VIT

Reg. No. :

Final Assessment Test (FAT) - APRIL/MAY 2023

Programme	**B.Tech**	Semester	**Winter Semester 2022-23**
Course Title	**DESIGN AND ANALYSIS OF ALGORITHMS**	Course Code	**BCSE204L**
		Slot	**E1+TE1**
Faculty Name	**Prof. Kirthica S**	Class Nbr	**CH2022235001175**
Time	**3 Hours**	Max. Marks	**100**

If any assumptions are required, assume the same and mention those assumptions in the answer script

Use of intelligence is highly appreciated.

Your answer for all the questions should have both the 'design' component and the 'analysis component'

The 'Design' component should include: understanding of the problem, logic to develop the pseudo code, illustration, pseudo code.

The 'Analysis' component should include: Computation of T(n), Time-complexity.

PART-A (4 X 15 Marks)

Answer All questions

01. There are N caves $C_1, C_2, \ldots, C_N$ (where N >= 3 is an integer) built along a line, each of which contains some money in it. Raja can take the money from any cave but he cannot take the money from any two adjacent caves. That is, if he takes the money from the C_i^{th} cave, then he cannot take the money from the C_{i+1}^{th} cave. There will be an alarm if he tries to take the money from the adjacent caves. **[15]**

a) Design two algorithms, one by brute force and another by dynamic programming, to help Raja take the maximum amount from the caves. (6 marks)

b) Compute the time complexity of both your algorithms, determine the better algorithm among the two, and illustrate with an example. (3 marks + 2 marks + 4 marks)

For example,

If there are 7 caves and the values in them are 6, 7, 1, 3, 8, 2, 4 respectively then Output is 19

Explanation: Raja will take 6, 1, 8 and 4, whose total is 19 from the caves

If there are 5 caves and the values in them are 5, 3, 4, 11, 2 respectively then Output is 16

Explanation: Raja will take 5 and 11, whose total is 16 from the caves

02. Consider an n × n matrix with each cell containing an alphabet of the English language.. The alphabets are randomly distributed in the matrix. Given such a matrix and a list of words which have a meaning in the English language:

a) Design a backtracking algorithm with all the required steps to trace the words in the matrix by starting from any position, navigating either horizontally, vertically, or diagonally. The algorithm should return the (x,y) co-ordinates for each letter of every word of the list found in the matrix. You may assume that the bottom left most alphabet of the matrix has co-ordinates (0, 0). (7 marks)

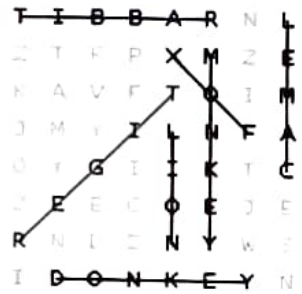
b) Compute the time complexity of your algorithm and illustrate the working of your algorithm with an example. (3 marks + 5 marks)

For example, we are given Figure 1 and the words CAMEL, DONKEY, FOX, LION. MONKEY, RABBIT, TIGER. These words are found as seen in Figure 2

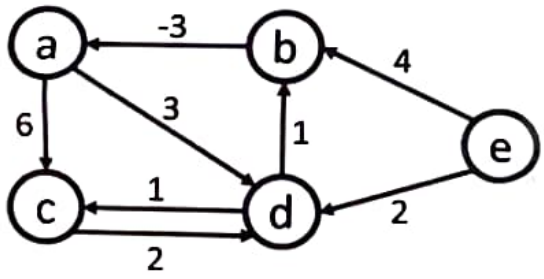
Figure 1

T	I	B	B	A	R	N	L
Z	T	F	P	X	M	Z	E
K	A	V	F	T	O	I	M
J	M	Y	I	L	N	F	A
O	Y	G	I	I	K	T	C
Z	E	E	C	O	E	J	E
R	N	D	Z	N	Y	W	S
I	D	O	N	K	E	Y	N

Figure 2



03. Figure 3 **[15]**



Given a weighted network with n nodes (a sample network is given in Figure 3), where a weight on an edge denotes the distance between the nodes connected by the edge. Each node calculates the distances between itself and all other nodes within the network and stores this information as a table. Each node sends its table to all neighboring nodes. When a node receives distance tables from its neighbors, it calculates the shortest routes to all other nodes and updates its own table to reflect any changes.

For example, the neighbors of the node e are nodes b and d. The shortest route from e to b has distance 3 because the distance from e to d is 2 and d to b is 1. If that changes then node b will update its table

Answer the following questions:

a) Assuming the above scenario, design an algorithm to compute the shortest paths from a given vertex to all other vertices in a weighted directed graph. Assume in general that weights of some of the edges may be negative. Determine the time complexity of your algorithm. (3 marks + 2marks)

b) Apply your algorithm on the graph given in Figure 3 to find the shortest distance from vertex 'a' to all other vertices. (6 marks)

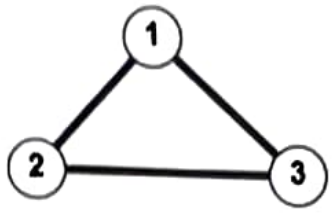
c) If the weight of the edge from b to a is -8 instead of -3, determine how the solution will change. (4 marks)

04. Let ACYL be the problem of finding the minimum number of edges that need to be removed from an undirected graph so that the resulting graph is acyclic (i.e. free of cycles). **[15]**

a) Design an algorithm for solving the problem ACYL, compute its time complexity and illustrate with an example. (4 +2 + 3 marks)

Example: Consider the undirected graph in Figure 4. It can be seen that removing any one of the edges will make the graph acyclic. Therefore the minimum number of edges that need to be removed from this undirected graph so that the resulting graph is acyclic is 1.

Figure 4



b) Demonstrate that verifying whether a directed graph is acyclic can be done quickly. (3 marks)

c) is the ACYL problem an NP-problem for directed graphs? Justify. (3 marks)

PART-B (4 X 10 Marks)

Answer All questions

05. A string w of parentheses (and) is balanced if it satisfies one of the following conditions: **[10]**

- w is the empty string.
- w = (x) for some balanced string x
- w = x y for some balanced strings x and y

For example, the string w = (((())()())((()))()) is balanced, because w = x y, where x = (((())()()) and y = (()())().

Design a greedy algorithm to compute the length of a longest balanced subsequence of a given string of parentheses. Compute its time complexity and illustrate with an example. (5 + 2 + 3 marks)

06. Design a divide and conquer algorithm for generating all the n! permutations of the n elements $a_1, a_2, \ldots, a_n$. Assume that the n factorial permutations may be generated in any order. For example, if the input is 1 2 3 then the output could be 1 2 3, 2 1 3, 3 1 2, 1 3 2, 2 3 1, and 3 2 1. Here we have generated all the permutations. The order in which these permutations were generated is immaterial. Compute the time complexity of your algorithm and illustrate with an example. (5 + 2 + 3 marks) **[10]**

07. a) Given 'n' points, design an algorithm with all required steps to determine whether any triplet (a set of three points) in the given set of n points form a triangle and if so return all such triplets. If no three points form a triangle, the algorithm should return NULL. (3 marks) **[10]**

b) Compute the time complexity of your algorithm. (2 marks)

Example: if the points are (1,1), (2,2), (3,3) and (4,4), no triangle can be formed with this set of points, and if the points are (1,0), (3,0), (4,3) and (2,0), then a triangle can be formed with the points (1,0), (3,0) and (4,3). In the second example, a triangle can also be formed with the points (1,0), (4,3) and (2,0).

c) Demonstrate that your algorithm works properly for the above two examples. (5 marks)

[10]

08. a) You are given a string S comprising of alphabets from the English language. You have to convert the string S to a palindrome (a string that reads the same backward as forward) by adding characters in front of it. You have to return *the shortest palindrome* you can find by performing this transformation..

Example

Input: S = "abcd"

Output: "dcbabcd"

Design an algorithm to solve this problem, compute the time complexity of the algorithm and illustrate with an example. (3 + 1 +1 marks)

b) Apply randomization to design an algorithm for the following problem : Given a string X of length n (the pattern) and a string Y of length m (the text), find the first occurrence of X as a consecutive block within Y. Compute the time complexity of the algorithm and illustrate with an example. (3 + 1 +1 marks)

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