

PRACTICE EXAM

Difficulty: MEDIUM

Questions: 10

Data Structures Exam - Medium Difficulty

Instructions:

- * Answer all questions to the best of your ability.
- * Read each question carefully before answering.
- * Show your work for problem-solving questions to receive partial credit.

Multiple Choice Questions (4 points each, 40 points total)

Instructions: Choose the *one best* answer for each question. Write the letter of your chosen answer on your answer sheet.

Question 1: Which of the following algorithms has a worst-case time complexity of $O(n \log n)$?

- A) Insertion Sort
- B) Heap Sort
- C) Linear Search
- D) List Search

Question 2: In a heap data structure, what is the index of the left child of a node at index i (assuming the heap is stored as an array)?

- A) $i/2$
- B) $i - 1$
- C) $2i$
- D) $2i + 1$

Question 3: What condition causes a "stack overflow" error?

- A) Trying to pop an element from an empty stack.
- B) Trying to enqueue an element into a full queue.
- C) Trying to push an element onto a full stack.
- D) Trying to dequeue an element from an empty queue.

Question 4: In a linked list, what does `head[L]` represent?

- A) The last element of the list.
- B) The number of elements in the list.
- C) A pointer to the first element of the list.
- D) A pointer to the tail element of the list.

Short Answer Questions (6 points each, 30 points total)

Instructions: Answer the following questions in 2-3 complete sentences.

Question 5: Explain the difference between "stack overflow" and "stack underflow".

Question 6: Briefly describe how the `ENQUEUE` operation works in a queue implemented using an array.

Question 7: What is the key difference between an array and a linked list in terms of how they store elements in memory?

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

Instructions: Show all steps in your reasoning and calculations to receive full credit.

Question 8: Trace the execution of the first two iterations ($j = 2$ and $j = 3$) of the Insertion Sort algorithm on the following array: $A = [9, 5, 1, 4, 3]$. Show the state of the array after each iteration.

Question 9: Suppose you have a heap implemented as an array: $A = [20, 13, 12, 11, 9, 7, 2, 1]$. What would the array look like after extracting the maximum element (20) once and then heapifying the array to maintain the heap property?

Question 10: Describe the steps involved in merging two sorted arrays using the merging two sorted arrays algorithm. Provide a simple example.