Birla Institute of Technology & Science, Pilani
Work-Integrated Learning Programmes Division
Second Semester 2024-2025
Mid Semester Test
EC-2 Regular

Course No.	: SE ZG55	
Course Title	: Artificial and Computational Intelligence	
Nature of Exam	: Closed Book	No. of Pages = 2
Weightage	: 30%	No. of Questions = 4
Duration	: 2 Hours	
Date of Exam	: 23/03/2025 1:00 PM	

Note:
1. Please follow all the Instructions to Candidates given on the cover page of the answer book.
2. All parts of a question should be answered consecutively. Each answer should start from a fresh page.
3. Assumptions made if any, should be stated clearly at the beginning of your answer.

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1. Consider six nodes with the following edges - $S \to A$, $S \to B$, $A \to C$, $A \to D$, $B \to G$. Show the traversal order and path found using BFS and DFS starting from node $S \to G$ (Assume ordering $A > B > C > D > G$. That is if both A and B are in the frontier, then A is expanded first.). Highlight the difference between the two algorithms.

   State TRUE/FALSE with justification for the following statements – "Depth-First Search (DFS) is complete in finite search spaces even without using a visited/explored set. Assume the graph may contain cycles."

   [8 Marks]

2. An autonomous drone navigates a 3D grid (8x8x8) where it can move in six directions (up, down, left, right, forward, backward) with a cost of 1, or diagonally in 3D space with a cost of $\sqrt{3}$. Obstacles block specific cubes. Starting at (0,0,0), the drone must reach (7,7,7).

   Are the following heuristics admissible for A* search? Justify your answer:

   Heuristic 1: 3D Manhattan distance $h_1(n) = |x_n - x_g| + |y_n - y_g| + |z_n - z_g|$

   Heuristic 2: 3D Chebyshev distance $h_2(n) = \max(|x_n - x_g|, |y_n - y_g|, |z_n - z_g|)$

   Heuristic 3: Euclidean distance $h_3(n) = 1.5\sqrt{(x_n - x_g)^2 + (y_n - y_g)^2 + (z_n - z_g)^2}$

   Heuristic 4: Number of axis-aligned moves required if all diagonals are blocked

   [8 Marks]

3. A genetic algorithm uses chromosomes of form $x = abcdefgh$ where each gene is a digit between 0-9. The fitness function is calculated as:

$$f(x) = (a + b) - (c + d) + (e + f) - (g + h)$$

   (a) What is the optimal solution and its maximum fitness value?

   (b) Given an initial population without any 9s, explain why the algorithm cannot reach the optimal solution without mutation.

   (c) What role does mutation play in avoiding this limitation?

[2 + 4 + 2 = 8 Marks]

4. Consider the following two modifications of the ant colony optimization (ACO) algorithm:

   (a) Each ant deposits a fixed amount of pheromone.

   (b) Each ant deposits a pheromone inversely proportional to the edge length.

   Compare and contrast the Ant Density and Ant Quantity pheromone update models in ACO. Explain how these models influence the balance between exploration and exploitation in pathfinding problems

   [6 Marks]