication processes are shown below:



Find the defuzzified output using the following methods:

(i) Center of Gravity (COG)

(ii) Weighted average method. [(CO4)(Apply/IOCQ)]

6 + (3 + 3) = 12

Group – E

8. (a) Define upper approximation, and lower approximation. [(CO5)(Understand/LOCQ)]

(b) Consider the following information system:

U	a_1	a_2	a_3
X_1	2	1	3
X_2	3	2	1
X_3	2	1	3
X_4	2	2	3
X_5	1	1	4
X_6	1	1	2
X_7	3	2	1
X_8	1	1	4
X_9	2	1	3
X_{10}	3	2	1

If attribute B = {a_1, a_2, a_3} is selected, find out the equivalence classes. Calculate the lower approximation, upper approximation, and boundary region of this rough set. [(CO5)(Apply/IOCQ)]

(2 + 2) + (4 × 2) = 12

9. (a) Show that the relation ***R*** is an equivalence relation in the set A = {1, 2, 3, 4, 5} given by the relation $R = \{(x, y): |x - y| \ is \ even \ number\}$. [(CO5)(Analyse/IOCQ)]

(b) Consider the following set of solutions for a multi-objective optimization problem with objective function of maximum f1 and minimum f2.

Solutions	f1	f2
s1	9	2
s2	7	5
s3	13	1
s4	11	3
s5	16	2

Find out the Pareto optimal solutions. [(CO6)(Apply/IOCQ)]

(c) Describe the steps of Multi-objective genetic algorithm. [(CO6)(Understand/LOCQ)]

3 + 3 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	37.5	62.5	0

Course Outcome (CO):

After the completion of the course students will be able to

CO1. Describe about soft computing concepts, technologies and their role in problem solving.
CO2. Analyze the genetic algorithms and their applications to solve optimization problems.
CO3. Demonstrate different neural network architectures, algorithms, applications and their limitations.
CO4. Apply the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic.
CO5. Identify the need for approximation analysis and rough set theory in developing applications.
CO6. Inspect various soft computing techniques in order to solve Multi-Objective Optimization Problem (MOOP).

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