Roll Number:_____

Thapar Institute of Engineering & Technology

Department of Computer Science and Engineering

AUXILIARY EXAMINATION

B. E. (2nd Year COE/CSE): Sem-IV
16st August, 2024
Monday, 5:30 To 8:30 PM
Time: 3 Hours, Max Marks: 100

Course Code: UCS415
Course Name: Design and Analysis of Algorithms
Name of Faculty: Dr. Tarunpreet Bhatia

Note: Attempt all Questions in sequence. Answer all sub-parts of each question at one place. Do mention Page No. of your attempt at front page of your answer sheet. Assume missing data (if any).

Q.1 (8)

a) Consider the following segment of code (where n > 1). Write the recurrence relation and calculate the right time complexity using recursion tree method of functions fun1.

```
int fun1(int n){
    if (n > 1)
    {
        for(int i = 0; i < n; i++)
            printf ("%d", i);
        return (n² + fun1(n/2) + fun1(n/4));
    }
}
```

(5+5)

b) We are given n-platform and two main running railway track for both direction. Trains which needs to stop at your station must occupy one platform for their stoppage and the trains which need not to stop at your station will run away through either of main track without stopping. Now, each train has three value first arrival time, second departure time and third required platform number. We are given m such trains you have to tell maximum number of train for which you can provide stoppage at your station. Write an efficient algorithm for this and also apply your algorithm to the data given in **Table 1**.

Table 1

Train	Arrival Time	Departure Time	Platform No.
1	10:00	10:30	1
2	10:20	10:50	1
3	11:00	11:30	2
4	11:15	11:45	1
5	11:30	12:00	3
6	10:15	10:45	2
7	10:40	11:00	3
8	11:05	11:35	3
9	11:25	11:55	2
10	11:40	12:10	1

Q.2 (7+8)

You are an event manager responsible for scheduling different events in a large conference hall. Each event requires a specific time slot, and some events have conflicting time requirements (i.e., they cannot be scheduled simultaneously). You are given a list of events $E_1, E_2, .. E_n$ and a conflict matrix C, where $C[i][j] = 1$ indicates that event E_i conflicts with event E_j, meaning they cannot be scheduled at the same time.

a) Write the pseudocode for your backtracking solution to find the minimum number of time slots required to schedule all events so that no two conflicting events are assigned the same time slot.

b) Apply your algorithm to the conflict matrix (**Fig. 1**) and determine the minimum number of time slots required. Show the intermediate steps.

$$C = \begin{pmatrix} 0 & 1 & 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 & 1 & 1 \\ 1 & 0 & 0 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 \end{pmatrix}$$

Fig 1

Q.3	A thief breaks into a house intending to rob it. He has a bag that can hold a maximum weight of 8 kg. Inside the house, there are four items, each with a specific weight and value (as shown in Table 2). The thief can either take an entire item or leave it behind. He want to choose the items to maximize his profit. **Table 2** **Item** | Mirror | Silver nugget | Painting | Vase **Weight (kg)** | 2 | 3 | 4 | 5 **Value ($)** | 10 | 20 | 50 | 60 a) Describe the pseudocode to find maximum profit using a dynamic programming approach, and calculate its time complexity. b) Demonstrate the intermediate steps to solve the above problem using a dynamic programming approach. You also need to provide the list of item he should choose to maximize the profit.	(6+10)
Q.4	Imagine you're working on a bioinformatics project where you need to analyze DNA sequences. You have a long DNA sequence "ABC ABCDAB ABCDABCDABDE" that is millions of base pairs long, and you need to identify the presence of a specific gene sequence within this larger DNA strand. The gene sequence you're looking for is a short pattern of nucleotides, "ABCDABD". a) Preprocess the pattern " ABCDABD " to generate the prefix table [0, 0, 0, 0, 0, 0, 0]. b) Apply the Knuth-Morris-Pratt algorithm to match the pattern within the long DNA sequence. Demonstrate all intermediate steps to solve the DNA sequence matching problem.	(5+12)
Q.5	A palindrome is a nonempty string over some alphabet that reads the same forward and backward. Examples of palindromes are all strings of length 1, civic, and racecar. For example, given the input ***character***, your algorithm should return ***carac***. Consider the input string = "***character***". Compute the longest palindrome ("***carac***" here), which is a subsequence of a given input string using dynamic programming. Show the step-by-step solution for this example by marking the entries in the table followed by printing the length and palindrome sequence. Also, write recursive equation to find longest palindrome subsequence and what is the running time of your algorithm?	(16)
Q.6	Imagine you are working as a logistics coordinator for a delivery company that needs to optimize its delivery routes. The company has five warehouses (A, B, C, D, and E) located in different cities, and each warehouse must be visited exactly once before returning to the starting point. The goal is to find the most efficient route that minimizes the total travel distance. The distances (in kilometers) between the warehouses are given in the **Table 3**. a) Using the branch-and-bound algorithm, solve the TSP for the given scenario to find the optimal delivery route. Show all the steps involved in your calculations, including state space tree and bounding calculations. b) Discuss the complexity of the TSP branch-and-bound algorithm within the classes P, NP, NP-Complete, and NP-Hard. Explain why solving TSP is computationally challenging and discuss the advantages of 2-approximation over branch-and bound for TSP. **Table 3** | | A | B | C | D | E | A | ∞ | 20 | 30 | 10 | 11 | B | 15 | ∞ | 16 | 4 | 2 | C | 3 | 5 | ∞ | 2 | 4 | D | 19 | 6 | 18 | ∞ | 3 | E | 16 | 4 | 7 | 16 | ∞ |	(12+6)