



**Mahindra University Hyderabad**  
École Centrale School of Engineering  
End Semester Examination

Program: B. Tech.    Branch: CSE, AI, ECE and CAM    Year: III    Semester: I  
Subject: Design and Analysis of Algorithm (CS/AI 3101)

Date: 19/12/2023  
Time Duration: 3 Hours

Start Time: 10:00 AM  
Max. Marks: 100

Instructions:

- 1) Answers written with pencil will not be evaluated.
- 2) Answer each question precisely and to the point.

1. Answer the following question (24 Marks)

a. Suppose we have the following recurrence relation

$$T(n) = T(n - 1) + 8$$

$$T(1) = 1$$

Solve the following recurrence relation using substitution or iteration method and compute the complexity. Validate your answer using master method. (10+2 marks)

b. Answer the following with respect to approximation algorithm

I. Why do we need approximation algorithm for certain problems? What is approximation ratio and how to calculate it? (6 marks)

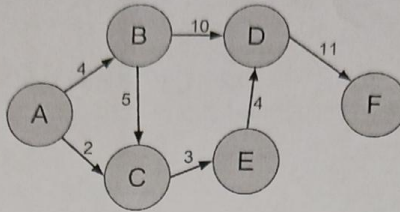
II. A social media platform tracks the relationships between users as an undirected graph, where each user is represented by a vertex and each friendship is represented by an edge. The platform aims to identify a group of users for a special event while minimizing the extent of users' awareness of each other. What approach can be used to solve this problem. Give an example to justify your answer. (6 marks)

2. Answer the following questions (24 Marks)

a. Suppose there is an array of infinite size, comprising a set of numbers followed by a set of asterisks (\*). For example, [1, 3, 5, 7, 9, \*, \*, \*, .....]. Write an algorithm using the concept of binary searching to efficiently determine the location of the first \* in the array. Due to the infinite size, direct indexing is not possible, so your algorithm should adapt to this constraint. What is the complexity of your algorithm? Justify your answer. (10+2 marks)

b. Consider a weighted, directed graph as given below

(10+2 marks)



Find the shortest paths and minimum distances from source node A to all other nodes using Dijkstra's algorithm. What is the time complexity of this algorithm?

3. Answer the following question

(22 Marks)

a. Define the 0/1 knapsack problem, specifying the input parameters and the objective of the problem. Given a set of  $N = 4$  items and knapsack capacity of 8 kg. (6+6 Marks)

Item weights: [2, 3, 4, 5]

Item values: [3, 4, 5, 6]

Find the maximum total value of items that can be stolen considering each item can either be selected completely or not selected at all.

b. Define the classes P, NP, and NPC (NP-complete) in the context of computational complexity theory. Discuss the idea of polynomial-time reduction. (6+4 Marks)

4. Answer the following question

(20 Marks)

a. What is backtracking approach of designing an algorithm? What kind of problems can be solved using backtracking. Illustrate backtracking using one example.

(3+3+4 Marks)

b. What is the limitation of FIFO and LIFO branch and bound. How LC branch and bound solve that problem. Explain the approach of ranking of nodes in LC branch and bound.

(3+3+4 Marks)

5. Consider the following cost matrix representing the assignment costs for each worker-job pair. Use the Branch and Bound algorithm to find assignment of workers to jobs, minimizing the total cost.

(10 Marks)

	$J_1$	$J_2$	$J_3$	$J_4$
$P_1$	2	7	5	2
$P_2$	3	2	6	7
$P_3$	8	4	7	3
$P_4$	6	3	4	1