BRAC UNIVERSITY
Department of Computer Science and Engineering

CSE 221: Algorithms

Answer the following questions.
Figures in the right margin indicate marks.

Name:	ID:	Section:

1. You are studying a searching algorithm used to find a specific value in a sorted array. This algorithm operates by dividing the search interval in half at each step, comparing the target value to the midpoint value, and then discarding one half of the search interval based on the comparison, continuing with the remaining half.
   a. Based on this description, identify the algorithm used. **[1]**
   b. Simulate the algorithm with the sorted array `[10, 20, 30, 40, 50, 60, 70, 80, 90, 100]` and the target value `70`. Show how the target value `70` is located step-by-step, providing the midpoints and search intervals for each iteration until the target is found. **[3]**
   c. Consider a rotated sorted array `[30, 40, 50, 60, 70, 80, 90, 100, 10, 20]` and find the value `70` using the modified version of the binary search algorithm. Explain how the algorithm adapts to handle the rotation and describe the steps taken to locate the target value `70`. **[2]**

2. You are the coordinator of the BRAC University Coding Club, organizing a programming contest. You have a list of contestants that need to be arranged based on their problem-solving speed (measured in problems per hour). However, if two contestants have the same speed, they need to be ranked by their accuracy (percentage of correct solutions).

   You decide to sort the contestants based on speed in ascending order, and if speeds match, by accuracy in descending order. Your initial sorting method repeatedly divides the list and sorts the sublists. However, your friend points out that this method uses extra memory and suggests using a sorting algorithm that is more memory efficient and works in-place.

Contestant No.	1	2	3	4	5	6	7	8	9
Speed	4	5	4	6	5	3	6	3	5
Accuracy	85	75	90	80	88	82	70	95	78

a. Why might your friend suggest a different sorting strategy that is more memory efficient and works in-place? What are the advantages of this approach? **[1]**

b. Simulate your initial sorting method on the given list of contestants and show the sorted order. **[4]**

c. Propose and simulate an optimized sorting method that uses a divide-and-conquer approach and works in-place. Show the step-by-step simulation and compare the final sorted results. **[2]**

3. Imagine you're a farmer named Sam who grows different types of vegetables in several continuous fields. Each field can grow a specific type of vegetable, and based on the market value of that vegetable, each field will bring a certain profit (positive integer) or loss (negative integer). The profit or loss is estimated and noted for each field.

Sam can start farming from any field, but once he starts, he must continue farming the next fields in sequence without skipping any, until he decides to stop, because his tractor can only move to the next adjacent field and cannot skip fields.

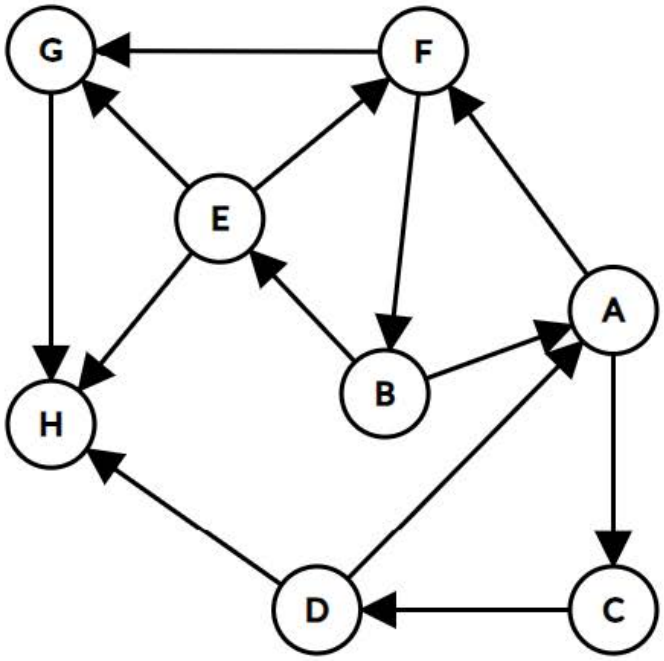
Sam needs to choose which sequence of fields to farm to maximize his profits. The following array represents the estimated profits or losses for ten consecutive fields on Sam's farm, based on the types of vegetables that can be grown in each field and their respective market values.

[4, -18, 16, -14, 12, -1, 3, 1, -20, 15]

a) Can you help Sam decide which sequence of fields to farm for maximum profit using an efficient algorithm? What would the profit amount be? **Show** a simulation of your proposed algorithm. You must show which sequence of fields he needs to select in order to achieve this maximum profit.
[4]

b) **Calculate** the time complexity of your algorithm using proper mathematical logic. An efficient algorithm should have time complexity less than or equal to O($N * log(N)$) where N is the number of fields. **[2]**

Please turn over for next question.



4. Based on the above graph, answer the following.

(a) Represent the graph using a suitable graph representation technique to determine the connectivity between two vertices in constant time. **[1]**

(b) Determine whether there is any cycle in the graph applying a suitable graph traversal algorithm. **[3]**

(c) List down all possible paths from A to H. **[2]**