Printed page: 4 **Subject Code: BMICSE0301**

Roll No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

M.Tech Integrated

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? (CO1, K1) 1

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 <u>one</u> of the following-

3-a.i	Algorithms A and B solve the same problem. Algorithm A has time complexity $\mathbf{T_1(n) = 50n + 10}$, and Algorithm B has $\mathbf{T_2(n) = 2n \log_2 n}$. 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 <u>one</u> 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 <u>one</u> 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 <u>one</u> 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 <u>one</u> 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 <u>one</u> of the following-

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

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 <u>one</u> 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 <u>one</u> 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 <u>one</u> 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 <u>one</u> 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, (p1, p2, …, p7) = (10, 5, 15, 7, 6, 18, 3), and (w1, w2, …, w7) = (2, 3, 5, 7, 1, 4, 1). Find the optimal solution. (CO5,K3) 10