SEMESTER: 3rd (2022 Batch)   SESSION: 2023 - 2024
BRANCH: M.C.A   CREDIT: 4
TIME: 2 Hours   FULL MARKS: 30

Subject: **CA3303 Design and Analysis of Algorithms**

INSTRUCTIONS:
1) Answer **ALL** the questions and should be written in order.
2) Marks of the question and part their of are indicated in the right hand margin.
3) Missing data, if any, may be assumed suitably.
4) Before attempting the question paper be sure that you have got the correct question paper.

Q1.(a) What is the smallest value of n such that an algorithm whose running time is $100n^2$ runs faster than a algorithm whose running time is 2^n on the same machine? [2]

(b) Write a recursive algorithm for generating fibonacci sequence and determine the time complexity of it. [5]

(c) Find a tight bound on the following function: [3]
$$f(x) = x^4 - 23x^3 + 12x^2 + 15x - 21$$

Q2.(a) What is the recurrence equation of Divide and Conquer Technique? Use this technique to perform the complexity analysis of Quick sort algorithm. [6]

(b) Solve the following recurrence using iteration method: [4]
$$T(n) = \begin{cases} 1, & \text{if } n = 1 \\ 3T(n/4) + n, & \text{if } n > 1 \end{cases}$$
OR

Discuss the different variations of Decrease and Conquer approach with suitable examples. [4]

Q3.(a) Apply Dijkstra's algorithm to find the shortest paths from vertex a to all the other vertices for the following weighted connected graph: [5]
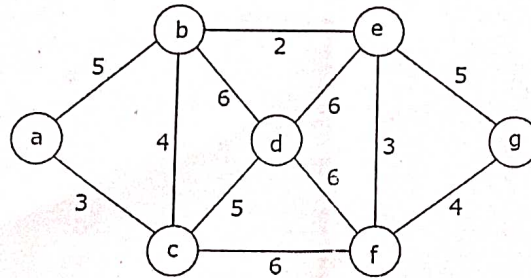
(b) Use heap sort algorithm to sort the following list of elements: [5]
32, 36, 29, 22, 20, 28, 14, 16, 15, 24
OR

Define 2-3 tree. Construct a 2-3 tree by successive insertion for the following list of alphabets in an empty tree: C O M P U T I N G [5]

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NATIONAL INSTITUTE OF TECHNOLOGY, JAMSHEDPUR
MID SEMESTER EXAMINATION (OCTOBER 2024)

SEMESTER: 3rd (2023 Batch)
BRANCH: M.C.A
TIME: 2 Hours

SESSION: 2024 - 2025
CREDIT: 4
FULL MARKS: 30

Subject: <u>CA3303 Design and Analysis of Algorithms</u>

INSTRUCTIONS:
1) Answer **ALL** the questions and should be written in order.
2) Marks of the question and part their of are indicated in the right hand margin.
3) Missing data, if any, may be assumed suitably.
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Q1.(a) For the given x and n, write an algorithm to compute $x^n/n!$. Determine the total running time and its complexity.
[3]

(b) State Master Theorem. Can the master theorem be applied to the following recurrence?
$$T(n) = 4T(n/4) + n / \log n$$
Why or why not?
[4]

(c) What is a tight bound? Find a tight bound on the following function:
$$f(n) = n^4 - 23n^3 + 12n^2 + 15n - 21$$
[3]

Q2.(a) Apply Strassen's algorithm to compute the following matrix multiplication using Divide and Conquer approach:
[6]

$$\begin{bmatrix} 1 & 0 & 2 & 1 \\ 4 & 1 & 1 & 0 \\ 0 & 1 & 3 & 0 \\ 5 & 0 & 2 & 1 \end{bmatrix} \times \begin{bmatrix} 0 & 1 & 0 & 1 \\ 2 & 1 & 0 & 4 \\ 2 & 0 & 1 & 1 \\ 1 & 3 & 5 & 0 \end{bmatrix}$$

Determine the time complexity of Strassen's algorithm.

(b) Explain brute-force algorithm for string matching problem with suitable example and perform the complexity analysis for it.
[4]

OR

Write an algorithm for fake coin detection problem and perform the complexity analysis of it.
[4]

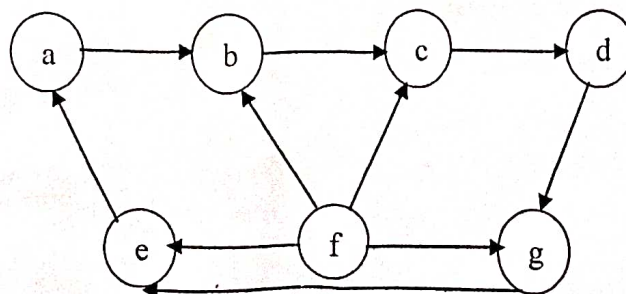Q3.(a) Solve the following system of equations by using LU decomposition method:
$$2x_1 - x_2 + x_3 = 1$$
$$4x_1 + x_2 - x_3 = 5$$
$$x_1 + x_2 + x_3 = 0$$
[5]

(b) What is topological sorting? Apply the DFS-based algorithm to solve the topological sorting problem for the following digraph:
[5]

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SEMESTER: 3rd (2022 Batch) SESSION: 2023 - 2024
BRANCH: M.C.A CREDIT: 4
TIME: 3 Hours FULL MARKS: 50

Subject: **CA3303 Design and Analysis of Algorithms**

INSTRUCTIONS:
1) All questions are compulsory.
2) All questions carry equal marks.
3) Marks of the question and part their of are indicated in the right hand margin.
4) Write all the parts of any question in one place only.
5) Do rough works in the last page only.

Q1.(a) Define best-case, average-case and worst-case analysis. [2]
  (b) Write an algorithm to determine whether all the elements in a given array are unique and also find the time complexity of it. [4]
  (c) Write a recursive algorithm for Tower of Hanoi problem and determine the time complexity of it. [4]

Q2.(a) What is transitive closure? Write Warshall's algorithm for computing the transitive closure. [3]
  (b) Apply Strassen's algorithm to compute the following matrix multiplication using Divide and Conquer approach: [7]

$$\begin{bmatrix} 1 & 0 & 2 & 1 \\ 4 & 1 & 1 & 0 \\ 0 & 1 & 3 & 0 \\ 5 & 0 & 2 & 1 \end{bmatrix} \times \begin{bmatrix} 0 & 1 & 0 & 1 \\ 2 & 1 & 0 & 4 \\ 2 & 0 & 1 & 1 \\ 1 & 3 & 5 & 0 \end{bmatrix}$$

Q3.(a) What do you mean by topological sorting? Explain the different methods to perform topological sorting with suitable examples. [5]
  (b) Given a chain of five matrices A, B, C, D and E with $p0 = 4$, $p1 = 5$, $p2 = 3$, $p3 = 2$, $p4 = 7$ and $p5 = 2$. Find $m[1, 5]$ and determine the order of parenthesization for optimal chain matrix multiplication using Dynamic Programming approach. [5]

Q4.(a) Solve the all pairs shortest path problem for the following digraph using Floyd's algorithm. [6]
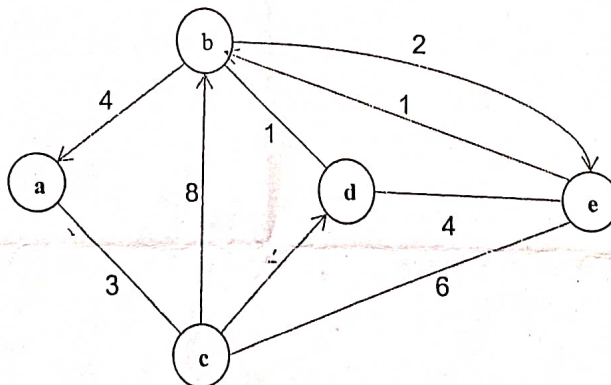
(b) Apply Greedy method to solve the following instance of Fractional Knapsack problem:

[4]

Item#	Weight	Value
I1	5	30
I2	10	20
I3	20	100
I4	30	90
I5	40	160

Knapsack Capacity, W = 60.

Q5.(a) Apply Branch and Bound algorithm to solve the Travelling Salesman Problem for the graph whose cost matrix is given below:

[5]

	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	∞

(b) Explain P, NP and NP-Complete class of problems. Give at least one example for each.

[5]

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SEMESTER: 3rd (2021 Batch)
BRANCH: M.C.A
TIME: 3 Hours

SESSION: 2022 - 2023
CREDIT: 4
FULL MARKS: 50

Subject: **CA3303 Design and Analysis of Algorithms**

INSTRUCTIONS:
1) Answer **ALL** the questions and should be written in order.
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Q1.(a) Consider the problem of counting, in a given text, the number of sub-strings that start with an A and end with a B. Design a Brute Force algorithm for this problem and determine its efficiency class. [5]

(b) Perform the compete complexity analysis of generating Fibonacci sequence using recursion. [5]

Q2.(a) How BFS differs from DFS? Design a DFS-based algorithm for checking if a graph is cyclic or not. [5]

OR

What is red-black tree? Construct a red-black tree by inserting the following keys in the order of their occurrence: 41, 38, 31, 12, 19, 48, 46 [5]

(b) Solve the following system of equations by using LU-decomposition method: [5]

$$3x_1 + x_2 + x_3 = 11$$
$$6x_1 + 4x_2 + x_3 = 29$$
$$x_1 + x_2 + x_3 = 7$$

Q3.(a) What is an activity selection problem? Apply Greedy approach to an activity selection problem along with the start and finish times of the jobs as follows:

Job	1	2	3	4	5	6	7	8	9	10
Start Time	1	2	3	4	7	7	9	9	11	12
Finish Time	3	5	4	7	10	9	11	13	12	14

Determine the optimal scheduling order of the jobs. [5]

(b) Construct A Huffman tree for the following data and obtain its Huffman code.

Character :   A   B   C   D   E

Probability: 0.4   0.1   0.2   0.15   0.15

(I) Encode the text ABACABAD using the generated code.
(II) Decode the text whose encoding is 100010111001010. [5]

Q4.(a) What is the difference between dynamic programming and divide and conquer technique? [2]

(b) What is transitive closure? Apply Warshall algorithm to find the transitive closure for the following directed graph: [4]
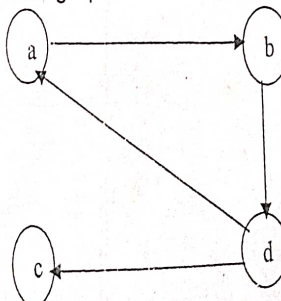
OR

What is LCS problem? Write an algorithm for LCS problem and determine its time complexity. [4]

(c) Apply Dynamic Programming algorithm to the following instance of the 0/1 Knapsack problem: [4]

Item	Weight	Value
1	2	12
2	1	10
3	3	20
4	2	15

Knapsack Capacity, W = 5.

OR

Given a chain of four matrices A, B, C and D with $p_0 = 5$, $p_1 = 4$, $p_2 = 6$, $p_3 = 2$ and $p_4 = 7$. Find m[1, 4] and determine the order of parenthesization for optimal chain matrix multiplication using Dynamic Programming approach. [4]

Q5.(a) Given a cost matrix for four persons A, B, C and D which are assigned the following jobs:

Persons	Jobs			
	1	2	3	4
A	-11	12	18	40
B	14	15	13	22
C	11	17	19	23
D	17	14	20	28

Obtain the minimum total cost of assignment using Branch and Bound technique where each person has exactly one task to perform. [5]

(b) What is Subset-Sum Problem? Apply Backtracking approach to solve the following instance of the subset-sum problem: [5]

S = {5, 10, 15, 20, 25} and d = 30

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Assignment
parallely sub.
kargy

subset sum
to update

NATIONAL INSTITUTE OF TECHNOLOGY, JAMSHEDPUR
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
END SEMESTER EXAMINATION (DECEMBER 2024)

SEMESTER: 3rd (2023 Batch)　　　　　　　　　SESSION: 2024 - 2025
BRANCH: M.C.A　　　　　　　　　　　　　　　CREDIT: 4
TIME: 3 Hours　　　　　　　　　　　　　　　　FULL MARKS: 50

Subject: CA3303 Design and Analysis of Algorithms

INSTRUCTIONS:
1) All questions are compulsory. ..
2) All questions carry equal marks.
3) Marks of the question and part their of are indicated in the right hand margin.
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Q1.(a) Discuss fundamentals of the analysis of algorithm efficiency. [4]

(b) Write a recursive algorithm to find the number of digits in the binary representation of a positive decimal number and also find the time complexity of it. [4]

(c) Let A and B be two algorithms with the following complexity functions:
$T_A(n) = n^2$ and $T_B(n) = 40n + 1200$. Which algorithm is better and why? [2]

Q2.(a) Explain the algorithm used for multiplication of two large numbers. What is the time complexity of this algorithm? Use this algorithm to compute the product of two 4-digit integers 1456 and 6533. [5]

(b) Construct an AVL tree for the following set of elements to be inserted in the order of their occurrence: [5]

H, I, J, B, A, E, C, F, D, G, K, L

Q3.(a) What do you mean by longest common subsequence? Apply dynamic programming to determine the longest common subsequence of given two strings $X = BACDB$ and $Y = BDCB$. [5]
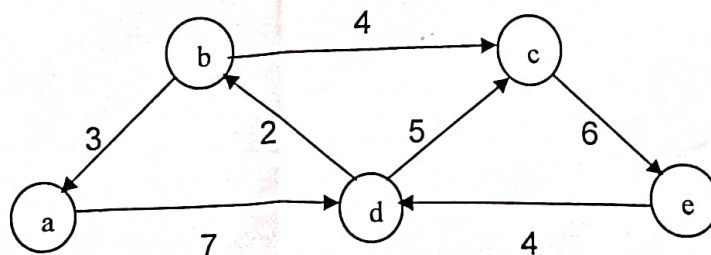
OR

What is memory function? Apply Dynamic Programming algorithm to solve the following instance of the 0/1 Knapsack problem: [5]

Item	Weight	Value
1	3	25
2	2	20
3	1	15
4	4	40
5	5	50

Knapsack Capacity, W = 6.

(b) Apply Dijkstra's algorithm to solve the following instances of the single-source shortest paths problem with vertex 'a' as the source vertex. [5]

P.T.O.

Q4.(a) Use Huffman's algorithm to construct an optimal binary prefix code for the letters in the following table: [5]

Characters	c	e	i	r	s	t	x
Frequency	0.11	0.22	0.16	0.12	0.15	0.10	0.14

(i) Encode the following text: exercise
(ii) Decode the following: 11100100111101

(b) How does Greedy algorithm works? Apply Greedy approach to a machine scheduling problem where deadlines are involved. The details of the jobs are follows:

Job	1	2	3	4	5	6	7
Deadline	3	4	4	2	3	1	2
Profit	35	30	25	20	15	12	5

Find the optimal scheduling order of the jobs considering deadline constraints and the associated maximum profit. [5]

Q5.(a) Apply Branch and Bound algorithm to solve the following assignment problem whose cost matrix is given below: [5]

Jobs

		1	2	3	4
	A	9	2	7	8
Persons	B	6	4	3	7
	C	5	8	1	8
	D	7	6	9	4

OR

What is subset sum problem? Apply backtracking to solve the following instance of the subset sum problem: A = {1, 2, 5, 6, 8} and d = 9. [5]

(b) What do you mean by complexity class? Discuss each class of problem with suitable examples. [5]

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