

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE- SEMESTER-V EXAMINATION – WINTER 2025****Subject Code:3150703****Date:02-12-2025****Subject Name: Analysis and Design of Algorithms****Time:10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

	<b>MARKS</b>
<b>Q.1 (a)</b> State the time complexity of following problems in descending order: Matrix multiplication, inserting element in binary search tree, inert node at beaning in linked list, linear search, selection sort, merge sort.	<b>03</b>
<b>(b)</b> Summarize and explain the properties of algorithm	<b>04</b>
<b>(c)</b> Apply bubble sort on the given data sequence: 77, 22, 55, 11, 33, 66, 44	<b>07</b>
 <b>Q.2 (a)</b> Write the algorithm for binary search	<b>03</b>
<b>(b)</b> Identify the constant c, $n_0$ and upper bound for given recurrences: $T(n) = 4n^2 + 3n - 4$ $T(n) = 6n^3 - 8n^2 + 9n + 2$	<b>04</b>
<b>(c)</b> Illustrate and solve recurrence for best and worst case of quick sort	<b>07</b>
<b>OR</b>	
<b>(c)</b> Construct solution using Merge sort on the given data sequence: 88, 77, 22, 55, 11, 33, 66, 99, 44. Also state its recurrence and solve it.	<b>07</b>
 <b>Q.3 (a)</b> Define principle of Optimality. Discuss with example.	<b>03</b>
<b>(b)</b> Differentiate: Dynamic programming vs divide and conquer	<b>04</b>
<b>(c)</b> Solve following instance of knapsack problem using dynamic programming: $W = [1, 2, 5, 6, 10]$ , $V = [1, 6, 18, 22, 30]$ and Knapsack capacity $M = 12$	<b>07</b>
<b>OR</b>	
 <b>Q.3 (a)</b> Define the characteristics of greedy algorithms	<b>03</b>
<b>(b)</b> Explain activity selection problem.	<b>04</b>
<b>(c)</b> Infer the Longest Common Subsequence for following strings: $X = 10010100$ $Y = 10011$	<b>07</b>
 <b>Q.4 (a)</b> State and explain methods to represent the graph	<b>03</b>
<b>(b)</b> Differentiate: BFS vs DFS	<b>04</b>

- (c) Outline algorithm for Prim's method and find MST for given graph using Prim's method 07

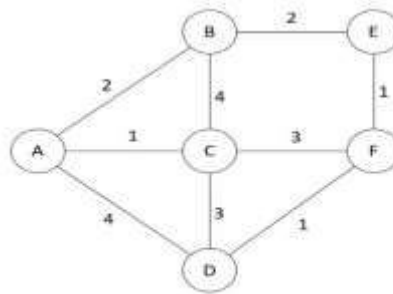


Figure 1

Figure 1

OR

- Q.4** (a) Define Articulation point, Acyclic Directed Graph, Back Edge 03  
 (b) Find prefix code for given data. A: 45, B: 30, C: 15, D: 12, E: 8 04  
 (c) Outline algorithm for Kruskal's method and find MST for the graph given in Figure 1, using Kruskal's method 07
- Q.5** (a) Show naïve string matching algorithm with example. 03  
 (b) Find topological sequence of vertices for the graph given in Figure 1. Consider A is starting vertex. 04

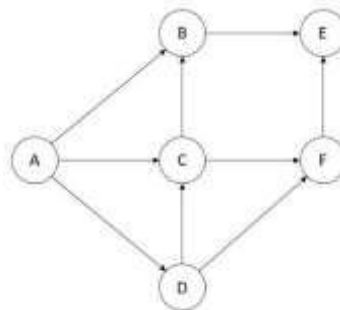


Figure for Question 5(B)  
for Topological sort

- (c) Explain backtracking method. What is 4 queen problem? Show its all possible solutions. 07

OR

- Q.5** (a) Explain polynomial time reduction 03  
 (b) Compare and contrast: Backtracking vs. Branch and Bound 04  
 (c) What do you mean by spurious hits? For modulo  $q=13$ , how many spurious hits does the Rabin-Karp encounters for the text  $T = 4359023141526739921$  when looking for the pattern  $P = 31415$ ? 07

\*\*\*\*\*

**GUJARAT TECHNOLOGICAL UNIVERSITY**

**BE- SEMESTER-V (NEW) EXAMINATION – WINTER 2024**

**Subject Code:3150703**

**Date:17-12-2024**

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

**Time:10:30 AM TO 01:00 PM**

**Total Marks:70**

**Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

- |            |  | <b>Marks</b> |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|------------|--|--------------|--------|-------|----|---|---|----|---|---|----|---|---|----|---|---|--|
| <b>Q.1</b> | (a) Define the following terms:<br>i) Function in mathematics ii) Linear inequalities  | <b>03</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | (b) Explain the need of amortized notation. Explain with suitable example.   | <b>04</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | (c) Write an algorithm for insertion sort. Calculate the best, average and worst case complexity of it.  | <b>07</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
| <b>Q.2</b> | (a) Sort the following elements using counting sort.<br>2, 5, 3, 0, 2, 3, 0, 3   | <b>03</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | (b) Sort the following elements using bucket sort.<br>10, 21, 29, 41, 52   | <b>04</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | (c) Write the Master theorem. Solve following recurrence using it.<br>(i) $T(n) = 3T(n/2) + n^2$<br>(ii) $T(n) = 2T(n/2) + n \log n$   | <b>07</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | <b>OR</b>  |              |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | (c) Write binary search algorithm using recursion. Derive its recurrence relation. Calculate its complexity using master theorem.  | <b>07</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
| <b>Q.3</b> | (a) Explain the steps of greedy strategy for solving a problem.  | <b>03</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | (b) Write an algorithm for Max-Min problem using divide and conquer approach. Calculate its complexity.  | <b>04</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | (c) The matrices A(5X10), B(10X15), C(15X20), and D(20X25) are given. Solve the matrix chain multiplication problem using dynamic programming.   | <b>07</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | <b>OR</b>  |              |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
| <b>Q.3</b> | (a) Enlist the general characteristics of greedy algorithms.   | <b>03</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | (b) Write an algorithm for matrix multiplication using divide and conquer approach. Calculate its complexity.  | <b>04</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | (c) For the given set of items and knapsack capacity = 5 kg, find the optimal solution for the 0/1 knapsack problem using dynamic programming.   | <b>07</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | <table border="1" style="margin: auto; border-collapse: collapse;"> <thead> <tr> <th>Item</th> <th>Weight</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>I1</td> <td>2</td> <td>3</td> </tr> <tr> <td>I2</td> <td>3</td> <td>4</td> </tr> <tr> <td>I3</td> <td>4</td> <td>5</td> </tr> <tr> <td>I4</td> <td>5</td> <td>6</td> </tr> </tbody> </table> | Item         | Weight | Value | I1 | 2 | 3 | I2 | 3 | 4 | I3 | 4 | 5 | I4 | 5 | 6 |  |
| Item       | Weight   | Value        |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
| I1         | 2  | 3            |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
| I2         | 3  | 4            |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
| I3         | 4  | 5            |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
| I4         | 5  | 6            |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
| <b>Q.4</b> | (a) Explain DFS with suitable example.   | <b>03</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |
|            | (b) Enlist the advantages and disadvantages of dynamic programming.  | <b>04</b>    |        |       |    |   |   |    |   |   |    |   |   |    |   |   |  |

- (c) Define minimum spanning tree. Explain Prim's algorithm with suitable example. **07**
- OR**
- Q.4** (a) Explain BFS with suitable example. **03**  
(b) Define principle of optimality. Explain its use in Dynamic Programming Method. **04**  
(c) "A greedy strategy will work for fractional Knapsack problem but not for 0/1", is this true or false? Explain with suitable example. **07**
- Q.5** (a) Define string matching problem. Define valid shift and invalid shift. **03**  
(b) Define the followings: **04**  
i) Articulation point ii) Acyclic Directed Graph iii) Back Edge iv) Tree  
(c) Explain P, NP, NP complete and NP-Hard problems. Give examples of each. **07**
- OR**
- Q.5** (a) Explain Backtracking Method. Give solutions for 4-queens problem using backtracking method. **03**  
(b) Explain in-order, pre-order and post-order traversals of the graph. **04**  
(c) Write short note on the followings: **07**  
i) Approximation algorithms  
ii) Randomized algorithms

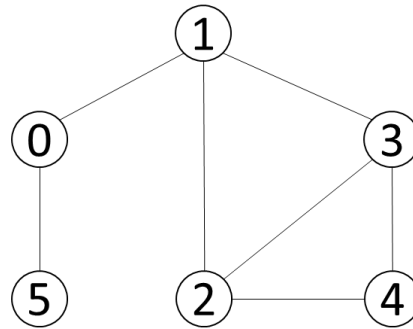
\*\*\*\*\*

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-V (NEW) EXAMINATION – WINTER 2023****Subject Code:3150703****Date:20-12-2023****Subject Name: Analysis and Design of Algorithms****Time:10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

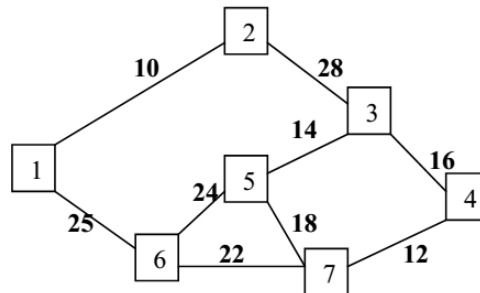
		MARKS																							
<b>Q.1</b>	(a) What is an algorithm? Explain various properties of an algorithm.	<b>03</b>																							
	(b) Solve the following using Master's theorem: <ol style="list-style-type: none"> <li>a. <math>T(n) = 2T(n/4) + 1</math></li> <li>b. <math>T(n) = 3T(n/4) + n \lg n</math></li> </ol>	<b>04</b>																							
	(c) Write selection sort algorithm and compute running time of algorithm.	<b>07</b>																							
<b>Q.2</b>	(a) Explain general characteristics of greedy algorithms.	<b>03</b>																							
	(b) What is asymptotic notation? Find out big-oh notation of the $f(n) = 3n^2 + 5n + 10$	<b>04</b>																							
	(c) Illustrate the working of the quick sort on input instance: 25, 29, 30, 35, 42, 47, 50, 52, 60. Comment on the nature of input i.e. best case, average case or worst case. Also discuss worst and best case of quick sort algorithm.	<b>07</b>																							
<b>OR</b>																									
	(c) Give the properties of Heap Tree. Sort the following data using Heap Sort Method: 20, 50, 30, 75, 90, 60, 80, 25, 10, 40.	<b>07</b>																							
<b>Q.3</b>	(a) Sort the List "G,U,J,A,R,A,T,S,A,R,K,A,R" in alphabetical order using merge sort.	<b>03</b>																							
	(b) Following are the details of various jobs to be scheduled on multiple processors such that no two processes execute at the same on the same processor. Show schedule of these jobs on minimum number of processors using greedy approach. <table style="margin-left: 40px; margin-top: 10px; border-collapse: collapse;"> <thead> <tr> <th style="padding: 2px;">Jobs</th> <th style="padding: 2px;">J<sub>1</sub></th> <th style="padding: 2px;">J<sub>2</sub></th> <th style="padding: 2px;">J<sub>3</sub></th> <th style="padding: 2px;">J<sub>4</sub></th> <th style="padding: 2px;">J<sub>5</sub></th> <th style="padding: 2px;">J<sub>6</sub></th> <th style="padding: 2px;">J<sub>7</sub></th> </tr> </thead> <tbody> <tr> <td style="padding: 2px;">Start time</td> <td style="padding: 2px;">0</td> <td style="padding: 2px;">3</td> <td style="padding: 2px;">4</td> <td style="padding: 2px;">9</td> <td style="padding: 2px;">7</td> <td style="padding: 2px;">1</td> <td style="padding: 2px;">6</td> </tr> <tr> <td style="padding: 2px;">Finish time</td> <td style="padding: 2px;">2</td> <td style="padding: 2px;">7</td> <td style="padding: 2px;">7</td> <td style="padding: 2px;">11</td> <td style="padding: 2px;">10</td> <td style="padding: 2px;">5</td> <td style="padding: 2px;">8</td> </tr> </tbody> </table>	Jobs	J <sub>1</sub>	J <sub>2</sub>	J <sub>3</sub>	J <sub>4</sub>	J <sub>5</sub>	J <sub>6</sub>	J <sub>7</sub>	Start time	0	3	4	9	7	1	6	Finish time	2	7	7	11	10	5	8
Jobs	J <sub>1</sub>	J <sub>2</sub>	J <sub>3</sub>	J <sub>4</sub>	J <sub>5</sub>	J <sub>6</sub>	J <sub>7</sub>																		
Start time	0	3	4	9	7	1	6																		
Finish time	2	7	7	11	10	5	8																		
	(c) Using algorithm find an optimal parenthesization of a matrix chain product whose sequence of dimension is (5,10,3,12,5,50,6) (use dynamic programming).	<b>07</b>																							
<b>OR</b>																									
<b>Q.3</b>	(a) Apply counting sort for the following numbers to sort in ascending order. 3, 1, 2, 3, 3, 1	<b>03</b>																							
	(b) Find the Optimal Huffman code for each symbol in following text ABCCEBABBFBACBEBDFAAAAABCDEEDCCBFEBFCAE	<b>04</b>																							
	(c) Solve following knapsack problem using dynamic programming algorithm with given capacity W=5, Weight and Value are as follows (2,12),(1,10),(3,20),(2,15)	<b>07</b>																							
<b>Q.4</b>	(a) Solve the following Task Assignment problem for minimization using following cost matrix. (Cost matrix represents cost of Task T performed by Person P).	<b>03</b>																							
	<table style="border-collapse: collapse; margin-left: auto; margin-right: auto;"> <thead> <tr> <th style="padding: 2px;"></th> <th style="padding: 2px;">T<sub>1</sub></th> <th style="padding: 2px;">T<sub>2</sub></th> <th style="padding: 2px;">T<sub>3</sub></th> </tr> </thead> <tbody> <tr> <td style="padding: 2px;">P<sub>1</sub></td> <td style="padding: 2px;">10</td> <td style="padding: 2px;">20</td> <td style="padding: 2px;">25</td> </tr> <tr> <td style="padding: 2px;">P<sub>2</sub></td> <td style="padding: 2px;">20</td> <td style="padding: 2px;">23</td> <td style="padding: 2px;">26</td> </tr> <tr> <td style="padding: 2px;">P<sub>3</sub></td> <td style="padding: 2px;">12</td> <td style="padding: 2px;">16</td> <td style="padding: 2px;">25</td> </tr> </tbody> </table>		T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	P <sub>1</sub>	10	20	25	P <sub>2</sub>	20	23	26	P <sub>3</sub>	12	16	25								
	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>																						
P <sub>1</sub>	10	20	25																						
P <sub>2</sub>	20	23	26																						
P <sub>3</sub>	12	16	25																						

- (b) Given coins of denominations 2, 3 and 4 with amount to be pay is 5. Find optimal no. of coins and sequence of coins used to pay given amount using dynamic method. 04
- (c) Write an algorithm to find out the articulation points of an undirected graph. Find out articulation points for the following graph. Consider vertex 0 as the starting point. 07



OR

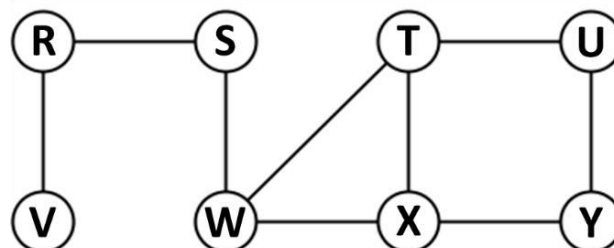
- Q.4** (a) Find out the NCR  $\binom{5}{3}$  Using Dynamic Method. 03
- (b) Write the Kruskal's Algorithm to find out Minimum Spanning Tree. Apply the same and find MST for the graph given below. 04



- (c) Explain Backtracking Method. What is N-Queens Problem? Give solution of 4-Queens Problem using Backtracking Method. 07
- Q.5** (a) Demonstrate Binary Search method to search Key = 14, form the array A = <2,4,7,8,10,13,14,60>. 03
- (b) Solve the following knapsack problem using greedy method. Number of items = 5, knapsack capacity W = 100, weight vector = {50,40,30,20,10} and profit vector = {1,2,3,4,5}. 04
- (c) Define P, NP, NP-complete, NP-Hard problems. Give examples of each 07

OR

- Q.5** (a) Explain in Brief: Polynomial reduction. 03
- (b) Traverse the following graph using Breadth First Search Technique. Also draw BFS Tree for a given graph. 04



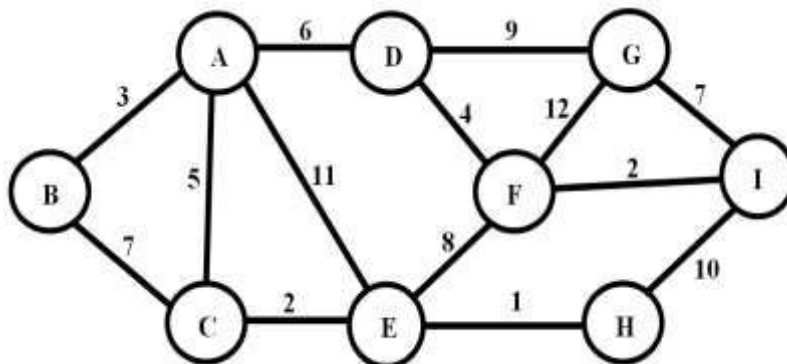
- (c) Explain spurious hits in Rabin-Karp string matching algorithm with example. Working modulo q=13, how many spurious hits does the Rabin-Karp matcher encounter in the text T = 2359023141526739921 when looking for the pattern P = 26739? 07

\*\*\*\*\*

**GUJARAT TECHNOLOGICAL UNIVERSITY****BE - SEMESTER-V (NEW) EXAMINATION – WINTER 2022****Subject Code:3150703****Date:09-01-2023****Subject Name:Analysis and Design of Algorithms****Time:10:30 AM TO 01:00 PM****Total Marks:70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Simple and non-programmable scientific calculators are allowed.

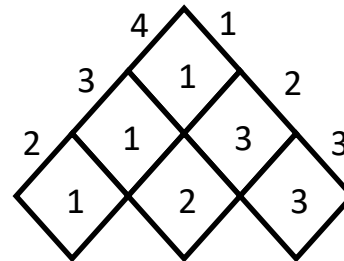
- |   | <b>Marks</b> |
|---|--------------|
| <b>Q.1 (a)</b> Sort the best case running times of all these algorithms in a non-decreasing order.<br>LCS, Quick-Sort, Merge-Sort, Counting-Sort, Heap-Sort, Selection-Sort, Insertion-Sort, Bucket-Sort, Strassen's Algorithm. | <b>03</b>    |
| <b>(b)</b> State whether the statements are correct or incorrect with reasons.<br>1. $O(f(n)) + O(f(n)) = O(2f(n))$<br>2. If $3n + 5 = O(n^2)$ , then $3n + 5 = o(n^2)$   | <b>04</b>    |
| <b>(c)</b> Explain asymptotic analysis with all the notations and its mathematical inequalities.  | <b>07</b>    |
| <br><b>Q.2 (a)</b> What is the use of Loop Invariant? What should be shown to prove that an algorithm is correct?   | <b>03</b>    |
| <b>(b)</b> Apply LCS on sequence $\langle A,B,A,C,B,C \rangle$ for pattern $\langle A,B,C \rangle$  | <b>04</b>    |
| <b>(c)</b> Write and explain the recurrence relation of Merge Sort.   | <b>07</b>    |
| <b>OR</b>   |              |
| <b>(c)</b> Perform the analysis of a recurrence relation $T(n) = 2T\left(\frac{n}{2}\right) + \theta(n^2)$ by drawing its recurrence tree.  | <b>07</b>    |
| <br><b>Q.3 (a)</b> Consider the array 2,4,6,7,8,9,10,12,14,15,17,19,20. Show (without actually sorting), how the quick sort performance will be affected with such input.   | <b>03</b>    |
| <b>(b)</b> "A greedy strategy will work for fractional Knapsack problem but not for 0/1", is this true or false? Explain.   | <b>04</b>    |
| <b>(c)</b> Apply Kruskal's algorithm on the given graph and step by step generate the MST.  | <b>07</b>    |

**Graph G(V,E)****FIG:1**

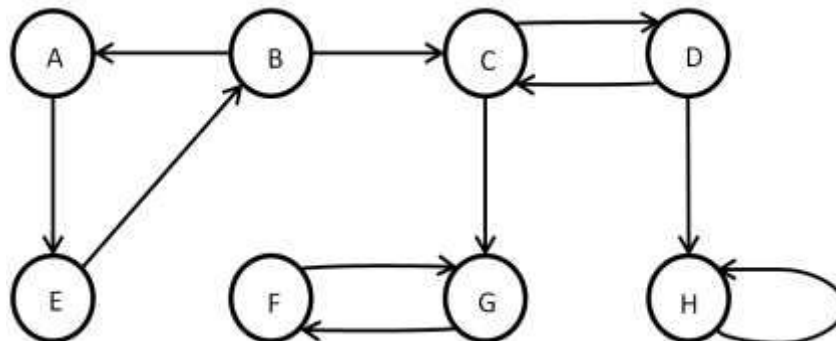
OR

- Q.3 (a)** Consider an array of size 2048 elements sorted in non-decreasing order. Show how the Binary Search will perform on this size by analysis of its recurrence relation. Derive the running time. **03**
- (b)** Explain the steps of greedy strategy for solving a problem. **04**
- (c)** Apply Prim's algorithm on the given graph in Q.3 (C) FIG:1 Graph  $G(V,E)$  and step by step generate the MST. **07**

- Q.4 (a)** Given is the S-table after running Chain Matrix Multiplication algorithm. Calculate the parenthesized output based on PRINT\_OPTIMAL\_PARENTHESES algorithm. Assume the matrix are names from  $A_1, A_2, \dots, A_n$  **03**

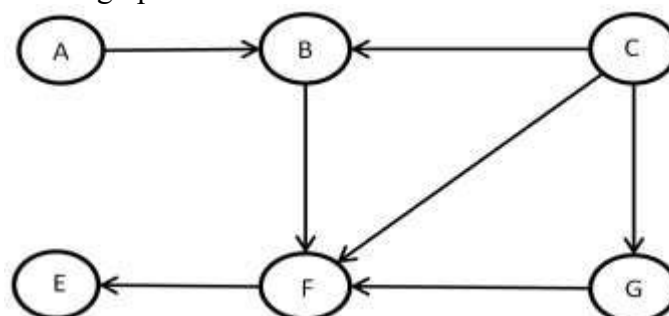


- (b)** Explain states, constraints types of nodes and bounding function used by backtracking and branch and bound methods. **04**
- (c)** Apply the algorithm to find strongly connected components from the given graph. **07**



OR

- Q.4 (a)** Consider a Knapsack with maximum weight capacity  $M$  is 7, for the three objects with value  $\langle 3, 4, 5 \rangle$  with weights  $\langle 2, 3, 4 \rangle$  solve using dynamic programming the maximum value the knapsack can have. **03**
- (b)** Explain the Minimax principle and show its working for simple tic-tac-toe game playing. **04**
- (c)** Given is the DAG, apply the algorithm to perform topological sort and show the sorted graph. **07**



- Q.5 (a)** When can we say that a problem exhibits the property of Optimal Sub-structure? **03**
- (b)** Create an example of string P of length 7 such that, the prefix function of KMP string matcher returns  $\pi[5] = 3$ ,  $\pi[3] = 1$  and  $\pi[1] = 0$  **04**
- (c)** Explain the 3SAT problem and show that it is NP Complete. **07**
- OR**
- Q.5 (a)** Explain Over-lapping Sub-problem with respect to dynamic programming. **03**
- (b)** Show that if all the characters of pattern P of size m are different, the naïve string matching algorithm can perform better with modification. Write the modified algorithm that performs better than  $O(n.m)$ . **04**
- (c)** Explain with example, how the Hamiltonian Cycle problem can be used to solve the Travelling Salesman problem. **07**

\*\*\*\*\*