COMSATS University Islamabad, Lahore Campus

☑ Terminal Examination – SPRING 2024

Course Title:	Design and Analysis of Algorithms				Course Code:	CSC301	Credit Hours: 3(3,0)
Course Instructor:	Dr. Hasan Jamal, Dr. Atif Saeed				Programme Name:	BS Computer Science	
Semester:	4th	Batch:	FA22-BCS	Section:	A, B, C, (D)	Date:	10/06/2024
Time Allowed:	**3 Hours**				**Maximum Marks:**		80
Student's Name:	[redacted]				Reg. No.	[redacted]	

Important Instructions / Guidelines:

- Be precise and to the point while answering any question. .
- Show all your work, as partial credits will be given. You will be graded not only on the correctness of your answer, but also on the clarity with which you express it. Please be neat.
- **Good luck!**

Question 1: **CLO: <1>; Bloom Taxonomy Level: <Applying>** **[Marks: 03 + 02 = 05]**

(a) Anagrams are words or phrases formed by rearranging the letters of a different word or phrase. For example study = dusty, night = thing etc. Given two strings, describe briefly in not more than five sentences, how would you develop a solution to determine if they are anagrams of each other in $\Theta(n)$ time?

(b) Organize the following six functions in increasing order of their growth rates:

$$n \lg n, \quad \lg n, \quad n^2, \quad 2^n, \quad \sqrt{n}, \quad n$$

Question 2: **CLO: <2>; Bloom Taxonomy Level: <Analyzing>** **[Marks: 10 + 05 = 15]**

(a) Solve the following recurrence using the "Recursion Tree Method".

$$T(n) = 2T(n-1) + 1$$

(b) Solve the following recurrence using the "Master Method."

$$T(n) = 6T\left(\frac{n}{2}\right) + n^3$$

Question 3: **CLO: <3>; Bloom Taxonomy Level: <Creating>** **[Marks: 10 + 10 + 10 = 30]**

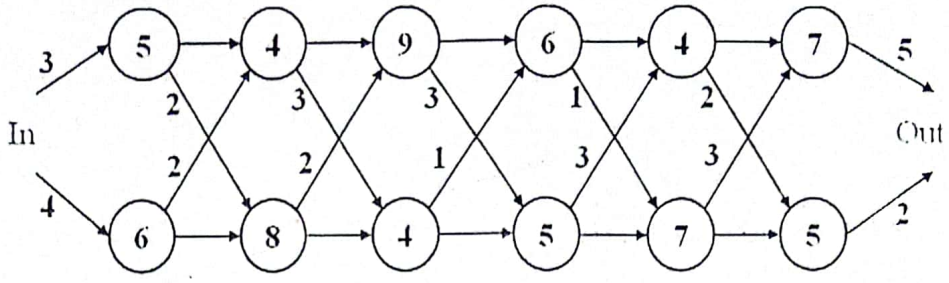
(a) Given the following two strings, CATEGORICAL and CEREMONIAL, determine the minimum edit distance using dynamic programming. Assume the insertion and deletion cost to be 1 and substitution cost to be 2.

(b) Apply the bottom-up dynamic programming algorithm to the following instance of the 0/1 knapsack problem. The weight capacity W = 8.

Item #	w_i	b_i
I_1	1	15
I_2	5	10
I_3	3	9
I_4	4	5

i. What is the maximum value/benefit (B) that can be achieved?
ii. Item number/s that can be added in the bag to achieve the above max value/benefit (B)?
iii. Item I_5 with $w_6 = 2$ and $b_6 = 5$ is newly introduced. What effect does I_5 have on the value of B? Show your steps.

(c) A car manufacturing factory has two assembly-lines, each having six service stations as shown in the figure below, along with all the associated costs. Using "dynamic programming", find out the fastest way through the factory.



Question 4: **CLO: <3>; Bloom Taxonomy Level: <Creating>** **[Marks: 06 + 04 = 10]**

a) Draw the Huffman tree corresponding to the encoding table below and list down the range of values for the frequency of character "I".

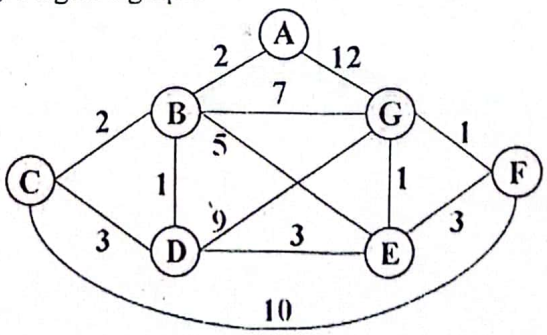
Characters	Frequency	Encoding
B	2	01101
F	1	01100
H	3	0111
I	?	00
L	5	010
M	15	10
S	15	11

b) Given 11 tasks with their start and finish times, determine the max number of mutually compatible activities as per Activity Selection Problem rules and list down the selected activities. Show your steps.

i	1	2	3	4	5	6	7	8	9	10	11
s_i	1	2	4	6	5	8	3	9	11	13	15
f_i	3	5	6	8	9	10	7	11	14	16	17

Question 5: **CLO: <4>; Bloom Taxonomy Level: <Understanding>** **[Marks: 08 + 02 + 10 = 20]**

Consider the following undirected, weighted graph.



(a) Step through Dijkstra's algorithm to calculate the single-source shortest paths from A to every other vertex. List down the vertices in the order which you marked them known and indicate the lowest-cost path from vertex A to vertex F.

(b) Draw the Minimum Spanning Tree for the graph given above.

(c) Determine the shortest path between all the possible pairs of vertices in the graph given above using Floyd-Warshall Algorithm.