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**003404**

## May 2023
## B.Tech. - IV SEMESTER
## Design & Analysis of Algorithms (PCC-CS-404)

Time : 3 Hours] [Max. Marks : 75

*Instructions :*

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

## PART–A

**1.** (a) What is the time complexity of the following code? Justify your answer.

```
int i, j, k = 0;
  for (i = n / 2; i <= n; i++) {
    for (j = 2; j <= n; j = j * 2) {
      k = k + n/2;
  }}
```
(1.5)

(b) Sort the following functions in the decreasing order of their asymptotic (big-0) complexity : $f_1(n) = n^{\sqrt{n}}$, $f_2(n) = 2^n$, $f_3(n) = (1.000001)^n$, $f_4(n) = n^{10} * 2^{(n/2)}$. (1.5)

(c) Differentiate Greedy algorithm and Dynamic programming. (1.5)

(d) State Job Sequencing with Deadline Problem. Write down time and space complexity if problem solved by Greedy approach. (1.5)

(e) Define Principle of Optimality with suitable example. (1.5)

(f) Draw state space tree of 4-Queens problem. (1.5)

(g) Why does Dijkstra's algorithm fail on negative weights? (1.5)

(h) Draw binary search trees for the given set of keys and their corresponding frequencies and find the Optimal among them. keys[ ] = {10, 12, 20}, freq[ ] = {34, 8, 50} (1.5)

(i) Explain Least Cost Search function for branch and bound algorithm design technique. (1.5)

(j) What is the importance of approximation algorithm? (1.5)

## PART–B

2. (a) Solve the following recurrence relation.

(i) $T(n) = 2T(n/2) + \log n$ with $T(1)=1$

(ii) $T(n) = 2T(\sqrt{n}) + 1$ if $n > 2$ and $T(n) = 2$ if $0<n<=2$. (10)

(b) How are time and space trade-offs used to optimize the performance of an algorithm? Provide an example of an algorithm that optimizes time at the expense of space and vice-versa. (5)

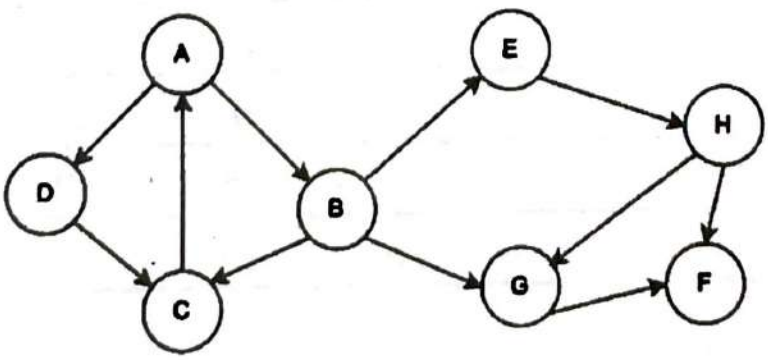
3. (a) Give a dynamic-programming solution to the 0-1 knapsack problem that runs in 0(n/W) time, where n is the number of items and W is the maximum weight of items that the thief can put in his knapsack.

Consider the weights and values of items listed below. The task is to pick a subset of these items such that their total weight is no more than 5 Kgs and o their total value is rnaximized.

| Item No. | Weight (Kg) | Values (Rs.) |
|---|---|---|
| 1 | 2 | 3 |
| 2 | 3 | 4 |
| 3 | 4 | 5 |
| 4 | 5 | 6 |

(b) Consider the given graph. In what order will the nodes be visited using a Breadth First Search and Depth First Search? (Assume starting vertex A) (5)

Note: If a node has multiple neighbors then select which is alphabetically near to node.



4. (a) The N-Queen problem is a classic problem in computer science, where the goal is to place N queens on an N × N chessboard so that no two queens attack each other.

(i) Write a brute-force algorithm to solve the N-Queen problem. Analyze the time complexity of your algorithm, and explain why it is not efficient for large values of N.

(ii) Write a backtracking algorithm to solve the N-Queen problem. Analyze the time complexity of your algorithm, and compare it with the brute-force algorithm. (12)

(b) Describe the Traveling Salesman Problem and explain why it is NP-complete. (3)

5. (a) A delivery truck travels between multiple destinations. The truck starts at city A and visits cities B, C, D, and E before returning to A. Design an algorithm to find the shortest path for the truck to travel while minimizing cost. Use following distance matrix to solve the problem. (8)

| | A | B | C | D | E |
|---|---|---|---|---|---|
| A | 0 | 10 | 20 | 15 | 30 |
| B | 10 | 0 | 25 | 30 | 20 |
| C | 20 | 25 | 0 | 35 | 15 |
| D | 15 | 30 | 35 | 0 | 10 |
| E | 30 | 20 | 15 | 10 | 0 |

(b) Write a short note on Randomized algorithms. (7)

6. (a) Define spanning tree. Write Kruskal's algorithm for finding minimum cost spanning tree. Describe how Kruskal's algorithm is different from Prim's algorithm for finding minimum cost spanning tree. (10)

(b) What is Topological Sorting? Explain with example. (5)

7. (a) What is the relationship among P, NP, NP-Hard and NP-Complete problems? Show with the help of a diagram. (8)

(b) In a given directed graph with source s and sink t, where each edge in the graph has a non-negative capacity. Find the maximum flow that can be sent from s to t. (7)