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Printed Page:-5 **Subject Code:- AMICA0501**

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)
MCA (Integrated)
SEM: V - THEORY EXAMINATION (2025 - 2026)
Subject: Design And Analysis Of Algorithms

Time: 3 Hours **Max. Marks: 100**

General Instructions:

IMP: *Verify that you have received the question paper with the 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. Define a recurrence relation? [CO1,K1] 1

(a) A relation between two variables that recurs infinitely

(b) A relation between two functions that recurs infinitely

(c) A mathematical expression that defines a function in terms of its value at smaller inputs

(d) A mathematical expression that defines a function in terms of its value at larger inputs

1-b. The control statements ,typically analyzed in algorithm analysis ? [CO1,K2] 1

(a) If-else

(b) For-loop

(c) While-loop

(d) All of the above

1-c. The following algorithms is an example of a divide-and-conquer approach? [CO2,K1] 1

(a) Selection Sort

(b) Bubble Sort

(c) Binary Search

(d) Insertion Sort

1-d. The primary disadvantage of the Naive String Matching algorithm? [CO2,K2} 1

(a) It requires extra space for hashing.

(b) It performs unnecessary comparisons, leading to high time complexity.

(c) It cannot handle large inputs.

(d) It is only suitable for numerical patterns.

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1-e. In the Divide and Conquer paradigm, which of the following steps takes the maximum time in Merge Sort? [CO3,K3] 1

(a) O(n2)
(b) O(nlogn)
(c) O(n)
(d) O(logn)

1-f. If a problem can be solved by combining optimal solutions to non-overlapping problems, the strategy is called [CO3,K2] 1

(a) Sorting
(b) Compression
(c) Searching
(d) Dynamic programming

1-g. The following is NOT an example of a Dynamic Programming problem? [CO4,K2] 1

(a) Coin Change Problem
(b) Longest Increasing Subsequence
(c) Merge Sort
(d) 0/1 Knapsack Problem

1-h. The Bellman-Ford algorithm, which finds the shortest path from a single source in graphs with negative weights, uses which technique? [CO4,K2] 1

(a) Greedy
(b) Divide and Conquer
(c) Dynamic Programming
(d) Brute-force

1-i. A binary tree where each node has either zero or two children is called a: [CO5,K1] 1

(a) Full binary tree
(b) Complete binary tree
(c) AVL tree
(d) Red-Black tree

1-j. In the N-Queens problem, the goal is to place queens on an N×N times , N×N chessboard so that: [CO5,K2] 1

(a) All queens are in one row
(b) Queens do not attack each other
(c) Queens are in each column
(d) Queens occupy all diagonal cells

2. Attempt all parts:-

2.a. Describe the "worst-case" time complexity of any algorithm? [CO1,K2] 2

2.b. Why is Linear Search considered inefficient for large datasets? [CO2,K2] 2

2.c. Sort the array [38,27,43,3,9,82,10] using Merge Sort. [CO3,K3] 2

2.d. Explain the Matrix Chain Multiplication problem? [CO4,K2] 2

2.e. Why might a B-tree be preferred over a binary search tree (BST) for disk storage? [CO5,K3] 2

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SECTION-B 30

3. Attempt all parts:-

3.a. Answer any one of the following:-

3.a.(i) Solve the following recurrences, where T(1) = 1 and T(n) for n>=2 satisfies.T(n) = 8T(n/2) + n^3. [CO1,K3] 6

3.a.(ii) Design an algorithm for calculating an input number is Prime or Not? [CO1,K6] 6

3.b. Answer any one of the following:-

3.b.(i) Discuss the operations in a Binary Search Tree (BST). Explain the insertion, deletion, and search operations and analyze their time complexities. [CO2,K2] 6

3.b.(ii) Describe the Insertion Sort algorithm with an example and evaluate its worst time complexity. [CO2,K5] 6

3.c. Answer any one of the following:-

3.c.(i) Find the shortest path in the below graph from the source vertex (S) by using the Bellman-Ford 6
S-A 0
S-B 2
A-B 1
A-C 2
B-C 2
C-D 1
B-D 5 [CO3,K5]

3.c.(ii) Using Prims algorithm, calculate the minimum spanning tree of the following given graph. 6
A-B:4,
A-H:8,
B-C:8,
B-H:11,
C-D:7,
C-F:4,
C-I:2,
D-E:9,
D-F:14,
E-F:10,
F-G:2,
G-H:1,
G-I:6,
H-I:7 [CO3,K5]

3.d. Answer any one of the following:-

3.d.(i) Calculate the optimal solution of the knapsack instance n=7, w=15, (P1,P2,…..,P7) = (10,5,15,7,6,18,3) and (w1,w2,….,w7) = (2,3,5,7,1,4,1) [CO4,K5] 6

3.d.(ii) Select the Matrix Chain Multiplication sequence and solve the following instance using Dynamic Programming:Given matrices with dimensions: A1: 10 × 20, A2: 20 × 30, A3: 30 × 40, A4: 40 × 30. Use Dynamic Programming to determine the minimum number of scalar multiplications required to multiply the matrices together. [CO4,K5] 6

3.e. Answer any one of the following:-

3.e.(i)	Explain n-Queens problem, while taking 4x4 and 8x8 as examples. [CO5,K2]	6
3.e.(ii)	Define m-way tree. Also explain how an AVL Tree is different from RB Tree? [CO5,K2]	6

SECTION-C 50

4. Answer any one of the following:-

4-a.	Given the following recurrence relation for the running time of a divide and conquer algorithm:T(n)=2T(n/2)+O(n) Use the Master Theorem to solve the recurrence relation.Provide a detailed explanation of each step involved in applying the Master Theorem. [CO1,K3]	10
4-b.	Explain the significance of asymptotic notations (Big-O, Big-Theta, and Big-Omega) in algorithm analysis. For each notation, provide a formal definition and an example. Then, discuss the growth rates of the following functions and determine the correct order of their growth:f(n)=n^2 +5n, g(n)=n log n, h(n)=10n & k(n)=log n Provide a step-by-step explanation of how these functions grow relative to each other and discuss their importance in performance analysis. [CO1,K2]	10

5. Answer any one of the following:-

5-a.	Given the array:[15, 7, 9, 3, 6, 12] Sort the array using Insertion Sort. Explain the inner loop workings and how each element is inserted in the correct position in the sorted portion.Determine the number of comparisons and shifts that occur during the sorting process.What is the time complexity in the best, worst, and average cases for Insertion Sort? [CO2,K3]	10
5-b.	Given the array: [11, 13, 11, 14, 11, 13, 12] Sort the array using Counting Sort.Show all the intermediate steps, including the counting of elements and the construction of the output array.What is the time complexity of Counting Sort in terms of Big-O notation? [CO2.K3]	10

6. Answer any one of the following:-

6-a.	Given the array: [29, 12, 45, 23, 56, 89, 15, 1, 34] Perform Quick Sort on the array. Show all intermediate steps after each partitioning, including the pivot selection and array state.Explain the recursive calls and how the array is divided at each level. How does the choice of pivot affect the performance of Quick Sort? [CO3,K3]	10
6-b.	Given the following set of characters and their frequencies:[(A, 5), (B, 9), (C, 12), (D, 13), (E, 16), (F, 45)] Construct the Huffman Tree using the given frequencies.Show the steps involved in merging nodes and creating the final tree.Generate the Huffman codes for each character based on the tree structure.Calculate the average code length. [CO3,K6]	10

7. Answer any one of the following:-

7-a.	Consider the following Graph G(V,E), Apply all pair shortest path algorithm for generating a result. A → B (3), A → C (1), B → C (7), B → D (5), C → D (2) [CO4,K5].	10
7-b.	Given four projects m = 4 and n = 3 resources. Profit P(i,j) is obtained if i-resource are allocated to project-j. Develop a path graph and calculate value of that path for maximum total profit from following Profit_Table data. Project ----- No. of resources [1 2 3] A 2 8 9	10

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B	5	6	7
C	4	4	4
D	2	4	5 [CO4,K6]

8. Answer any <u>one</u> of the following:-

8-a.	Construct the m-way tree corresponding to following insertions (8,14,2,15,3,1,16,6,5,27,37,18,25,7,13,20,22,23,24,16,18,17,3) Consider the tree size of Order = 4. [CO5,K6]	10
8-b.	Construct an RB tree and show the resulting of inserting 10,20,30,15,25,5,12,35,40,32,50,11 in this order into an RB Tree. [CO5,K6]	10