Total No. of Questions: 21

Enrollment No : _____

MEDICAPS UNIVERSITY

Faculty of Engineering / Science

End Semester Examination May 2025

CS3CO42 / BC3CO69 Design & Analysis of Algorithms

Programme	:	B.Tech. / B.Sc.	**Branch/Specialisation**	:	CSE All / CS
Duration	:	3 hours	**Maximum Marks**	:	60

Note: *All questions are compulsory. Internal choices, if any, are indicated. Assume suitable data if necessary. Notations and symbols have their usual meaning.*

Section 1 (Answer all question(s))

		Marks	CO	BL
Q1.	Let T(n) be the recurrence relation defined by: T(n)=3T(n/3) + n/2 What is the time complexity of T(n)? ○ O(n) ◉ O(n logn) ○ $O(n^2)$ ○ O(logn)	1	2	2
Q2.	What is the best-case time complexity of the Insertion Sort algorithm? ◉ O(n) ○ O(n logn) ○ $O(n^2)$ ○ O(logn)	1	1	1
Q3.	The time complexity of Radix Sort is given as O(d(n+k)), where d is the number of digits, n is the number of elements, and k is the range of digits. In which of the following cases does Radix Sort perform better than comparison-based sorting algorithms like Merge Sort? ○ When d is significantly larger than n ○ When k is much smaller than n ◉ When d=O(logn) and k=O(n) ○ When k is close to n^2	1	2	2
Q4.	Consider an array of size "n" sorted in descending order. If we apply Quick Sort with the first element as the pivot, what will be the time complexity? ○ O(n) ○ O(n logn) ◉ $O(n^2)$ ○ O(logn)	1	2	2
Q5.	Huffman coding is used for- ○ Sorting ◉ Data Compression ○ Encryption ○ Generating Huffman tree	1	2	2
Q6.	In Prim's Algorithm for Minimum Spanning Tree (MST), how is the next edge selected at each step? ○ The edge with the smallest weight among all edges. ◉ The edge with the smallest weight that connects a new vertex to the MST. ○ The edge with the smallest weight among the unprocessed edges. ○ The edge that connects two unprocessed vertices with the smallest weight.	1	2	2
Q7.	Two assembly lines A and B each have n stations. The time taken at station *i* of each line is given, along with entry and exit times. Which approach will be most suitable to find the minimum time required to complete all stations? ○ Greedy Algorithm ○ Divide and Conquer ◉ Dynamic Programming ○ Backtracking	1	1	1

Q8. Consider a 0/1 Knapsack problem where the capacity of the knapsack is W = 5, and there are 3 items with the following weights and values: **1 3 3**

Item	Weight	Value
1	2	10
2	3	20
3	4	30

Using Dynamic Programming, what would be the maximum value of the given knapsack that can be obtained?

- (•) 30
- ( ) 40
- ( ) 50
- ( ) 60

Q9. In the m-Coloring problem, what is the constraint that must be satisfied? **1 1 1**

- (•) No two adjacent vertices should have the same color.
- ( ) Every vertex must be assigned a different color.
- ( ) The graph should be bipartite.
- ( ) A vertex can have multiple colors.

Q10. In the N-Queens problem, what is the worst-case time complexity of the backtracking algorithm? **1 1 1**

- ( ) O(N)
- ( ) O(N^2)
- (•) O(N!)
- ( ) O(2^N)

Section 2 (Answer all question(s))

Marks CO BL

Q11. Solve the following recurrence using any method: **4 3 3**

(i) $T(n)=2T(n/2) + n^2$

(ii) $T(n)=T(n/3) + T(2n/3) + n$

Rubric	Marks
Solution of (1)	2
Solution of (2)	2

Q12. (a) Write an algorithm/program in any language for Selection Sort and analyze its time complexity for both best and worst case. **6 4 4**

Rubric	Marks
Algorithm/Program -4 marks Analysis of Complexity- 1 marks Only Complexity is written- 1 marks	6

(OR)

(b) Write an algorithm/program in any language for Bubble Sort and and analyze its time complexity for both best and worst case.

Rubric	Marks
Algorithm/Program- 4 marks Analysis of Complexity- 1 marks If only complexity is written- 1 marks	6

Section 3 (Answer all question(s))

Marks CO BL

Q13. Justify the reason for having Quick Sort worst-case time complexity of $O(n^2)$ with the help of suitable example? **4 2 2**

Rubric	Marks
Why does Quick Sort have a worst-case time complexity of O(n^2)?	4

Q14. (a) Explain how Bucket Sort differs from Radix Sort in terms of implementation and efficiency. Demonstrate a scenario where Bucket Sort performs worst. **6 2 2**

Rubric	Marks
Explain how Bucket Sort differs from Radix Sort in terms of implementation and efficiency. Provide a scenario where Bucket Sort performs worst.	6

(OR)

(b) Explain Strassen's Matrix. Derive the recurrence relation for Strassen's Algorithm and solve it using the Master Theorem.

Rubric	Marks
Explain Strassen's Matrix.-4 marks Derive the recurrence relation for Strassen's Algorithm, Solve it using the **Master Theorem**- 2 marks	6

Section 4 (Answer all question(s))

Marks CO BL

Q15. Differentiate the working of Prim's and Kruskal's algorithms for finding the Minimum Spanning Tree (MST). **4 4 4**

Rubric	Marks
Explain the differences between Prim's and Kruskal's algorithms for finding the Minimum Spanning Tree (MST).	4

Q16. (a) A message having following characters and their respective frequencies: **6 5 5**

A	B	C	D	E
5	9	12	13	16

Construct the Huffman tree. Determine the Huffman codes for each character. Calculate the total number of bits required to encode a message of 100 characters with this distribution.

Rubric	Marks
Construct the Huffman tree- 2 marks Determine the Huffman codes for each character. 2 marks Calculate the total number of bits required to encode a message of 100 characters with this distribution. 2 marks	6

(OR)

(b) Explain job sequencing problem and its time complexity. Consider 4 jobs with their respective profits and deadline, and demonstrate the solution of this problem using an efficient approach.

Job	Profit	Deadline
A	100	2
B	50	1
C	200	2
D	30	1

Rubric	Marks
Explain job sequencing with deadlines- 2 marks Complexity- 1 marks Consider 4 jobs with the following profits and deadline - 3marks	6

Section 5 (Answer all question(s))

Marks CO BL

Q17. What is Dynamic Programming? Explain the principle of optimality. **4 2 2**

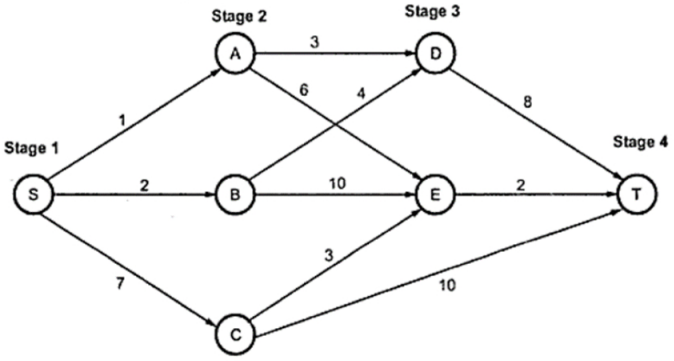
Rubric	Marks
What is Dynamic Programming? -2 marks Explain the principle of optimality. -2marks	4

Q18. (a) Given two sequences X and Y, find the Longest Common Subsequence (LCS) using dynamic programming: **6 5 5**
X = "ACDBE", Y = "ABCDE",

Rubric	Marks
Longest Common Subsequence + Process	6

(OR)

(b) Using Dynamic Programming, determine the shortest path from source (S) to destination (T) in the given multistage graph-
(i) Compute the minimum cost to reach T from S.
(ii) Identify the path taken for this shortest route.



Multistage graph

Rubric	Marks
(a) Compute the minimum cost to reach T from S. (b) Identify the path taken for this shortest route.	6

Section 6 (Answer any 2 question(s))

Marks CO BL

Q19. Explain the difference between Backtracking and Branch & Bound approaches with suitable examples. **5 2 2**

Rubric	Marks
Explain the difference between Backtracking and Branch & Bound approaches. -4 marks Examples- 1 marks	5

Q20. Describe P, NP, NP-Complete, and NP-Hard problems using suitable example. **5 1 1**

Rubric	Marks
Define P, NP, NP-Complete, and NP-Hard problems.-4 marks Examples-1 marks	5

Q21. Explain the Sum of Subset problem and how Backtracking approach helps solve it. **5 2 2**

Rubric	Marks
Explain the Sum of Subset problem.-2.5 marks How Backtracking helps solve it.- 2.5 marks	5

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