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RAMAIAH Institute of Technology
(Autonomous Institute, Affiliated to VTU)
(Approved by AICTE, New Delhi & Govt. of Karnataka)
Accredited by NBA & NAAC with 'A+' Grade

SEMESTER END EXAMINATIONS – AUGUST 2024

Program	:	**B.E :- Computer Science and Engineering**	**Semester**	:	**IV**
Course Name	:	**Design and Analysis of Algorithms**	**Max. Marks**	:	**100**
Course Code	:	**CS43 / CS42(OO)**	**Duration**	:	**3 Hrs**

Instructions to the Candidates:

- Answer one full question from each unit.

UNIT - I

1. a) Apply master theorem for the following time complexities. CO1 (06)

i) $T(n) = 3T\left(\frac{n}{2}\right) + n^4$

ii) $T(n) = 4T\left(\frac{n}{2}\right) + n^3$

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

b) Give examples for linear time and quadratic time complexity of an algorithm. CO1 (06)

c) Define the following terms with respect to stable matching algorithm with an example. CO1 (08)

i. Matching
ii. Perfect Matching
iii. Instability
iv. Stable Matching.

2. a) Determine the stable matching set S for the following set of men and women using Gale-Shapley algorithm and also describe the algorithm. CO1 (08)

Men's Preference List				
1	4	1	2	3
2	2	3	1	4
3	2	4	3	1
4	3	1	4	2

Women's Preference List				
1	4	1	3	2
2	1	3	2	4
3	1	2	3	4
4	4	1	3	2

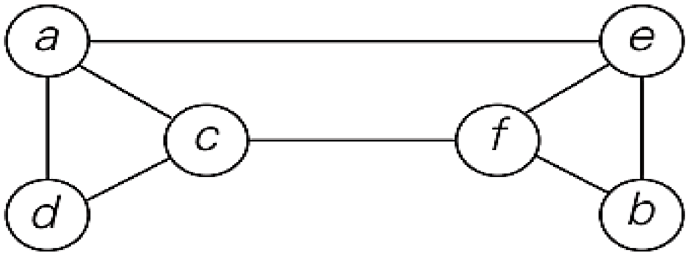
b) Design an algorithm to merge two sorted lists into one list and compute the time complexity for the same. CO1 (06)

c) Define three asymptotic notations and express the following using asymptotic notations in terms of Big-O, Omega and Theta. CO1 (06)
i) 100n +5 ii) n(n-1)/2.

UNIT - II

3. a) Write an algorithm to calculate the number of inversions using the divide and conquer approach. Identify the number of inversions for the input {9,10,3,4,8,2,15,3,2,1} using the same. CO2 (08)

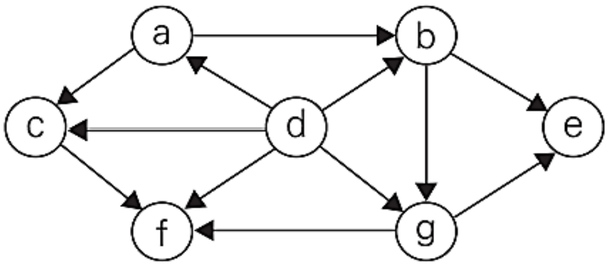
b) Write an algorithm for Breadth-First Search (BFS) that utilizes an adjacency list to represent the graph and Compute the BFS traversal for the following graph with **source vertex as a**. CO2 (06)



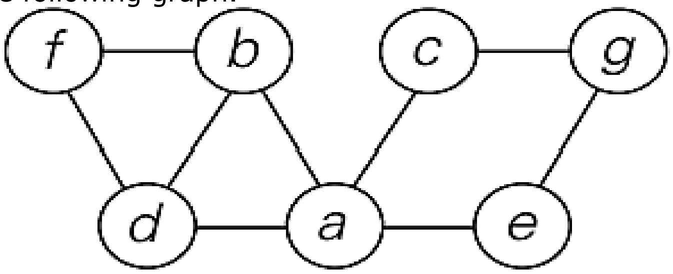
c) Prove that the time complexity of merge sort is O(n log n) using "unrolling method" and deduce the recurrence relation for the same. CO2 (06)

4. a) Write an algorithm for quick sort. Draw the tree of recursive calls to quicksort with input values **l** and **r** of subarray bounds and split position **s** of a partition obtained for the input 5 3 1 9 8 2 4 7. CO2 (08)

b) Apply the DFS-based algorithm to solve the topological sorting problem to the below digraph: CO2 (06)



c) Consider the following graph. CO2 (06)



i. Write down the adjacency matrix and adjacency lists specifying the above graph.

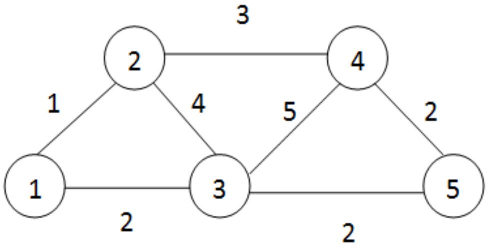
ii. Starting at vertex **a** and resolving ties by the vertex alphabetical order, traverse the graph by depth-first search and construct the corresponding depth-first search tree. Give the order in which the vertices were reached for the first time (pushed onto the traversal stack) and the order in which the vertices became dead ends (popped off the stack).

UNIT - III

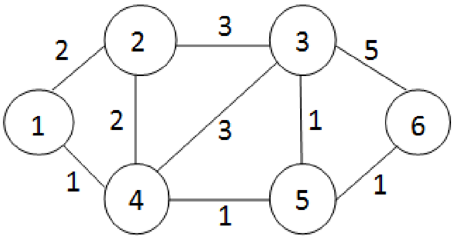
5. a) Apply the Minimizing the Maximum Lateness approach for the following set of intervals. CO3 (08)

	1	**2**	**3**	**4**	**5**	**6**
tj	5	3	2	4	5	1
dj	10	6	3	18	14	16

	b)	Compute minimum spanning tree for the following graph using Prim's algorithm with source node as 1.	CO3	(07)



	c)	Differentiate between fixed-length encoding, variable length encoding and optimal prefix encoding for a given set of alphabets. Which encoding is more suitable and why?	CO3	(05)
6.	a)	Evaluate the shortest path from source node 1 to all other nodes for the following graph using Dijkstra's algorithm.	CO3	(08)



	b)	Design an Optimal caching algorithm to prove SFF incurs no more misses than any other schedule S∗ and hence is optimal. Illustrate the optimizing cache misses with the following values. a, b, c, d, a, d, e, a, d, b, c , k=3.	CO3	(08)
	c)	Prove that "Greedy algorithm for interval scheduling returns an optimal set A".	CO3	(04)

UNIT- IV

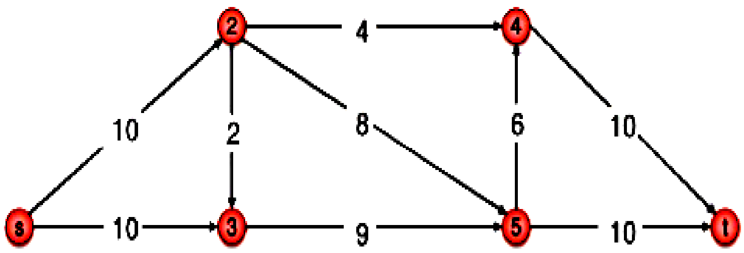
7.	a)	Solve the Knapsack instance with the given input data by identifying the items to be placed in the knapsack with capacity W=5 and write an iterative algorithm for the same. Comment on its time efficiency.	CO4	(08)

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

	b)	Write an algorithm that calculates shortest paths in a graph containing negative edges. Discuss its computational time complexity.	CO4	(06)
	c)	Exemplify the guidelines and algorithmic strategy for addressing the survey-design problem concerning a specific set of customers and products.	CO4	(06)
8.	a)	Design a recursive procedure to find the optimal weight of the intervals for a given set of intervals with their weights. Comment on its running time. List the intervals that needs to be selected so that maximum weight of the intervals is achieved for the following set of intervals?	CO4	(08)

Interval	**1**	**2**	**3**	**4**	**5**
Start time	1	2	4	6	5
Finish time	3	5	6	7	8
Weight	5	6	5	4	11

b) Demonstrate the Ford-Fulkerson algorithm to find the maximum flow in the given graph. CO4 (06)



c) Discuss the airline scheduling problem with an example. CO4 (06)

UNIT - V

9. a) Explain Vertex cover and Independent set problem with an example. Construct a proof to determine that both of the problems are NP-Complete. CO5 (08)

b) Prove that Hamiltonian Path is NP-Complete. CO5 (07)

c) Define P, NP, NP-Complete & NP-Hard problems. Give examples. CO5 (05)

10. a) Describe polynomial time reduction. CO5 (05)

b) Describe polynomial time reduction? Construct a proof for the following - "Suppose X is an NP-complete problem. Then X is solvable in polynomial time if and only if P = NP." CO5 (08)

c) Formulate travelling salesman problem and prove its NP-completeness. CO5 (07)

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