ARTIFICIAL INTELLIGENCE
(MCA1104)

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) Among the given options, which search algorithm requires less memory?
(a) Optimal Search (b) Depth First Search
(c) Breadth-First Search (d) Linear Search

(ii) In 8-Puzzle problem without heuristic the time complexity is
(a) O(320) (b) O(1013) (c) O(1024) (d) O(1310)

(iii) A* algorithm is based on
(a) Breadth-First-Search (b) Depth-First –Search
(c) Best-First-Search (d) Hill climbing

(iv) What are the main components of the expert systems?
(a) Inference Engine (b) Knowledge Base
(c) Inference Engine & Knowledge Base (d) None of the mentioned

(v) Which problem can frequently occur in backward chaining algorithm?
(a) Repeated states (b) Incompleteness
(c) Complexity (d) Both Repeated states and Incompleteness

(vi) In a Bayesian Network, a directed edge from node X to node Y implies that:
(a) X is always the cause of Y
(b) Y is conditionally independent of all other nodes given X
(c) Y's probability distribution depends directly on X
(d) X and Y must have identical probability values

(vii) 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}

(viii) Which of the following is NOT an operation typically used in fuzzy logic?
(a) Fuzzy Union (b) Fuzzy Subtraction
(c) Fuzzy Intersection (d) Fuzzy Complement

(ix) 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

(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) Soft computing techniques, such as fuzzy logic, neural networks, and evolutionary algorithms, are designed to handle problems involving uncertainty, imprecision and _____.

(xii) Agents behaviour can be best described by _____.

(xiii) The _____ operation in fuzzy logic is used to determine the membership of elements in the intersection of two fuzzy sets.

(xiv) In genetic algorithms, the process of selecting individuals for reproduction is typically based on their _____.

(xv) The initial state and the legal moves for each side define the _____ for the game.

Group - B

2. Consider the following game tree where terminal node values represent utilities for MAX**.** Assume left-to-right evaluation order**.**

(i) Apply the Minimax algorithm and compute:
- The value at each internal node
- The final value at the root (MAX) *[(CO2)(Apply/IOCQ)]*

(ii) Now apply Alpha–Beta pruning with left-to-right evaluation and show:
- All branches that are pruned based on their α and β values
- The final value at the root *[(CO2)(Apply/IOCQ)]*

(6 + 6) = 12

3. (a) Describe the terms Local maximum, Plateau and Ridge in Hill-Climbing algorithm. *[(CO2)(Apply/HOCQ)]*

(b) Solve the 8-puzzle problem with heuristic as the "number of misplaced tiles" where the start and goal states are shown below. *[(CO2)(Finding/IOCQ)]*

START

1	2	3
	4	6
7	5	8

GOAL

1	2	3
4	5	6
7	8	

6 + 6 = 12

Group - C

4. Consider the following statements:
(i) John likes all kind of food. (ii) Apple and Vegetables are food.
(iii) Anything anyone eats and not killed is food. (iv) Anil eats peanuts and still alive.
(v) Harry eats everything that Anil eats.
With the help of FOL , proof by resolution
F: John likes peanuts. *[(CO3)(Analyze/IOCQ)]*

12

5. (a) Consider the following set of premises.
"If it does not rain or if it is not foggy, then the sailing race will be held and the lifesaving demonstration will go on".
"If the sailing race is held, then the trophy will be awarded".
"The trophy was not awarded".
From the above set of premises conclude that -" It rained". *[(CO3)(Execute/IOCQ)]*

(b) Given the following premises
1. $p \wedge q$
2. $(pvs) \rightarrow r$
3. rvt
Applying the propositional rules of inference, prove that t is true. *[(CO3)(Apply/IOCQ)]*

(c) Implication is good for "for all(∀)" quantifier. It is not good for "there exists(∃)" quantifier.
Establish the statement with suitable example. *[(CO3)(Explain/LOCQ)]*

4 + 4 + 4 = 12

Group - D

6. (a) Consider a dentist database as follows:

T	C	H	Probability
0	0	0	0.576
0	0	1	0.008
0	1	0	0.144
0	1	1	0.072
1	0	0	0.064
1	0	1	0.012

1	1	0	0.016
1	1	1	0.108
Sum			= 1

(1) Find the probability of observing cavity and Hole(jointly)
(2) Find the probability of observing a Hole.
(3) Find the probability of observing Cavity after observing Hole *[(CO4)(Apply/IOCQ)]*

(b) Describe the Bayesian Network parameters. *[(CO4)(Understand/LOCQ)]*

(3 + 3 + 3) + 3 = 12

7. (a) 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 sets:
(i)$(\widetilde{A} \cap \widetilde{B})(x)$, (ii)$\tilde{A}(x) \ominus \tilde{B}(x)$ *[(CO5)(Apply/IOCQ)]*

(b) Consider two fuzzy sets $\tilde{A}$ and $\widetilde{B}$, 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
$\widetilde{B}$	0.4	0.5	0.6	0.8	0.9

Express the following λ-cut sets using Zadeh's notation:
(i) $\left(\overline{\widetilde{A} \cap \widetilde{B}}\right)_{0.6}$, (ii) $\left(\overline{\widetilde{A} \cup \widetilde{B}}\right)_{0.8}$? *[(CO5)(Apply/IOCQ)]*

6 + (3 + 3) = 12

Group - E

8. (a) Consider a population of 5 individuals with the following fitness values:
- Individual 1: Fitness = 2
- Individual 2: Fitness = 5
- Individual 3: Fitness = 3
- Individual 4: Fitness = 7
- Individual 5: Fitness = 4

Using Roulette Wheel Selection, calculate the probability of selection for each individual. *[(CO6)(Apply/IOCQ)]*

(b) Using Rank-Based Selection to the previous problem, assign ranks to each individual and calculate the selection probability based on their ranks. Assume the ranks are assigned from 1 to 5 (1 being the highest rank). *[(CO6)(Apply/IOCQ)]*

6 + 6 = 12

9. (a) Explain in details, the operations of particle swarm optimization algorithm. What are the advantages of this algorithm? *[(CO6)(Understand/LOCQ)]*

(b) Evaluate two real-world applications of evolutionary algorithms. How do evolutionary algorithms improve solutions in these applications? *[(CO6)(Evaluate/HOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	13.54	73.96	12.5