



- > KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE  
 > DON'T WRITE ANYTHING ON THE QUESTION PAPER

COs	CO Statements
CO1	Understand the fundamental analysis and time complexity for a given problem.
CO2	Articulate linear, non-linear data structures and legal operations permitted on them.
CO3	Identify and apply suitable algorithms for searching and sorting.
CO4	Discover various tree and graph traversals.
CO5	Explicate hashing, heaps, and AVL trees and realize their applications.

BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Answer ALL Questions  
(10 X 10 = 100 Marks)

1. An R&D team implements a recursive matrix multiplication algorithm following the recurrence
- $$T(n) = 8T(n/2) + c n^2.$$
- They propose replacing it with Strassen's approach:
- $$T(n) = 7T(n/2) + c n^2.$$
- a) Solve each recurrence relations using the Master theorem. [3]  
 b) Compare asymptotic growth and memory cost. [3]  
 c) Justify which is preferable for very large matrices ( $n \geq 1024$ ). [4]
2. A hospital emergency department handles both walk-in and ambulance cases. Ambulance patients must be treated immediately, while others follow the First-Come-First-Served order.
- Question:**
- a) Use two queues (normalQ, emergencyQ) or a Double-Ended Queue (Deque). [4]  
 b) Demonstrate the enqueue/dequeue process for the sequence [W1, A1, W2, W3, A2, W4], where W = Walk-in and A = Ambulance. [4]  
 c) Show the final order of treatment. [2]

3. An e-commerce site uses a stack to manage browser history. Design an algorithm using two stacks to simulate navigation (back, forward, visit a new page). CO2 BL3

4. A software system represents polynomial expressions using linked lists. CO2 BL4  
Given:  
 $P_1 = 3x^3 + 2x^2 + 5$  and  $P_2 = 4x^3 + x^2 + 6x + 4$

Question:

a) Illustrate how these polynomials are stored in a singly linked list (each node containing coefficient, power, and next). [4]

b) Write an algorithm to add the two polynomials using traversal and node manipulation. [4]

c) Analyze the time complexity and justify why linked lists are preferred over arrays for this task. [2]

5. A robotics lab automates disk movement in a three-peg "Tower of Hanoi" setup, where the robotic arm can move only one disk at a time and must always place smaller disks above larger ones. CO2 BL3

Question:

a) Develop a recursive algorithm to solve the Tower of Hanoi for  $n = 4$  disks, using stacks to represent pegs (Source S, Auxiliary A, Destination D). [2.5]

b) Trace the first six moves explicitly, showing stack operations (push, pop) on each peg after every move. [2.5]

c) Derive and explain the time complexity recurrence and solve it to obtain  $T(n) = 2^n - 1$ . [2.5]

d) Discuss how the stack mechanism supports recursion in this algorithm. [2.5]

6. A hospital maintains sorted patient records by ID. The IDs are stored as: CO3 BL4  
[1023, 1056, 1080, 1102, 1125, 1150, 1183, 1210, 1250]

For a new emergency case with ID 1102, demonstrate Binary Search steps and compute the number of comparisons made. Compare this with Linear Search for the same dataset.

7. A social media company sorts post timestamps (in seconds) to show the most recent first. The sample dataset is: CO3 BL5  
[45, 12, 67, 34, 89, 23, 10, 90, 56, 38]

Evaluate the most efficient sorting technique among Quick Sort, Merge Sort, and Counting Sort, given that all values range between 0-100.

8. Given the infix expression:  
 $(A + B) * (C - D) + E / F$  CO4 BL3  
 Construct the Expression Tree. Write its preorder, Inorder, and Postorder traversals, and determine the height of the tree.

9.a) A delivery company connects five cities: A-B (4 km), A-C (2 km), B-C (1 km), B-D (5 km), C-D (8 km), D-E (3 km). Starting from A, compute the shortest path to all other cities using Dijkstra's algorithm. Present stepwise distance updates. CO4 BL6

OR

9.b) A city wants to build a low-cost road network connecting stations A-E. The cost matrix (in ₹ lakhs) is given below: CO4 BL6

	A	B	C	D	E
A	0	2	0	6	0
B	2	0	3	8	5
C	0	3	0	0	7
D	6	8	0	0	9
E	0	5	7	9	0

Model this as a weighted graph and compute the Minimum Spanning Tree using Prim's or Kruskal's algorithm. Indicate edges included and total cost.

10.a) A database uses the following key sequence for insertion into a Binary Search Tree:  
 [50, 30, 20, 40, 70, 60, 80, 10] CO5 BL5

- i) Draw the BST formed after all insertions. [5]
- ii) Analyze its complexity if a new key 5 is inserted. Suggest how an AVL tree work for the same. [5]

OR

10.b) A banking application hashes 6-digit customer IDs using  $h(k) = k \bmod 10$ . Given the keys [1001, 2011, 2021, 3012, 4056, 5011, 6021], evaluate collision resolution methods and demonstrate insertion using CO5 BL5

- i) Linear Probing and [5]
- ii) Separate Chaining.