PRACTICE EXAM

Difficulty: MEDIUM

Questions: 10

Algorithms & Data Structures Exam

Instructions: Please answer all questions to the best of your ability.

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

Instructions: Choose the best answer for each question.

Question 1: In the provided INSERTION-SORT algorithm, what is the purpose of the 'key' variable?
A) It stores the index of the element being compared.
B) It stores the value of the element being inserted into the sorted portion.
C) It represents the size of the array.
D) It stores the value of the element being compared.

Question 2: In the INSERTION-SORT algorithm, the 'while' loop condition is 'i > 0 and A[i] > key'. What does 'i > 0' ensure?
A) That the loop continues until the end of the array.
B) That the loop iterates through all possible values of j.
C) That the algorithm doesn't access an index outside of the array bounds.
D) That the key is correctly assigned.

Question 3: Based on the provided recurrence relation T(n) = 2T(n/2) + ■(n), what general type of algorithm design paradigm is likely being analyzed?
A) Greedy algorithm
B) Dynamic programming
C) Divide and conquer
D) Branch and bound

Question 4: In the merging of two sorted arrays example, what determines the order in which elements are placed into the final merged array?
A) The order they appear in the first input array.
B) The order they appear in the second input array.
C) Comparing the current elements of both input arrays.
D) Random assignment.

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

Instructions: Answer each question in 2-3 sentences.

Question 5: Explain the role of the inner `while` loop in the provided INSERTION-SORT algorithm.

Question 6: What is the significance of 'Theta(n)' in the recurrence relation $T(n) = 2T(n/2) + \blacksquare(n)$?

Question 7: Briefly explain the high-level steps involved in merging two sorted arrays into a single sorted array.

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

Instructions: Show your work and provide a detailed explanation for each answer.

Question 8: Using the INSERTION-SORT algorithm provided, trace the execution of the algorithm on the following array: [5, 1, 4, 2, 8]. Show the state of the array after each iteration of the outer loop (the 'j' loop).

Question 9: Given the recurrence relation $T(n) = T(n-1) + \blacksquare(n)$ and the guess $T(n) \leq cn^2$, explain the steps involved in attempting to prove this upper bound using substitution method. Point out one challenge encountered when trying to prove the upper bound.

Question 10: Consider merging two sorted arrays A = [2, 5, 8] and B = [1, 3, 9]. Show step by step how the two arrays are merged and write the final result.