

# PRACTICE EXAM

**Difficulty: MEDIUM**

**Questions: 10**

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# Algorithms and Data Structures Exam

## Instructions:

Please answer all questions to the best of your ability. Read each question carefully and provide thorough answers.

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

Instructions: Choose the best answer for each question.

**Question 1:** What is the purpose of the 'key' variable in the provided INSERTION-SORT algorithm?

- A) To store the index of the element being inserted.
- B) To store the value of the element being inserted.
- C) To store the length of the array.
- D) To store the index of the smallest element.

**Question 2:** In the INSERTION-SORT algorithm, the inner `while` loop continues as long as which two conditions are met?

- A) `i > 0` and `A[i] < key`
- B) `i < n` and `A[i] > key`
- C) `i > 0` and `A[i] > key`
- D) `i < n` and `A[i] < key`

**Question 3:** According to the recurrence relation  $T(n) = 2T(n/2) + \Theta(n)$ , with the guess being  $T(n) \leq cn \lg n$ . What must 'c' be greater than or equal to in the upper bound proof?

- A) -1
- B) 0
- C) 1
- D) 2

**Question 4:** Professor Reza Sedaghat teaches which course according to the text?

- A) COE 248
- B) COE 482
- C) COE 428
- D) EE 428

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

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

**Question 5:** Explain the role of the variable 'i' in the INSERTION-SORT algorithm.

**Question 6:** Briefly describe the main goal of the merging two sorted arrays algorithm.

**Question 7:** What does  $\Theta(n)$  represent in the context of the recurrence relation  $T(n) = 2T(n/2) + \Theta(n)$ ?

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

Instructions: Provide a detailed explanation of your reasoning and show all relevant steps.

**Question 8:** Based on the provided INSERTION-SORT algorithm example, trace the execution of the algorithm for the first two iterations ( $j=2$  and  $j=3$ ) on the array  $A = [5, 1, 4, 2, 8]$ . Clearly show the changes to the array  $A$ , the values of 'key' and 'i', and the condition of the 'while' loop at each step.

**Question 9:** Using the information provided about the recurrence relation  $T(n) = T(n-1) + \Theta(n)$ , explain how the upper bound  $T(n) \leq n^2$  is derived, and the constraint on 'c' to satisfy the upper bound proof.

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