Register No.: .... Name: ....

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

SIXTH SEMESTER B.TECH DEGREE EXAMINATION (R,S), MAY 2024
COMPUTER SCIENCE AND ENGINEERING

(2020 SCHEME)

Course Code : **20CST306**

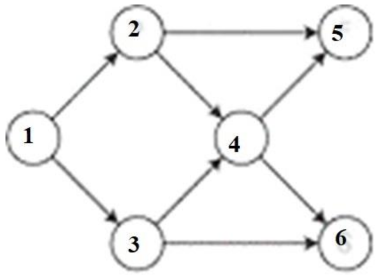
Course Name: **Algorithm Analysis and Design**

Max. Marks : **100** **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

1. Define time complexity and space complexity. Find the time and space complexities of an algorithm to find the **k^th^** smallest element in an unsorted array of **n** integers.
2. Find the complexity of the following function:
```
void function(int n)
{
int count = 0;
for (int i=n/2; i<=n; i++)
for (int j=1; j<=n; j = 2 * j)
for (int k=1; k<=n; k = k * 2)
count++;
}
```
3. Define Strongly Connected Components of a graph. Give an algorithm to find the Strongly Connected Components in a graph.
4. Find at least two topological orderings for the following graph:



5. Write an algorithm to merge two sorted arrays and analyse the complexity.
6. State the control abstraction of greedy strategy for algorithm design.
7. Write a Dynamic Programming Algorithm for Matrix Chain Multiplication Problem.
8. State and explain N-queens problem.
9. Explain approximation algorithm for Bin Packing using First Fit heuristic.

10. Define 'intractable problems'. Illustrate 'intractable problems' with a suitable example.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Determine a good asymptotic upper bound on the recurrence $T(n) = 3T(\frac{n}{2}) + n$ using recursion tree method. (7)

b) Differentiate between the various asymptotic notations used to represent the growth rate of running time of algorithms, appropriate curves for each notation are to be plotted and explained. (7)

OR

12. a) State the Master theorem for solving recurrence equations and explain the three cases of the Master Theorem. (5)

b) Using Master Theorem, solve the following: (9)

i. $T(n) = 3T(n/4) + n \log n$

ii. $T(n) = 4T(n/2) + n^2$

iii. $T(n) = 2T(\sqrt{n}) + 1$

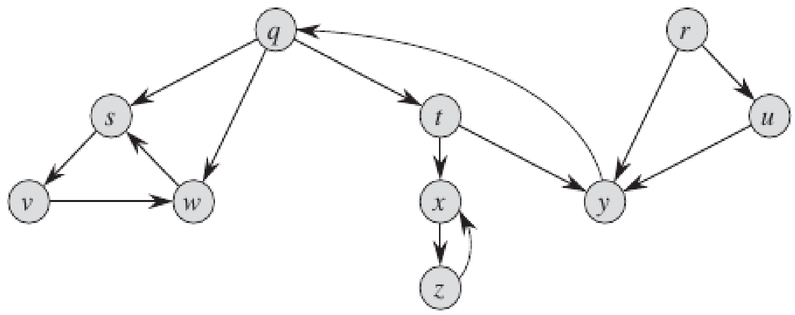
MODULE II

13. a) Compare the advantages of height balanced binary search trees over binary search trees, illustrating both with suitable examples and diagrams. (6)

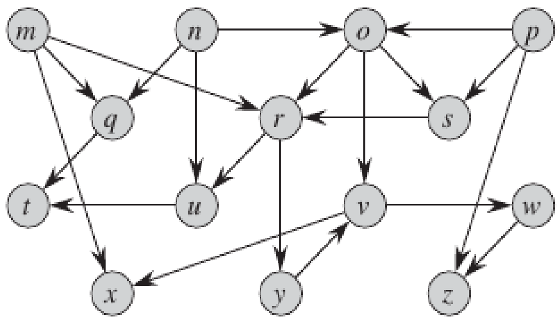
b) Construct an AVL tree over the following data (insert in the given sequence): 21,26,30,9,4,14,28,18,15,10,2,3,7 (8)

OR

14. a) Illustrate the working of depth-first search works on the following graph. You may assume that the DFS procedure considers the vertices in alphabetical order, and also assume that each adjacency list is ordered alphabetically. Show the discovery and finishing times for each vertex, and show the classification of each edge. (7)



b) Show the ordering of vertices produced by TOPOLOGICAL-SORT algorithm when it is run on the following DAG. You may assume that the DFS procedure called by TOPOLOGICAL-SORT considers the vertices in alphabetical order, and also assume that each adjacency list is ordered alphabetically. (7)



MODULE III

15. a) Differentiate between Prim's Algorithm and Kruskal's algorithm for determining the minimum spanning trees of a given graph G. Also give both algorithms and illustrate them with a suitable example for both. (9)

b) Analyze the time complexities of both Prim's and Kruskal's algorithms. Also explain how the asymptotic running time of Prim's algorithm by using a Fibonacci heap. (5)

OR

16. a) Write the Strassen's algorithm for matrix multiplication and use it to compute the following matrix product, showing each step (9)

$$\begin{pmatrix} 1 & 3 \\ 7 & 5 \end{pmatrix}\begin{pmatrix} 6 & 8 \\ 4 & 2 \end{pmatrix}$$

b) Write Greedy Algorithm for fractional Knapsack Problem. Also find the optimal solution for the following fractional Knapsack problem. (5)
n=4, m = 60, W={40, 10, 20, 24} and P={280, 100, 120, 120}

MODULE IV

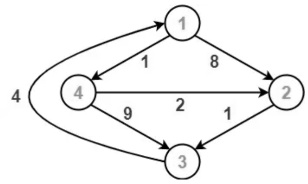
17. a) State Matrix Chain Multiplication Problem. Write a dynamic programming algorithm for Matrix Chain Multiplication Problem. (7)

b) Using Dynamic Programming, find the fully parenthesized matrix product for multiplying the chain of matrices < A1 A2 A3 A4 A5 A6 > whose dimensions are <5X10>, <10X3>, <3X12>, <12X5>, <5X50> and <50X6> respectively. Also determine the total number of multiplications required by the parenthesization. (7)

OR

18. a) Write the Floyd-Warshall Algorithm for finding All-pairs shortest paths. (6)

b) Using Floyd Warshall Algorithm, find the shortest path distance between every pair of vertices of the following graph. (8)



MODULE V

19. a) Define the terms NP-Hard and NP–Complete Problems and give examples for each. Also list and explain the steps required to show that a given problem is NP-Complete. (7)

b) Illustrate the concept of polynomial time reductions with suitable diagrams or examples and explain. (7)

OR

20. a) Prove that the vertex cover problem is NP-Complete. (7)

b) Write the RANDOMIZED QUICKSORT algorithm. Also analyze its worst-case running time and compare the result with the worst-case running time of the general QUICKSORT algorithm. (7)

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