PRACTICE EXAM

Difficulty: MEDIUM

Questions: 10

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# Algorithms and Data Structures Exam

## Section 1: Multiple Choice Questions (40 points total, 10 points each)

Instructions: Choose the best answer for each question.

**Question 1:** Which of the following best describes the purpose of the `key` variable in the provided INSERTION-SORT algorithm?
A) It stores the index of the element being inserted.
B) It temporarily stores the value of the element being inserted.
C) It stores the value of the element being compared against.
D) It stores the size of the array.

**Question 2:** In the INSERTION-SORT algorithm, what is the purpose of the `while i > 0 and A[i] > key` loop?
A) To find the correct position to insert `key` in the sorted subarray.
B) To iterate through the entire array.
C) To swap the `key` with the next element.
D) To initialize the algorithm.

**Question 3:** What is the recurrence relation, T(n), defined as?
A) T (n) = T (n-1) + Θ(n)
B) T (n) = 2T (n/2) + Θ(n)
C) both A and B
D) none of the above

**Question 4:** According to the example code, what is the first step in merging two sorted arrays?
A) Divide the arrays into smaller sub-arrays.
B) Compare the first elements of each array.
C) Sort each array individually.
D) Reverse the order of the arrays.

## Section 2: Short Answer Questions (30 points total, 15 points each)

Instructions: Answer each question in 2-3 complete sentences.
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Question 5: (15 points) Explain the role of the index `i` in the INSERTION-SORT algorithm, specifically within the `while` loop.

Question 6: (15 points) Briefly describe the difference between the upper bound and lower bound.

Section 3: Problem-Solving Questions (30 points total, 15 points each)

Instructions: Provide a detailed explanation for each problem.

Question 7: (15 points) Trace the execution of the INSERTION-SORT algorithm on the array `[5, 1, 4, 2, 8]`. Show the array's state after each iteration of the outer loop (the loop controlled by `j`).

Question 8: (15 points) Given the recurrence relation $T(n) = T(n-1) + \Theta(n)$ and the guess $T(n) \leq cn^2$, show the upper bound.
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