



Academic year 2022-2023 (Odd Semester)

**Department of Information Science and Engineering**

Date	March 2023	Maximum Marks	60
Course Code	22MIT12TL	Duration	110 Mins
Sem	I	CIE - I	

**Advanced Algorithms and Applications**

**Part – A**

Sl. No.	Questions	M	BT	CO
1	What is the advantage of array data structure over linked list?	1	L1	CO1
2	Compare the quick sort and Merge sort algorithm with time complexity analysis?	1	L2	CO2
3	What is the time complexity of the binary search algorithm?	1	L1	CO1
4	What is the time complexity to insert an element to the front and rear end of a LinkedList?	1	L2	CO2
5	What is the maximum number of children a node can have in an n-ary tree?	1	L1	CO1
6	Worst case time complexity to access an element in a BST can be?	1	L2	CO1
7	What is the time complexity to search an element in a BST which is completely balanced?	1	L2	CO1
8	With what data structure can a priority queue be implemented? and mention the most efficient data structure to implement the same?	1	L2	CO1
9	Write three applications of priority queue?	1	L2	CO2
10	What is the best time complexity to find the minimum element in a binary search tree?	1	L1	CO1

**PART B**

QNo	Questions	M	BT	CO
1.	Write the properties of 2-3-4 trees and mention the general structure of 2-3-4 tree? Insert the elements 10,20,30,40,50,60,70,80,90,100 into 2-3-4 tree?	10	L3	CO1
2.	What is priority queue? Compare the implementation of priority queue using array and heap?	10	L2	CO2
3. a	Solve the following recurrence relation by Master Theorem Method: a. $T(n) = 3T(n/2) + n^2$ b. $T(n) = 4T(n/2) + n^2$	03	L2	CO2
3. b	Apply Dijkstra's algorithm for the following graph to find Single Source Shortest Path from the source 0	07	L3	CO2

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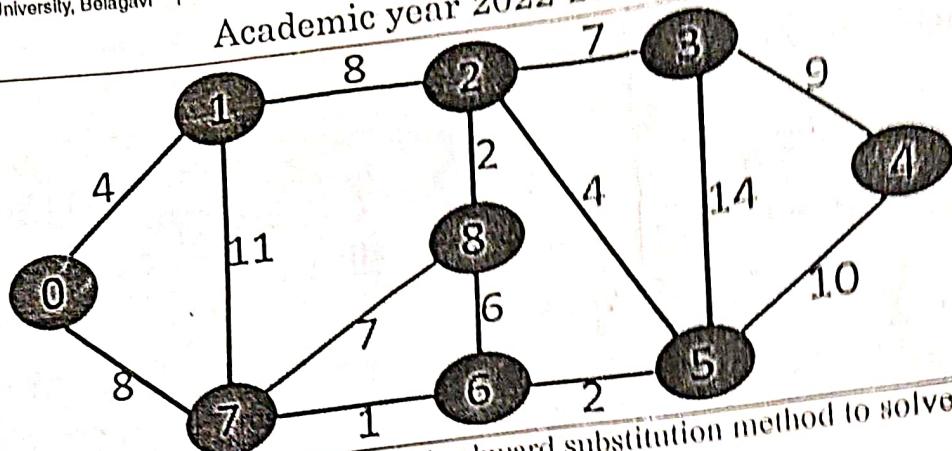


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RV College of Engineering™

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New Delhi

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4. Apply recursion tree method and backward substitution method to solve the following Recurrence relation:  
 $T(n) = 2T(n/2) + n$

Questions related Introduction to Algorithms

- a. Write an algorithm to find factorial of a number and set up a recurrence relation for the same. [3 Marks]

- b. Find the time complexity to find  $A \cap B$  problem

Where A and B are integer array [2 Marks]

Find the time complexity to find the biggest element in an array, to access nth element in an array, Bubble sort, Selection sort, Insertion Sort. [5 Marks]

10 L3 CO1

- 5.

10 L2 CO1

Course Outcomes

CO1	Understand the fundamentals of different Data Structures and their applications
CO2	Evaluate advanced data structures and algorithms with an emphasis on persistence.
CO3	Analyze the impact of Data Structures on algorithms with efficiency as a parameter
CO4	Design and implement efficient solutions to real world problems or Prove NP-Complete otherwise

BT-Blooms Taxonomy, CO-Course Outcomes, M-Marks

Marks Distribution	Particulars		CO1	CO2	CO3	CO4	L1	L2	L3	L4	L5	L6
	Test	Max Marks	37	23	-	-	4	26	27	-	-	-



Academic year 2022-2023 (Odd Semester)

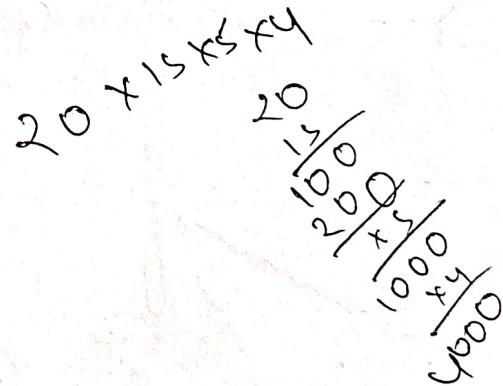
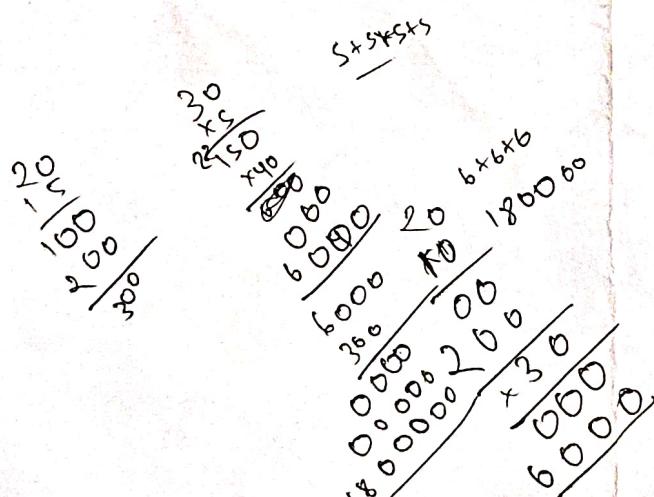
**Department of Information Science and Engineering**

Date	16 <sup>th</sup> May 2023	Maximum Marks	10
Course Code	22MIT12TL	Duration	30 Min
Sem	1	CIE - II	

Advanced Algorithms and Applications (Quiz-II)

**PART A**

QNo	Questions	M	BT	CO
1.	Consider the two matrices P and Q which are $10 \times 20$ and $20 \times 30$ matrices respectively. What is the number of multiplications required to multiply the two matrices?  2 3 4	01	L2	CO4
2.	Consider the matrices P, Q, R and S which are $20 \times 15$ , $15 \times 30$ , $30 \times 5$ and $5 \times 40$ matrices respectively. What is the minimum number of multiplications required to multiply the four matrices? Show the calculation.	02	L3	CO3
3.	What is the time complexity of the following dynamic programming implementation of the matrix chain problem?	01	L3	CO4
4	Find the Longest Common Subsequence of the following strings:  String A = "acbaed"; String B = "abcadf";	01	L3	CO3
5	Write one application of LCS problem	01	L2	CO2
6.	What is the objective of activity selection problem?	02	L2	CO3
7.	Given below are some famous algorithms, write the Design Paradigm a. Dijikstra's Algorithm, b. Kruskal's Minimum Spanning Tree c. Merge Sort	02	L2	CO4





Academic year 2022-2023 (Odd Semester)

Department of Information Science and Engineering

Date	26 <sup>th</sup> April 2023	Maximum Marks	50
Course Code	22MIT12TL	Duration	90 Min
Sem	I	CIE - II	

Advanced Algorithms and Applications

PART B

QNo	Questions	M	BT	CO
1.	<p>Apply Finite automata string matching algorithm to find the following pattern in the main text.</p> <p>Pattern : ACACAGA</p> <p>Main Text: <u>ACACACAA</u>ACA<u>ACACAGA</u></p> <p>Show the steps to find the pattern in the main text.</p> <p>Write the time efficiency of the above algorithm.</p>	10	L3	CO3
2.	<p>Explain spurious hits in Rabin-Karp string matching algorithm with an example. Working modulo <math>q = 13</math>, how many spurious hits does the Rabin-Karp matcher encounter in the text <math>T = 2359023141526739921</math> when looking for the pattern <math>P = 31415</math> ?</p>	10	L2	CO2
3.	<p>Find the Longest Common Subsequence for text X and Y</p> <p><math>X = XMJYAUZ</math>, <math>Y = MZJAWXU</math> using Dynamic programming and Compare the same with Brute force approach</p> <p>Show the tabular form and write the LCS for the above</p>	10	L3	CO3
4.	<p>Each Directed Edge is labeled with capacity. Use the Ford-Fulkerson algorithm to find the maximum flow.</p> <pre> graph LR     S((S)) -- 16 --&gt; v1((v1))     S((S)) -- 13 --&gt; v2((v2))     v1((v1)) -- 12 --&gt; v3((v3))     v1((v1)) -- 10 --&gt; v2((v2))     v2((v2)) -- 4 --&gt; v3((v3))     v2((v2)) -- 14 --&gt; v4((v4))     v3((v3)) -- 20 --&gt; t((t))     v3((v3)) -- 7 --&gt; v4((v4))     v4((v4)) -- 4 --&gt; t((t))     v4((v4)) -- 9 --&gt; v3((v3))   </pre>	10	L3	CO2



Academic year 2022-2023 (Odd Semester)

	Check whether a given graph is Bipartite or not and also write the applications of Bipartite graph.	05	L2	CO2
5.a				

Course Outcomes

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CO3	Analyze the impact of Data Structures on algorithms with efficiency as a parameter
CO4	Design and implement efficient solutions to real world problems or Prove NP-Complete otherwise

BT-Blooms Taxonomy, CO-Course Outcomes, M-Marks

Marks Distribution	Particulars		CO1	CO2	CO3	CO4	L1	L2	L3	L4	L5	L6
	Test	Max Marks	-	25	25	-	-	30	20	-	-	-



Academic year 2022-2023 (Odd Semester)

Department of Information Science and Engineering

Date	26 <sup>th</sup> May 2023	Maximum Marks	10 + 50
Course Code	22MIT12TL	Duration	110 Min
Sem	I	CIE - III	

Advanced Algorithm; and Applications

Quiz Questions				
QNo	Questions	M	BT	CO
1.	Write atleast 2 triplets for the following equation: $A^2 + B^2 = C^2$	01	L2	CO4
2.	Find the least positive value of $x$ such that $71 \equiv x \pmod{8}$	02	L3	CO3
3.	List two applications of Clique Problem?	02	L1	CO3
4.	The number of trees in a binomial heap with $n$ nodes is	01	L2	CO2
5.	In a binomial heap the root value is greater than left child and less than right child. State whether the above statement is TRUE or FALSE? Find atleast 2 clique in the following graph?	01	L1	CO3
6.		01	L2	CO3
7.	Find the smallest multiple of 10 which has remainder 2 when divided by 3, and remainder 3 when divided by 7.	02	L2	CO3

Part-B Questions

QNo	Questions	M	BT	CO
1.	Find all solutions $x$ , if they exist, to the system of equivalences: $2x \equiv 6 \pmod{14}$ $3x \equiv 9 \pmod{15}$ $5x \equiv 20 \pmod{60}$	10	L3	CO4
2.	Write the procedure to find the vertex cover for the following graph? And write the applications of Vertex cover problem	10	L2	CO3



W10

Academic year 2022-2023 (Odd Semester)

3.	Given the sequence {4, 10, 3, 12, 20, and 7}, the matrices have size $4 \times 10$ , $10 \times 3$ , $3 \times 12$ , $12 \times 20$ , $20 \times 7$ . Compute $M_{[i,j]}$ , $0 \leq i, j \leq 5$ using Dynamic Programming Technique.	10	L3	CO4
4.	Define Binomial Heap? Merge the following two Binomial heaps and write the procedure for the same?			
5.a		10	L2	CO2
5.b				
5.a	Write a short note on Task Scheduling algorithm?	5	L1	CO3
5.b	Bringout the similarity and differences between Dynamic Programming and Divide and Conquer design technique?	5	L1	CO2

Course Outcomes

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Marks Distribution	BT-Blooms Taxonomy, CO-Course Outcomes, M-Marks										
	Particulars		CO1	CO2	CO3	CO4	L1	L2	L3	L4	L5
Test	Max Marks	-	16	23	21	13	25	32	-	-	-



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2  
1030  
50

Academic year 2023-2024 (Odd Sem)

## DEPARTMENT OF INFORMATION SCIENCE AND ENGINEERING

Date	13 <sup>th</sup> May 2024	Maximum Marks	50+10
Course Code	22MIT12TL	Duration	90 + 20 Min
Sem	I	CIE-3	
UG/PG	PG	Faculty: Dr. B M Sagar	

**Advanced Algorithms and Applications**

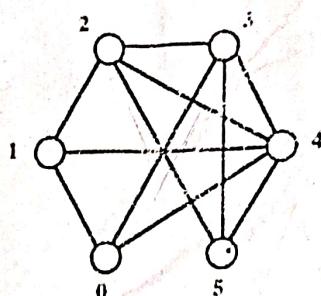
## Part-B

Q. No.	Questions	M	BT	CO																											
1.	How can the matrix chain multiplication problem be effectively solved using the Dynamic Programming method? Consider a scenario where matrices A1, A2, A3, and A4 have dimensions $3 \times 1$ , $1 \times 4$ , $4 \times 5$ , and $5 \times 4$ , respectively. Utilize the Dynamic Programming approach to determine the optimal parenthesizing sequence for multiplying these matrices together while minimizing the total number of scalar multiplications?	10	3	4																											
2.	How can the Greedy algorithm be employed to efficiently solve the activity selection problem, which involves maximizing the number of non-overlapping activities from a given set with start and finish times? Provide the algorithm for the same	10	2	3																											
	<table border="1"> <thead> <tr> <th>Activity</th> <th>A1</th> <th>A2</th> <th>A3</th> <th>A4</th> <th>A5</th> <th>A6</th> <th>A7</th> <th>A8</th> </tr> </thead> <tbody> <tr> <td>Start</td> <td>1</td> <td>6</td> <td>1</td> <td>4</td> <td>2</td> <td>5</td> <td>3</td> <td>4</td> </tr> <tr> <td>End</td> <td>3</td> <td>4</td> <td>2</td> <td>6</td> <td>9</td> <td>8</td> <td>5</td> <td>5</td> </tr> </tbody> </table>	Activity	A1	A2	A3	A4	A5	A6	A7	A8	Start	1	6	1	4	2	5	3	4	End	3	4	2	6	9	8	5	5			
Activity	A1	A2	A3	A4	A5	A6	A7	A8																							
Start	1	6	1	4	2	5	3	4																							
End	3	4	2	6	9	8	5	5																							
3.	What is the minimum size of a Vertex Cover for the given graph, where each edge is incident to at least one vertex in the cover? Provide the vertices that form the minimum Vertex Cover?	10	3	4																											
4.	Create a 3-SAT problem instance involving Boolean variables and clauses. Then, demonstrate how this 3-SAT problem can be transformed into an instance of the 0/1 Knapsack problem. Provide an example illustrating the reduction process and the resulting 0/1 Knapsack instance.	10	3	4																											



Academic year 2023-2024 (Odd Sem)

5.	Given the social network depicted by the provided graph, determine the maximum size clique present within the network. Additionally, discuss the significance of identifying cliques in social networks, particularly in understanding community structures and facilitating information dissemination among network members.	10	3	3
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### Part-A

Q. No.	Questions	M	BT	CO
1	Elucidate the relationship between a complete graph and a clique within a graph.	2	2	3
2	Provide a scenario illustrating how identifying a vertex cover in a network graph can aid in safeguarding critical network nodes	2	2	4
3	What is the fundamental difference between the complexity classes P and NP in computational theory?	2	1	3
4	What are the differences in time complexity between the brute force approach and dynamic programming technique for solving the Matrix Chain Multiplication problem?	2	2	3
5	What is the significance of representing Boolean formulas in Conjunctive Normal Form (CNF) when solving the 3-SAT problem?	2	1	3

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BT-Blooms Taxonomy, CO-Course Outcomes

Marks Distribution	Particulars		CO1	CO2	CO3	CO4	CO5	L1	L2	L3	L4	L5	L6
	Test	Max Marks	-	-	28	32	-	04	16	40	-	-	-

### Course Outcomes:

CO1:	Understand the fundamentals of different Data Structures and their applications
CO2:	Evaluate advanced data structures and algorithms with an emphasis on persistence
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## RV COLLEGE OF ENGINEERING®

(An Autonomous Institution affiliated to VTU, Belagavi)

I Semester Master of Technology (Information Technology)

## ADVANCED ALGORITHMS AND APPLICATIONS

Time: 03 Hours

Maximum Marks: 100

Instructions to candidates:

- Each unit consists of two questions of 16 marks each.
- Answer FIVE full questions selecting one from each unit.
- Question 11, lab component is compulsory.

63

## UNIT-1

1	a	Insert the following elements into an empty Red-Black tree. 1,2,3,4,5,6,7,8,9	12 04
	b	Mention 4 properties of Red-Black tree. Explain the Big-Oh notation.	
2	a	Apply recursion tree method and backward substitution method to solve the following recurrence relation:	08
	b	Insert the following elements into Binary Search Tree and comment on the best and worst case of the same. 10, 20, 30, 40, 50, 60, 70, 80, 90, 100.	
	c	What are the four main properties of heap?	

## UNIT-2

3	a	Consider the undirected weighted graph shown in Fig 3a. Step through Dijkstra's algorithm to calculate the single-source shortest paths from A to every other vertex. Show your steps in the tabular form. Cross out old values and write in new ones, from left to right within each cell, as the algorithm proceeds. Also. List the vertices in the order which you marked them known. Finally, indicate the lowest-cost path from node A to node F.	10 06
	b	Fig 3a List the important applications of bipartite graph.	
4	a	Write an algorithm to extract minimum element from Fibonacci heap.	06
	b	OR	

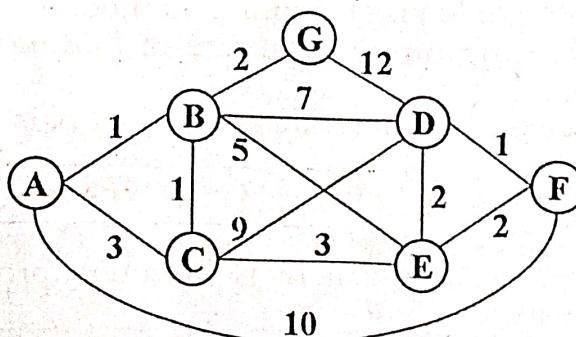


Fig 3a

81

10  
06

25

b

Apply Johnson's algorithm to find all pair shortest path for the following graph shown in Fig 4b.

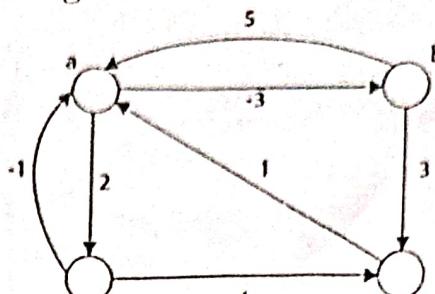


Fig 4b

10

**UNIT-3**

- 5 a Apply Finite Automata algorithm to find the following substring in the main string.  
Sub-string: *BADA*  
Main string: *BANGALORE\_BADD\_BADA*

08

- b Use the Chinese Remainder theorem to find an  $x$  such that  
 $x \equiv 2 \pmod{5}$   
 $x \equiv 3 \pmod{7}$   
 $x \equiv 10 \pmod{11}$

08

**OR**

- 6 a In a RSA cryptosystem, a participant A uses two prime numbers  $p = 3$  and  $q = 11$  to generate the public and private keys. If the public key of A is 28, then how do you calculate the private key of A?

12

- b Write the algorithm steps and analyze the time complexity of the algorithm.

04

- Compare the time complexity of Rabin Karp algorithm with Brute Force string matching algorithm.

**UNIT-4**

- 7 a  $X = BDCB$  and  $Y = BACDB$  to find the longest common subsequence using dynamic programming method.

10

- Compare the time complexity of finding *LCS* by *DP* and Brute force method.

06

- b How is convex hull related to closest pair problem?

**OR**

- 8 a Solve the following activity selection problem by Greedy and Brute force method.

07

Start time	Finish time	Activity name
5	9	B1
1	2	B2
3	4	B3
0	6	B4
5	7	B5
8	9	B6

b	How can the matrix chain multiplication problem be effectively solved using the dynamic programming method? Consider a scenario where matrices A <sub>1</sub> , A <sub>2</sub> , A <sub>3</sub> and A <sub>4</sub> have dimensions 5 × 4, 4 × 6, 6 × 2 and 2 × 7 respectively. Utilize the dynamic programming approach to determine the optimal parenthesizing sequence for multiplying these matrices together while minimizing the total number of scalar multiplications.	09 1-
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### UNIT-5

9 a	Provide an example of a problem that belongs to the class P and explain why it is considered to be in P. Similarly, give an example of a problem that belongs to the class NP and explain why it falls into the NP class.	08
b	Explain the Clique problem and discuss the applications of the same.	08
<b>OR</b>		
10 a	Discuss the applications of Vertex Cover problem.	06
b	Explain the 3-SAT problem instance involving Boolean variables and clauses. Then, demonstrate how this 3-SAT problem can be reduced into known problem.	10 3 5
Lab component		
11 a	Write a program to implement the Dijkstra algorithm using binary heap. Determine its complexity.	10 7
b	Write a program to implement to solve string matching problem using naïve approach.	10