Roll No. | | | | | | | | | | |

# B.E (FT) END SEMESTER EXAMINATIONS – MAY / JUNE 2024

Computer Science and Engineering
Semester III
**CS6104 – Data Structures and Algorithms**
(Regulation 2018 - RUSA)

Time: 3 Hours | Answer ALL Questions | Max. Marks 100

## PART-A (10 x 2 = 20 Marks)

1. Write the recurrence relation for the algorithm given below and determine the time complexity:

```
test(n) {
    value = 0;
    for i = 1 to n {
       value = value + i
    }
    return test(n - 1)
}
```

2. Identify the postfix representation corresponding to the following infix expression:
   (((M * (N + O)) / P) – (Q * (R + (S / T))))
3. What modification is to be done in a regular binary tree to make it a threaded binary tree?
4. Name a divide and conquer algorithm for matrix multiplication. How does it differ from the brute force technique in terms of time complexity?
5. Consider the weights and values of items listed below. Note that there is only one unit of each item.

| Item Number | Weight in kilograms | Value in Rupees |
|---|---|---|
| 1 | 10 | 60 |
| 2 | 7 | 28 |
| 3 | 4 | 20 |
| 4 | 2 | 24 |

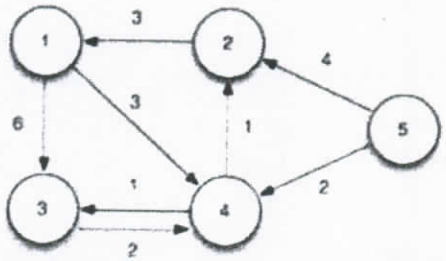
   A greedy algorithm is developed to pick a subset of these items (ensuring that no item is split) such that their total weight does not exceed 11 kgs and their total value is the maximum that can be obtained. The algorithm sorts the items by their value-to-weight ratios in descending order and packs them greedily, starting from the first item in the ordered list. Determine the subset identified by the algorithm. Is the identified subset the optimal one?
6. Identify any two longest common subsequences between "programming" and "permutation".
7. Compare and contrast backtracking and branch & bound techniques.
8. Consider a double hashing scheme in which the primary hash function is $h_1(k) = k \bmod 23$, and the secondary hash function is $h_2(k) = 1 + (k \bmod 19)$. Assume that the table size is 23. Determine the address returned by probe 1 in the probe sequence (assume that the probe sequence begins at probe 0) for key value 90.
9. List a few real world applications of string matching algorithms.
10. If a polynomial time algorithm is designed to solve the sum of subsets problem, can the vertex cover problem be solved in polynomial time? Justify.

## PART – B ( 8 x 8 = 64 marks)
## (Answer any 8 questions)

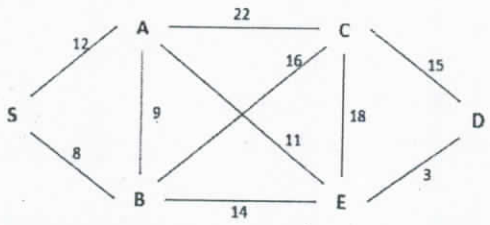
11. Prove by induction that $\sum_{i=1}^{n} i = \frac{n(n+1)}{2}$.
12. Given a singly linked list and a positive integer 'k', write an algorithm to find the maximum sum obtained by adding any k consecutive nodes of the linked list.
13. The electoral board has decided to maintain two separate queues for 'm' males and 'n' females for voting. Candidates are allowed to enter into the booth based on following conditions.
    a. One female candidate followed by a male candidate, If m:n ratio is ≈ 1:1.
    b. One female candidate followed by two male candidates, else if m:n ratio is ≈ 2:1.

    Devise an algorithm to implement the above scenario

14. Store the letters of the word "MAJESTIC" in a Binary Search Tree (BST) by inserting the letters in the order in which they occur in the word. Illustrate the creation of BST. State the rules for deletion of nodes and show the step by step procedure for deleting the nodes M, C and E.
15. Explain how the partitioning algorithm of Quicksort can be used to find the $k^{th}$ smallest element in a list of n elements in linear time.
16. Write an algorithm to find the shortest path from a source vertex to all the remaining vertices of a given graph G = (V, E). Apply your algorithm to the below graph to find the shortest path, assume the source vertex is at '1'.




17. Write Prim's algorithm and obtain the minimum cost spanning tree using the same for the graph given below:




18. Using dynamic programming, find an optimal parenthesization for a chain of 6 matrices with dimensions: 5×10, 10×3, 3×12, 12×5, 5×50 and 50×6.
19. Draw the state space tree generated by Least Cost Branch & Bound for the following 0/1 knapsack instance: number of items (n) = 4, profit of items (P) = {40, 42, 25, 12}, weight of items (W) = {4, 7, 5, 3}, capacity of knapsack (m) = 10.
20. Construct a max heap by inserting the following elements in order: 14, 24, 12, 11, 25, 8, and 16. Write an algorithm to sort the elements in the heap in ascending order using a stack.
21. Simulate the KMP string matching algorithm to identify all occurrences of the string "onions" in the string "onionionspl".
22. Brief the procedure to reduce a vertex cover problem to a clique problem in polynomial time and illustrate with the graph given in question number 17.

## PART – C ( 2 x 8 = 16marks)

23. An organization has 'n' workers with skill levels S1, S2, S3, … Sn. At any point of time, the organization ensures that the upper bound for the skill level of each employee is 'u'. The organization is in the process of allotting cabins for its workers. Due to scarcity of cabins, a decision is made to accommodate a maximum of two workers in any cabin. While allotting cabins, it is to be ensured that the sum of the skill levels of the workers in the same cabin does not exceed 'u'. Design a greedy algorithm to determine the minimum number of cabins required for the 'n' workers. Example: If S = [9, 4, 6, 5, 3, 2, 9, 7, 8] and u = 10, the minimum number of cabins required for the workers is 6. Illustrate the algorithm for the given example and analyse the time complexity of the algorithm.
24. Depict the graph given below as an adjacency matrix and list the sequence of nodes visited in order when each of the following traversal techniques is used: breadth first search and depth first search. Which of traversal technique would be better to travel from node A to node F? Justify.