PRACTICE EXAM

Difficulty: MEDIUM

Questions: 10

Data Structures and Algorithms Exam (Medium Difficulty)

Instructions:

Answer all questions to the best of your ability. Read each question carefully and provide complete answers where necessary.

Section 1: Multiple Choice Questions (4 points each, 40 points total)

Instructions: Choose the best answer for each question.

Question 1: What is the time complexity of the given recurrence relation: T(n) = T(n-1) + lgn, if n > 1 and T(n) = Θ(1) if n = 1?
A) O(lgn)
B) O(n)
C) O(nlgn)
D) O(n^2)

Question 2: In the provided Insertion Sort algorithm, what is the primary purpose of the `while` loop?
A) To iterate through the entire array
B) To find the correct position for the `key` element within the sorted portion of the array
C) To swap elements in the array
D) To initialize the `key` variable

Question 3: Based on the Bellman-Ford algorithm example, what does d[v] represent?
A) The predecessor of vertex v in the shortest path
B) The shortest path estimate from the source vertex to vertex v
C) The cost of the edge connecting to vertex v
D) The total number of vertices in the graph

Question 4: What is the result of the merging two sorted arrays if the elements are 20, 12, 13, 11, 7, 9, 2, 1?
A) Unchanged as: 20, 12, 13, 11, 7, 9, 2, 1
B) 1, 2, 7, 9, 11, 12, 13, 20
C) An error because only sorted arrays can be merged
D) A new unsorted array with duplicate elements

Section 2: Short Answer Questions (6 points each, 30 points total)

Instructions: Answer each question in 2-3 complete sentences.

Question 5: Explain the general principle behind the Insertion Sort algorithm.

Question 6: In the context of the Bellman-Ford algorithm, what does "relaxing" an edge mean?

Question 7: In the recurrence relations, what is the significance of the base case and what will occur if it is omitted?

Section 3: Problem-Solving Questions (10 points each, 30 points total)

Instructions: Provide detailed steps and explanations for your answers.

Question 8: Using the provided example of Insertion Sort, show the state of the array [9, 5, 1, 4, 3] after the second iteration of the outer `for` loop (when j = 3). Clearly indicate the values of `key` and `i` at that point.

Question 9: Given the following graph represented by its edges and their weights: S-A(5), S-C(-2), A-B(1), B-D(3), C-A(2), C-D(7), C-B(6), D-T(1), B-T(9). Apply one iteration of Bellman-Ford algorithm. Assume 'S' is the source node. Present the d[v] and p[v] values after the first edge relaxation round, processed in alphabetical order of the source node and then destination node.

Question 10: Explain how you would merge two sorted arrays [1, 3, 5, 7] and [2, 4, 6, 8] to create a single sorted array. Provide the steps, explaining the logic of the merging process.