Reg. No.																

Question Paper Code	14543

B.E. / B.Tech. - DEGREE EXAMINATIONS, APRIL / MAY 2026

Fourth Semester

Computer Science and Engineering (AIML)

24AMPC401 - NATURE INSPIRED COMPUTING TECHNIQUES

Regulations - 2024

Duration: 3 Hours | Max. Marks: 100

PART – A (i) (MCQ)
(16 × 1 = 16 Marks)
Answer ALL Questions

		Marks	K – Level	CO
1.	Nature-inspired computing is derived from a) Circuits b) Natural processes c) Databases d) Networks	1	K1	CO1
2.	An agent is a) Autonomous entity b) Program c) Data d) Hardware	1	K1	CO1
3.	Fractals can be applied in a) Repeating pattern design b) Data deletion c) Sorting d) Storage	1	K2	CO1
4.	Simulated Annealing is inspired by a) Biology b) Databases c) Networks d) Metallurgy cooling process	1	K2	CO2
5.	While solving a traveling salesman problem, an algorithm gets stuck in a local optimum. Which method helps escape it? a) Selection b) Hill Climbing c) Simulated Annealing d) Crossover	1	K3	CO2
6.	A fitness function that poorly evaluates solutions will most likely result in a) Reduced mutation b) Faster convergence c) Better solutions d) Incorrect optimization	1	K2	CO2
7.	In Particle Swarm Optimization, inertia weight controls a) Memory b) Speed only c) Balance between exploration and exploitation d) Mutation	1	K2	CO3
8.	Two paths exist: one is short but discovered late, and one is longer but discovered early. ACO is likely to initially favor a) Long path b) Both equally c) No path d) Short path	1	K3	CO3
9.	If pheromone evaporation is too high, the algorithm will a) Stop exploration b) Converge quickly c) Become deterministic d) Forget good solutions too fast	1	K2	CO3
10.	In Danger Theory-based AIS, ignoring safe signals may result in a) Unnecessary immune response b) Less memory c) Faster computation d) Reduced detection	1	K3	CO4
11.	Immune Network Theory deals with a) Sorting b) Searching c) Interaction among antibodies d) Data transmission	1	K1	CO4
12.	Pattern recognition in immune computing is used to a) Store data b) Identify antigens c) Delete data d) Sort elements	1	K1	CO4

13.	DNA strands store information using a) Binary digits b) Memory cells c) Electrical signals d) Base sequences	*1*	*K1*	*CO5*
14.	In DNA-based computation, an increase in problem variables leads to exponential strand growth. This creates difficulty in a) Encoding b) Amplification c) Data storage only d) Managing and isolating correct solutions	*1*	*K3*	*CO5*
15.	A hybrid model combines Genetic Algorithm and PSO, but performance decreases compared to using them individually. The most likely reason is a) Poor integration of algorithms b) Lack of parallelism c) Excessive mutation d) Low population size	*1*	*K3*	*CO6*
16.	In a real-time traffic control system, a swarm algorithm fails due to delayed decisions. The main limitation is a) Convergence time b) Low storage c) Lack of agents d) Poor mutation	*1*	*K3*	*CO6*

PART – A (ii) (Short Answer Questions)
(6 × 3 = 18 Marks)
Answer ALL Questions

17.	A scientist is modeling the structure of a snowflake. The snowflake exhibits repeating geometric patterns at different scales. i. Make use of fractal geometry, and explain how it helps in modeling the snowflake structure. ii. How does self-organization contribute to the formation of snowflake patterns?	*3*	*K3*	*CO1*
18.	Parents: P1 = 10011, P2 = 01101. Crossover point = 4. Simplify single-point crossover and determine the resulting offspring.	*3*	*K4*	*CO2*
19.	Two ants traverse a graph with edge distances: LM = 3, LN = 2, MN = 5. Initial pheromone $\tau = 1.2$. • Ant1 path: L → M → N → L (length 9) • Ant2 path: L → N → M → L (length 10) Evaporation rate $\rho = 0.05$. Analyze the updated pheromone level on edge LM.	*3*	*K4*	*CO3*
20.	Organize the importance of antibody memory in artificial immune systems for anomaly detection applications.	*3*	*K3*	*CO4*
21.	Consider the CNF formula: $F=(A \vee B) \wedge (\neg A \vee C) \wedge (\neg B \vee \neg C)$ Verify whether A = 1, B = 0, C = 1 satisfies the formula. Demonstrate each clause separately.	*3*	*K4*	*CO5*
22.	A smart agriculture project uses AI and swarm intelligence techniques for irrigation control, crop monitoring, and pest management. Analyze the following: i. How do these technologies enhance agricultural productivity and food security? ii. What could be the possible impacts on biodiversity and the natural ecosystem?	*3*	*K3*	*CO6*

PART - B (Descriptive Answer Questions)
(6 × 11 = 66 Marks)
Answer ALL Questions

23.	a)	A smart water management system uses municipal regulations and local reservoir sensor data. Apply the concepts of bottom-up and top-down determination to design a hybrid water distribution system. Explain how local water-level information and central policies can optimize supply.	*11*	*K3*	*CO1*
		OR			
	b)	An environmental scientist analyzes forest fire behavior in dry regions. Apply the concepts of chaos theory and fractals to explain how small temperature or wind variations can trigger widespread forest fires. Discuss how these principles can support better disaster management planning.	*11*	*K3*	*CO1*

24. a) Determine the fitness probabilities of the following chromosomes using Roulette Wheel Selection: [1100101010110, 0111010010101, 1001110001010, 0010101111001] *11* *K4* *CO2*

OR

b) A courier service must deliver packages to 4 cities (P, Q, R, S) starting and ending at P. Distances (km) between cities are given below: *11* *K4* *CO2*

	P	Q	R	S
P	0	7	9	8
Q	7	0	5	6
R	9	5	0	4
S	8	6	4	0

Initial Population (Routes):
- [P, R, Q, S]
- [P, S, R, Q]
- [P, Q, S, R]
- [P, S, Q, R]

Using a Genetic Algorithm, Examine the near-optimal delivery route.

25. a) Given x(k)=(2,5), PBest=(7,3), GBest=(4,8) and inertia=(1,2). Solve the updated velocity and position using the PSO velocity updates equation. Explain the role of the cognitive and social components. *11* *K3* *CO3*

OR

b) A team of 20 rescue robots is deployed after an earthquake to search for survivors in damaged buildings. Each robot has: *11* *K3* *CO3*
- Limited movement and sensing range.
- No centralized management.
- Local communication abilities.

Make use of swarm robotics principle and explain how the robots can distribute search tasks and coordinate rescue operations efficiently.

26. a) Illustrate the Forest's Algorithm with an example. *11* *K3* *CO4*

OR

b) A credit card fraud detection system uses pattern recognition. *11* *K3* *CO4*
- T1 = Regular small purchases
- T2 = Large transaction in a foreign country
- T3 = Multiple rapid transactions

T1 is considered normal behaviour.
1. Identify non-self-patterns.
2. Explain how pattern recognition detects fraud.

27. a) A network engineer must test nodes A, E, F, G exactly once. Available routes: A→E, E→F, F→G, A→F, E→G *11* *K4* *CO5*

DNA computing is used to solve the routing problem.
1. Explain the encoding of nodes and communication links
2. Describe the generation of all possible node traversal sequences
3. Apply Adleman's algorithm filtering rules
4. Identify the Hamiltonian Path(s)
5. Compare DNA computation with conventional graph traversal approaches

OR

	b)	Analyze the application of Lipton's solution to SAT problem and explain with an example.	*11*	*K4*	*CO5*
28.	a)	Identify the environmental and computational impact of large-scale AI-based healthcare monitoring systems.	*11*	*K3*	*CO6*
		OR			
	b)	Make use of Genetic Algorithms, and how it is used for fraud detection in banking systems.	*11*	*K3*	*CO6*