Course Code : CST 227 **KQLR/RS – 24 / 1056**

Fourth Semester B. Tech. (Computer Science and Engineering) Examination

DESIGN AND ANALYSIS OF ALGORITHMS

Time : 3 Hours] [Max. Marks : 60

Instructions to Candidates :—

(1) Due credit will be given to neatness and adequate dimensions.

(2) Assume suitable data wherever necessary.

(3) Illustrate your answers wherever necessary with the help of neat sketches.

1. (a) Solve the recurrence relation using substitution method :

$$T(n) = 4T(n/3) + n \qquad n > 1$$
$$= 1 \qquad n = 1$$

5(CO1)

(b) Solve the recurrence relation using the recurrence tree method :

$$T(n) = 2T(n/2) + n$$

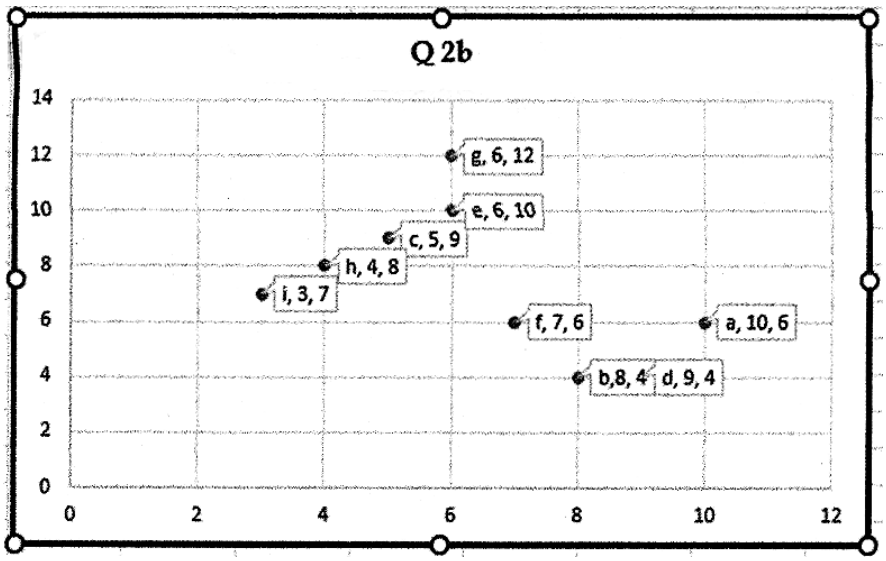
5(CO1)

2. (a) Suppose you are working as a software engineering for a logistics company that manages a vast inventory of products stored in multiple warehouses across different locations. To streamline the inventory management system, you are tasked to implement the divide and conquer based strategy whose complexity is logarithmic in all the cases to sort a list of product IDs in ascending order.

The company's database contains records of 10 unique product IDs [30, 27, 28, 45, 38, 24, 26, 21, 37, 41, 36, 20] that need to be sorted efficiently for inventory tracking and analysis. Write an **algorithm** for suggested solution.

5(CO2)

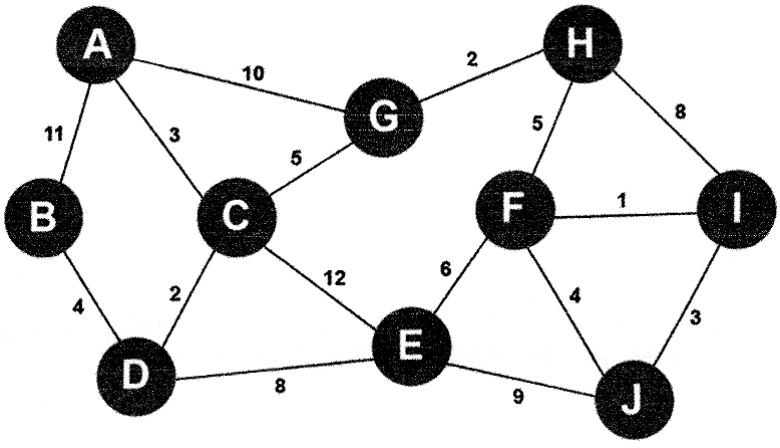
(b) In air-traffic control, you may want to monitor planes that come too close together, since this may indicate a possible collision. Identify the name of method which uses divide and conquer Strategy. Write an **algorithm** for suggested solution and comment on time **complexity**.



5(CO2)

3. (a) Imagine you are a project manager for a construction company tasked with building a network of roads to connect several towns in a rural area. Each town is represented as a node and the distances between them are represented as weighted edges on a graph shown below.

Provide a step-by-step explanation of how Kruskal's algorithm is applied to select the edges for the minimum spanning tree. Include the edges selected at each iteration, the total distance covered by the MST and justify your selections based on the algorithm's criteria. Additionally, provide the **algorithm** and comment on its **complexity**.



5(CO2)

(b) You have a set of eight valuable items with varying weights and values, along with the weight capacity of your backpack. The details of the items are as follows :

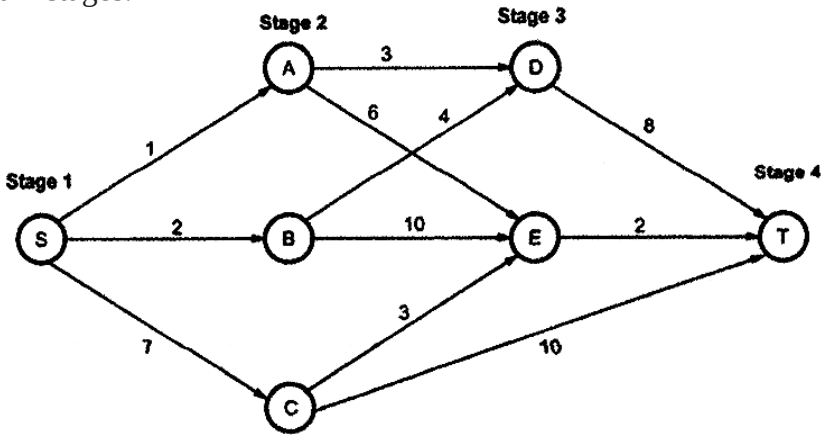
Profit	10	15	25	30	5	20	28	35
Weight	2	3	5	7	1	4	6	8
Item	**I1**	**I2**	**I3**	**I4**	**I5**	**I6**	**I7**	**I8**

Apply the Knapsack algorithm using maximum profit, minimum weight and profit / weight ratio to determine the optimal selection of items for packing. Capacity = 15, n = 8.
Write an **algorithm** for the strategy giving optimal results and comment on time **complexity**. 5(CO2)

4. (a) Identify the similar component of longest size between two given strings by construction a matrix. Write an algorithm, to print the LCS and application of this problem.

String 1 : A B C D E F G H I J
String 2 : X B C Y D E H J I Z 5(CO3)

(b) Given a multistage construction project with interconnected facilities and associated costs for each stage. The details of the project are shown in graph, consists of four stages.



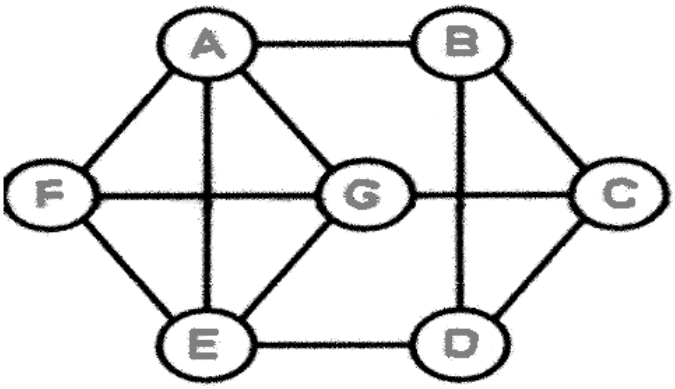
Utilize the Multistage Graph algorithm to determine the optimal sequence of construction stages that minimizes the total cost of completing the project. Write an **algorithm** for Multistage Graph and comment on time **complexity**. 5(CO3)

5. (a) A graph G = (V, E) with 8 vertices shows below. Provide the answers for following questions :

(i) Explain the constraints used in backtracking solutions for Hamiltonian Cycle problem.

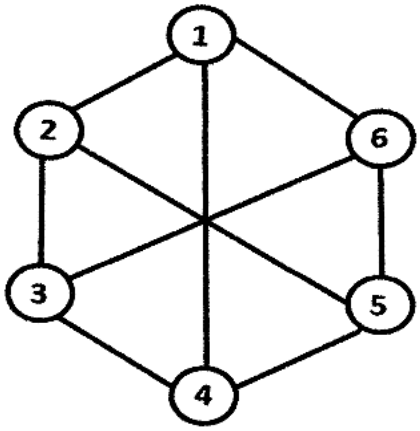
(ii) Write an **algorithm** for suggested solution and comment on time **complexity**.

(iii) Create a state space tree with explanation.



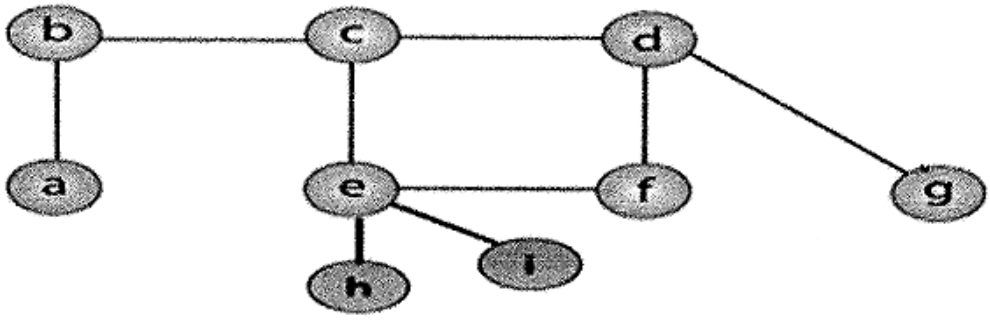
5(CO3)

(b) You are given a map of a fictional country with several regions and borders. The goal is to color the regions in such a way that no two adjacent regions have the same color. You have been provided with a graph where each region corresponds to a vertex and an edge connects two vertices if the corresponding regions share a border.



Demonstrate an **algorithm** to color this map with minimum number of colors. Also explain your color choices with minimum number of colors and comment on **complexity**. 5(CO3)

6. (a) Discuss vertex cover problem. Write the approximation algorithm for vertex cover problem. Also explain the steps required to calculate minimum size vertex cover for given graph.



5(CO4)

(b) Explain NP-complete problem. How to prove any problem as NP-Complete ? Using reduction principle prove the NP-Completeness of Vertex Cover problem using the solution of Clique. 5(CO4)