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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM: III - THEORY EXAMINATION (2025-2026)

Subject: DATA STRUCTURES AND ALGORITHMS-1

Time: 3 Hours

Max. Marks:100

General Instructions:**IMP:** Verify that you have received question paper with correct course, code, branch etc.

1. This Question paper comprises of three Sections -A, B, & C. It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.
2. Maximum marks for each question are indicated on right hand side of each question.
3. Illustrate your answers with neat sketches wherever necessary.
4. Assume suitable data if necessary.
5. Preferably, write the answers in sequential order.
6. No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.

SECTION – A

20

1. Attempt all parts:-

- 1-a. Which of the following characteristics does not belong to an algorithm? 1
(CO1, K1)
- A. Finiteness
B. Unambiguity
C. Machine dependency
D. Input / Output
- 1-b. The time complexity of an algorithm measures: (CO1, K1) 1
- A. Amount of memory used
B. Amount of input given
C. Running time as a function of input size
D. Number of variables used
- 1-c. Bubble sort is also known as: (CO2, K1) 1
- A. Sinking sort
B. Shaker sort

- C. Exchanging sort
- D. Both A and C

- 1-d. Worst-case time complexity of binary search is: (CO2, K1) 1
- A. $O(1)$
 - B. $O(n)$
 - C. $O(\log n)$
 - D. $O(n^2)$
- 1-e. A good hash function should: (CO3, K1) 1
- A. Produce collisions frequently
 - B. Spread keys uniformly
 - C. Use large computation
 - D. Expand key size
- 1-f. You are designing a browser history system where a user can: i.) Move forward to next visited page ii.) Move backward to previous page, Which linked list design would you propose? (CO3, K2) 1
- A. Singly Linked List
 - B. Double linked List
 - C. Circular linked list
 - D. Queue
- 1-g. Tail recursion occurs in a situation when: (CO4, K1) 1
- A. Recursive call is last statement
 - B. No recursive call
 - C. Recursive
 - D. None
- 1-h. Which data structure is used in recursion? (CO4, K1) 1
- A. Queue
 - B. Tree
 - C. Stack
 - D. Array
- 1-i. Greedy choice in Activity Selection is (CO5, K1) 1
- A. Select the activity with the shortest duration
 - B. Select the activity with the earliest finish time
 - C. Select activity with the latest start time
 - D. Select a random activity
- 1-j. In a Huffman tree, the highest-frequency character has: (CO5, K1) 1
- A. Longest code
 - B. Shortest code
 - C. Random code
 - D. No code

2. Attempt all parts:-

- 2.a. Discuss the need of asymptotic notations (CO1,K1) 2
- 2.b. Given a 2D list A [-100:100] [-5:50]. Find the address of element A [99, 49] in row major order, considering base address 10 and each element requires 4 bytes for storage. (CO2,K2) 2
- 2.c. Write node structure for a doubly linked list. (CO3,K2) 2
- 2.d. What is ADT? Explain the stack ADT. (CO4,K1) 2
- 2.e. Write any two characteristics of the Greedy Algorithm. (CO5,K1) 2

SECTION – B

30

3. Attempt all parts:-

3.a. Answer any one of the following-

- 3-a.i Algorithms A and B solve the same problem. Algorithm A has time complexity $T_1(n) = 50n + 10$, and Algorithm B has $T_2(n) = 2n \log_2 n$. For approximately what value of n does Algorithm B become faster than Algorithm A? (CO1,K2) 6

- 3-a.ii Solve the recurrence using the Master Theorem:
 $T(n) = 4T(n/2) + n$ (CO1,K2) 6

3.b. Answer any one of the following-

- 3-b.i A 3D array A[4][3][2] is stored in **column-major order**. Find the address of A[2][1][1]. Assume the base address and storage requirement for each element by yourself. (CO2,K2) 6

- 3-b.ii Which sorting algorithm among Bubble, Selection, and Insertion performs the **least number of swaps**, and why? (CO2,K2) 6

3.c. Answer any one of the following-

- 3-c.i List the merit and demerit of circular linked list with writing function of insertion and display. (CO3,K2) 6

- 3-c.ii Write a function for insertion, deletion and display of queue using linked list. (CO3, K2) 6

3.d. Answer any one of the following-

- 3-d.i Define stack? Given the stack operations (P = push, R = pop), what is the output? Operations: P (5), P (3), P (8), R, P (2), R, R Also write Push and pop function using array. (CO4, K2) 6

- 3-d.ii Write an algorithm to solve Tower of Hanoi problem using recursion. (CO4, K3) 6

3.e. Answer any one of the following-

- 3-e.i Explain with a small example why Greedy works for Activity Selection but fails for 0/1 Knapsack. (CO5,K3) 6

- 3-e.ii Construct a Huffman Tree for the characters {a, b, c, d, e, f} with frequencies {5, 7, 10, 15, 20, 45}. Encode each character and calculate average code length. (CO5,K3) 6

SECTION – C

50

4. Answer any one of the following-

- 4-a. Prove or disprove the following equalities: (CO1,K3) 10
- a) $n \log n = O(n^2)$
- b) $n^2 = O(n \log n)$
- c) $\log^2 n = O(n)$

- d) $100n + 500 = \Theta(n^2)$
- 4-b. Differentiate between primitive and non-primitive data types. Provide two examples from each category. (CO1,K1) 10
5. Answer any one of the following-
- 5-a. Write the Insertion sort algorithm. Illustrate the operation of INSERTION-SORT on the array $A = \{31, 41, 59, 26, 41, 58\}$. (CO2,K2) 10
- 5-b. Define the Hashing. Explain why double hashing reduces clustering compared to linear probing (CO2,K2) 10
6. Answer any one of the following-
- 6-a. Discuss the advantages, if any, of a two way list over a one-way list for each of the following operations: (CO3,K3) 10
- (i) Traversing the list to process each node.
- (ii) Deleting a node whose location LOC is given
- (iii) Searching an unsorted list for a given element ITEM
- (iv) Searching a sorted list for a given element ITEM
- (v) Inserting a node before the node with a given location LOC.
- 6-b. Perform **polynomial addition using linked lists** for the following: 10
- $P(x) = 9x^6 - 4x^3 + 8x^2 - 10$
- $Q(x) = 5x^6 + 7x^4 + 2x^3 + 6$
- Explain **node comparisons**, **link movement**, and **final merged list**. (CO3,K3)
7. Answer any one of the following-
- 7-a. Write a **non-recursive** version of binary search using a loop. Using the algorithm search element 7 in the following array: (CO4,K2) 10
- 1, 3, 4, 6, 7, 8, 10, 13, 14, 18, 19
- Write a function for binary search using recursion.
- 7-b. Write an algorithm for the conversion of infix to postfix expression. Convert the infix to postfix and then evaluate: 10
- $(7 + 3) * (5 - 2^2) + 6$ (CO4,K2)
8. Answer any one of the following-
- 8-a. Explain the Divide-and-Conquer approach in Merge Sort. Given the array: 10
- $A = [38, 27, 43, 3, 9, 82, 10]$
- Show step-by-step how merge sort divides and merges the array. Write the Algorithm for the same. (CO5,K3)
- 8-b. Consider the following instance of the knapsack problem: $n = 7$, $m = 15$, $(p_1, p_2, \dots, p_7) = (10, 5, 15, 7, 6, 18, 3)$, and $(w_1, w_2, \dots, w_7) = (2, 3, 5, 7, 1, 4, 1)$. Find the optimal solution. (CO5,K3) 10