

SOFT COMPUTING (MCAP1203)

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) In order to apply Simulated Annealing (GA), an optimization problem should be formulated as

(a) Maximization problem	(b) Minimization problem
(c) Decision problem	(d) None of (a), (b) & (c).
 - (ii) Which of these is NOT a specified method that is used for the selection of the parents?

(a) Steady-state	(b) Tournament selection
(c) Boltzmann selection	(d) Elitism.
 - (iii) 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 α -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) $\{50, 60, 70, 80\}$
 - (iv) Consider a fuzzy set $\tilde{A}(x) = \{(a, 0.4), (b, 0.6), (c, 1), (d, 1), (e, 0.8)\}$. The Support of $\tilde{A}(x)$ i.e. $Sup(\tilde{A})$ is

(a) $\{b, c, d, e\}$	(b) $\{a, b, e\}$	(c) $\{c, d\}$	(d) $\{a, b, c, d, e\}$
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 - (v) Which of the following ANN architectures contains bidirectional interconnections?

(a) Single-layered feed forward	(b) Multi-layered feed forward
(c) Competitive networks	(d) None of (a), (b) & (c).
 - (vi) Which of the following activation functions is not differentiable?

(a) Identity function	(b) Heaviside function
(c) Sigmoid function	(d) None of (a), (b) & (c).
 - (vii) How many passes are required by Hebb learning algorithm?

(a) One	(b) Two
(c) No fixed number of passes	(d) None of (a), (b) & (c).

- (viii) Which of the following ANN learning algorithms is not a supervised learning?
 (a) Perceptron learning
 (b) Widrow-Hoff learning
 (c) Adaline
 (d) A single layer feed-forward neural network with pre-processing
- (ix) 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.
- (x) Let $I = (U, A)$ be an information system and $P \subset Q \subset A$ and $x, y \in U$ be objects of I . Then which of the following statements is true?
 (a) If x and y are P -indiscernible then they are Q -indiscernible
 (b) If x and y are Q -indiscernible then they are P -indiscernible
 (c) The P and Q -indiscernibility of x and y are unrelated
 (d) None of the above.

Group - B

2. (a) Consider the following individuals with the fitness value:

Individual	A	B	C	D	E	F	G	H
Fitness	3.2	2.5	4.45	5.2	2.56	1.5	3.5	4.6

Also consider $N_p = 6$ and $\mathbf{r} = \{0.35, 0.25, 0.42, 0.53, 0.68, 0.81\}$ is a random vector (wheel stopping point). Using $\mathbf{r}$, construct the mating pool by applying Roulette-Wheel selection algorithm. [[CO2](Apply/IOCQ)]

- (b) Also apply the Rank-Based selection algorithm to construct the mating pool ($N_p = 6$) using the same random vector $\mathbf{r}$ define above. Comment on the results. [[CO2](Apply/IOCQ)]
- (c) Explain with a proper example the difference between Phenotype and Genotype. [[CO2](Understand/LOCQ)]
5 + 4 + 3 = 12

3. (a) Explain the drawbacks of 'Hard Computing' that give room to implement the 'Soft Computing' techniques. [[CO1](Understand /LOCQ)]
- (b) Explain with example the Roulette-wheel selection algorithm. [[CO2](Understand/LOCQ)]
- (c) Analyze how the limitations of Roulette-wheel selection is overcome in Rank-based selection? [[CO2](Analyze/IOCQ)]
4 + 4 + 4 = 12

Group - C

4. (a) Carry out the Exclusive - OR problem using Perceptron (Multiple feed forward network). Draw the decision boundary and adjust the weight accordingly. [[CO3](Apply/IOCQ)]
- (b) What are limitations of single layer perceptron model? How it can be overcome. [[CO3](Understand/LOCQ)]

- (c) What does the learning rate do in Back-Propagation training?

[[CO3](Remember/LOCQ)]

6 + 4 + 2 = 12

5. (a) Construct a Kohonen self-organizing Map to cluster the two given vectors [0 0 1 1] and [1 0 0 0]. The number of clusters to be clustered is two. Assume the initial learning rate to be 0.5. [[CO3](Apply/IOCQ)]
- (b) Briefly describe two popular activation functions in neural network. [[CO3](Apply/IOCQ)]
- (c) Design a Hebb net to implement logical AND function (use bipolar inputs and targets). [[CO3](Apply/IOCQ)]
- 4 + 4 + 4 = 12**

Group – D

6. (a) Plot the following membership function $\mu_{\tilde{A}}(x)$ for fuzzy set $\tilde{A}$ and find bandwidth, core, cross-over points and support for the same. Why this fuzzy set $\tilde{A}$ is said to be normal?

Is this fuzzy set is symmetric with respect to $x = 4$?

$$\mu_{\tilde{A}}(x) = \begin{cases} = 0 & \text{if } x \leq a \\ = (x - a) / (b - a) & \text{if } a \leq x \leq b \\ = 1 & \text{if } b \leq x \leq c \\ = (d - x) / (d - c) & \text{if } c \leq x \leq d \\ = 0 & \text{if } d \leq x \end{cases}$$

Where $a = 1, b = 3, c = 5$ and $d = 7$.

[[CO4](Apply/IOCQ)]

- (b) Explain the following defuzzification methods with a suitable example
(i) Mean of Maximum (MOM), (ii) Center of Gravity (COG).

[[CO4](Understand/LOCQ)]

6 + 6 = 12

7. (a) Consider a set $P = \{P1, P2, P3, P4\}$ of four varieties of paddy plants, set $D = \{D1, D2, D3, D4\}$ of the various diseases affecting the plants and $S = \{S1, S2, S3, S4\}$ be the common symptoms of the diseases. Let R be a relation on $P \times D$ and S be a relation on $D \times S$.

R

	D1	D2	D3	D4
P1	0.0	0.5	0.2	0.8
P2	0.3	0.1	0.3	0.2
P3	0.5	0.0	0.4	0.4
P4	0.8	0.9	0.5	1.0

and **S**

	S1	S2	S3	S4
D1	1.0	0.9	0.3	0.5
D2	0.9	0.8	1.0	0.8
D3	0.2	0.1	0.5	1.0
D4	0.8	1.0	0.6	1.0

Obtain the association of the plants with the different symptoms of the diseases using max-min and max-product composition. [[CO4](Apply/IOCQ)]

- (b) Consider $R = "x \text{ is considerable larger than } y"$ and $S = "x \text{ is very close to } y"$ are two fuzzy relations given below.

$$R = \begin{pmatrix} x \backslash y & y_1 & y_2 & y_3 & y_4 \\ x_1 & 0.6 & 0.1 & 0.1 & 0.5 \\ x_2 & 0.0 & 0.2 & 0.3 & 0.5 \\ x_3 & 0.9 & 1.0 & 0.7 & 0.8 \end{pmatrix} \quad S = \begin{pmatrix} x \backslash y & y_1 & y_2 & y_3 & y_4 \\ x_1 & 0.4 & 0.0 & 0.3 & 0.6 \\ x_2 & 0.5 & 0.4 & 0.5 & 0.7 \\ x_3 & 0.3 & 0.0 & 0.2 & 0.5 \end{pmatrix}$$

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". [[CO4](Apply/IOCQ)]
8 + 4 = 12

Group – E

8. (a) Consider the following *Loan applicants' data set (I)*, presents a decision system for a number of individuals seeking loan from a bank and the bank's decision in this regard.

#	Name	Gender	Age	Income	Car	Defaulter	Loan Granted
1	Pushpesh	M	Middle-aged	High	Yes	Yes	No
2	Arpan	M	Middle-aged	High	No	No	Yes
3	Riya	F	Young-adult	High	No	No	Yes
4	Rumela	F	Aged	Low	No	No	No
5	Disha	F	Middle-aged	Middle	No	No	Yes
6	Kanchan	M	Aged	High	No	No	No
7	Isita	F	Young-adult	High	No	No	Yes
8	Akash	M	Young-adult	High	Yes	Yes	No
9	Ranajit	M	Middle-aged	Middle	No	No	Yes
10	Sanjana	F	Middle-aged	Middle	No	No	Yes
11	Sayon	M	Middle-aged	High	Yes	No	Yes
12	Santanu	M	Aged	Low	No	No	No

Let $B = \{Age, Income, Car\} \subset A = \{Gender, Age, Income, Car, Defaulter\}$ be a set of attributes. Then

- (i) Compute $IND_B(I)$
 (ii) If $X = \{x \in U \mid Loan\ Granted(x) = Yes\}$ then compute B -lower and B -upper approximations of X and determine if X is rough in terms of knowledge in B . Calculate $\mu_x^B(x)$ for each $x \in U$. [[CO5](Apply/IOCQ)]
 (b) Consider $B \subset C$, set of condition attributes and $X \subset U$, set of objects. When X is defined as
 (i) roughly B -definable, (ii) totally B -undefinable. [[CO5](Understand/LOCQ)]
8 + 4 = 12

9. (a) What do you mean by rough membership? [[CO5](Remember/LOCQ)]
 (b) How TSP can be solved using ACO? Describe operations performed in different phases. [[CO6](Analyze/IOCQ)]
 (c) Explain the artificial Bee Colony algorithm. [[CO6](Understand/LOCQ)]
3 + 5 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	35.42	64.58	0

Course Outcome (CO):

After the completion of the course students will be able to:

MCAP1203.1: Identify different soft computing concepts and technologies to solve real-time problems.

MCAP1203.2: Analyze genetic algorithms to solve single and multi-objective optimization problems.

MCAP1203.3: Identify different neural network architectures, algorithms, applications and their limitations.

MCAP1203.4: Relate the partial knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic.

MCAP1203.5: Substantiate the need for approximate analysis using rough set.

MCAP1203.6: Compare between various evolutionary algorithms and apply them suitably.

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