Roll Number:_____

Thapar Institute of Engineering & Technology
Department of Computer Science and Engineering
AUXILIARY EXAMINATION

B. E. (2nd Year COE/CSE, 3rd Year EM): Sem-IV/VI
21st August, 2023
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 A networking company uses a Huffman compression technique to encode the message before (7+3)
transmitting over the network. Consider the characters with their frequency as shown in **Table 1**:

Table 1

Character	D	A	T	S	R	U	C	E
Frequency	18	37	29	50	17	30	6	13

a) Encode the message "DATASTRUCTURES" before transmitting on a network. Show intermediate steps.
b) If the codeword for character "C" is reversed, will there be any effect on decoding the message at receiver. Justify your answer with example.

Q.2 Consider 3 keys A, B, and C (in sorted order) to be searched for in a binary search tree (BST) with (12)
probabilities 0.5, 0.1, and 0.05, respectively. The probabilities of unsuccessful search for above key values are 0.15, 0.1, 0.05 and 0.05 respectively. How many different binary search trees exists? Compute and construct Optimal BST for above values using Dynamic programming approach. You need to calculate the optimal search cost also.

Q.3 Imagine yourself as a wedding planner organizing the rehearsal dinner before a big wedding. There (12)
are a total of 8 people attending the rehearsal dinner: A, B, C, ... , H are relatives of the bride and groom. You are told that some of these people have serious issues as shown in **Table 2**:

Table 2

People	A	C	E	G	B	D	F	H
Doesn't get along with	F, G, H	B, D, E, G, H	C, D, F, G	A, C, E, F	C, D, H	B, C, E	A, E, G	A, B, C

To make the rehearsal dinner go smoothly you are instructed to find a way to seat these people so that people that don't get along must be seated at different tables. Design an algorithm using backtracking to set up the seating arrangements with so many incompatibility issues to worry about. Also, apply your algorithm to obtain the seating plan such that minimum number of tables are required.

Q.4 Imagine you are a computer scientist working on a project that involves DNA sequence analysis. (10)
You've come across a DNA sequence represented as a string T: "ACGTAGCTAGCTA," and you want to find occurrences of a specific DNA pattern within this sequence using the Rabin-Karp string matching algorithm. The pattern you're searching for is "TAGC." Your task is to apply the Rabin-Karp algorithm with a modulo value $q = 5$ and calculate the hash value of the pattern and spurious hits encountered during the search process. Show the step-by-step calculation and sliding window, including the ASCII values of the characters and the resulting hash value.

Q.5 Elena is a talented artisan who creates beautiful handcrafted items for a local craft fair. However, she (10) has limited space on her display table, and she wants to choose the items that will maximize her potential earnings without exceeding the table's capacity.

> Here are the available crafts:
> Hand-Painted Vase - Weight: 3 kg, Value: 150
> Wooden Sculpture - Weight: 2 kg, Value: 120
> Embroidered Tapestry - Weight: 5 kg, Value: 250
> Ceramic Figurine - Weight: 4 kg, Value: 200

Elena's display table can only hold items with a combined weight of 7 kg. Write and apply the recursive equation to determine the maximum value she can achieve by selecting the optimal combination of crafts to display on her table using dynamic programming. You also need to provide the list of crafts she should choose to maximize her potential earnings.

Q.6 a) Solve the following recurrence relation using recursion tree. (7)
$$T(n) = T\left(\frac{n}{3}\right) + T\left(\frac{2n}{3}\right) + n \ \ where \ T(1) = 1$$
b) Define the concept of class P, Class NP, NP-Complete and NP-Hard with mathematical (7) representation and suitable Venn diagram.

Q.7 You are given a flow network as shown in the **Fig 1**. You need to find the augmenting path of highest (10) bottleneck capacity and its max-flow from source s to target t using Ford-Fulkerson algorithm.
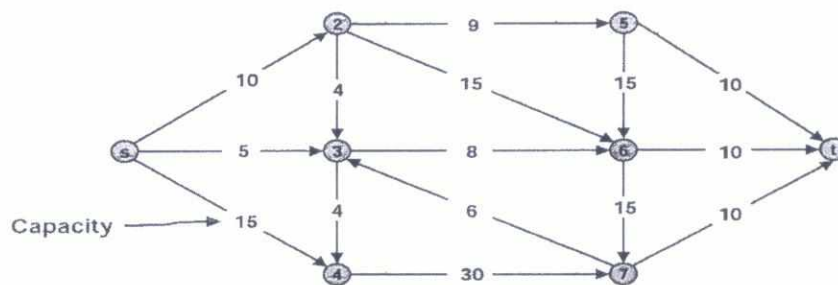

Fig 1

Q.8 a) Write the algorithm to find the subset of elements that are selected from a given set w (12) (containing n non-negative elements). Solve n = 4, w = (11, 13, 24, 7) and m = 31 by creating solution space tree.

(10)

b) Given a Directed Acyclic Graph **(Fig 2)**, find topological sorting of the vertices. Show intermediate steps.
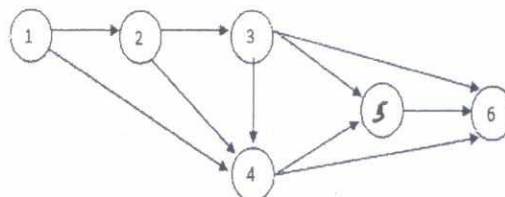

Fig 2