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Continuous Assessment Test- II [CAT - II]

Year	: II
Semester	: III
Branch	: B.E Computer Science and Engineering
Sub. Code	: CS23331
Subject Name	: Design and Analysis of Algorithms
QP Code	: 072103

[Regulations 2023]

(Common to Information Technology, Artificial Intelligence and Machine Learning, Computer Science and Design, Artificial Intelligence and Data Science)

Date: 15.11.2024**Time: 120 Minutes****Marks: 75****Answer ALL Questions****Part A [2 x 2 = 4 Marks]**

- 3.4. What is its average time complexity for finding the kth smallest element in an array? [A2] CO3
- 3.5. How does partitioning work in Quick Sort? [A2] CO3

Part B [1 x 11 = 11 Marks]

- 3.6. a. Write a function to solve the Towers of Hanoi problem for 'n' disks using recursion. Also, provide a brief explanation of how the function operates for n = 4. [B1] CO3

[OR]

- b. Theoretically analyze and compare the worst-case and average-case time complexities of Quick Sort and Merge Sort. Under what circumstances might Merge Sort perform better than Quick Sort? [B1] CO3

Answer ALL Questions**Part A [4 x 2 = 8 Marks]**

- 4.1. What is the role of the state in a dynamic programming problem, and how does it relate to the overall solution? [A2] CO4
- 4.2. Differentiate Tabulation from Memoization [A2] CO4

- 4.3. Write the recurrence relation used in the dynamic programming approach for solving the TSP. [A1] CO4
- 4.4. List the operations needed to transform one string into the other. [A2] CO4

Part B [2 x 11 = 22 Marks]

- 4.5. a. You are a teacher comparing two students' assignments. You want to find the longest common subsequence of words between the two submissions to check for similarities. Given two strings representing the student submissions, submission1 = "I love C and Java programming" and submission2 = "I enjoy C and Python programming", use dynamic programming to find the longest common subsequence.

[OR]

- b. You are developing a basic text editor that suggests corrections for misspelled words. The editor compares the user's input with a correct word from a dictionary and calculates how many changes (insertions, deletions, or substitutions) are needed to fix the misspelling. Given a misspelled word input = "bakery" and the correct word correct Word = "cookery ", use dynamic programming to find the minimum number of edits required to transform the input into the correct word.

- 4.6. a. Scenario:
You are working as a bioinformatician analyzing DNA sequences from two different species to find the longest common substring, which may provide insights into shared evolutionary traits. Use dynamic programming to solve this problem.

Task:

Given two DNA sequences, sequence1 = "AGGTABAC" and sequence2 = "GXTXAYBAC", implement the dynamic programming approach to find the longest common substring.

[OR]

- b. You are working as a data analyst at a financial company. Your task is to analyze stock price trends over a period of days and identify the longest period during which the stock prices were non-decreasing. This helps

traders understand the longest stable or growing period in the stock's performance, which can guide their investment decisions.

Given an array of daily stock prices, $\text{stockPrices} = [100, 98, 101, 102, 97, 98, 99, 103]$, find the Longest Non-Decreasing Subsequence (LNDS) of stock prices. A non-decreasing subsequence means that each subsequent price in the sequence is either greater than or equal to the previous price.

Answer ALL Questions

Part A [4 x 2 = 8 Marks]

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|------|--|------|-----|
| 5.1. | What happens in the backtracking process of the n-Queens problem when no valid position is found for a queen in the current row? | [A2] | CO5 |
| 5.2. | State the purpose of bounding function in a branch and bound algorithm. | [A2] | CO5 |
| 5.3. | Provide an example of a problem that belongs to the class P and state why. | [A2] | CO5 |
| 5.4. | How does the concept of 'tractability' relate to problems in the P class? | [A2] | CO5 |

Part B [2 x 11 = 22 Marks]

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|------|---|------|-----|
| 5.5. | a. Outline the procedure for solving the n-Queens problem using the backtracking method. Detail the steps involved, including how to initialize the board, place queens, check for conflicts, and store solutions. Illustrate your explanation with an example where the board size is 4x4 (n=4). | [B1] | CO5 |
| | [OR] | | |
| b. | Imagine you are packing for a hiking trip, and you have a backpack with a maximum weight capacity of 50 pounds. You have the following items to choose from, each with a given weight and value: | [B1] | CO5 |

Item	Weight (pounds)	Value (dollars)
1	10	60
2	20	100
3	30	120

Use Branch and Bond based Solution to solve it.

- 5.6. a. Explain the Nearest Neighbor Heuristic for solving the Traveling [B2] CO5 Salesman Problem (TSP). Given the following distance matrix representing distances between 5 cities, use the Nearest Neighbor approximation algorithm starting from city A to find a solution. Show the sequence of cities visited and the total distance covered.

	A	B	C	D	E
A	0	2	9	10	4
B	2	0	6	5	8
C	9	6	0	3	7
D	10	5	3	0	6
E	4	8	7	6	0

[OR]

- b. Explain the Minimum Spanning Tree (MST)-Based Approximation [B2] CO5 algorithm for solving the TSP with an example. Compare the results with the optimal solution of TSP and discuss.