

# PRACTICE EXAM

**Difficulty: MEDIUM**

**Questions: 10**

## Algorithms and Data Structures Exam

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

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

Instructions: Choose the best answer for each question.

**Question 1:** According to the given pseudocode for INSERTION-SORT, what is the purpose of the 'key' variable?

- A) It holds the index of the element being inserted.
- B) It holds the value of the element being inserted.
- C) It holds the value of the element being compared.
- D) It holds the index of the element being compared.

**Question 2:** In the INSERTION-SORT algorithm demonstrated, when does the `while` loop terminate?

- A) When `i` is equal to `j`.
- B) When `i` is less than 0 or `A[i]` is less than `key`.
- C) When `i` is greater than 0 and `A[i]` is less than `key`.
- D) When `i` is less than 0 and `A[i]` is greater than `key`.

**Question 3:** Based on the provided example of merging two sorted arrays, what is the main goal of the merging process?

- A) To combine two unsorted arrays into a single array.
- B) To sort each of the two arrays independently.
- C) To combine two sorted arrays into a single sorted array.
- D) To reverse the order of elements in the arrays.

**Question 4:** Based on the recurrence relations provided, what general form does  $T(n) = 2T(n/2) + \Theta(n)$  follow?

- A) It follows the form for linear search.
- B) It follows the form for binary search.
- C) It follows the form for merge sort.
- D) It follows the form for bubble sort.

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

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

**Question 5:** (15 points) Explain the role of the inner `while` loop in the INSERTION-SORT algorithm. How does it contribute to the overall sorting process?

**Question 6:** (15 points) Briefly describe the difference between the upper bound and lower bound analysis shown for the recurrence relation  $T(n) = 2T(n/2) + \Theta(n)$ .

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

Instructions: Provide a detailed explanation of your solution.

**Question 7:** (15 points) Given the initial array `[5, 1, 4, 2, 8]`, trace the execution of the INSERTION-SORT algorithm. Show the state of the array after each iteration of the outer `for` loop (i.e., after each insertion).

**Question 8:** (15 points) Suppose you have two sorted arrays `A = [3, 5, 7, 9]` and `B = [2, 4, 6, 8]`. Demonstrate the merging process to create a single sorted array `C`. Show each step of the merging operation.