Registration No : | | | | | | | | | | |

Total Number of Pages : 02

B. Tech/ IDD (B.Tech and M.Tech)
RCS4C002 / RIT4C002

4th Semester Reg/Back Examination: 2023-24
Design and Analysis of Algorithm
CSE, IT, CSEAI, CSEAIME, CSEDS, CST, ELECTRICAL & C.E, ELECTRONICS & C.E

Time : 3 Hour
Max Marks : 100
Q. Code : P587

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.
The figures in the right hand margin indicate marks.

Part-I

Q1 **Answer the following questions:** **(2 x 10)**

a) What is the running time of Quick sort when all elements of array **A** have the same value?
b) The elements 61, 18, 25, 30, 90, 20 are inserted one by one in the given order into a Max Heap. The resultant Max Heap is ……
c) Arrange the following functions in the increasing order of their growth.
$ln\ 2^n$, $n^{1.001}$, $n \log n$, e^n, n^{10}
d) Give an asymptotic upper bound for the recurrence $T(n) = T(n-1) + n$.
e) Why greedy algorithm cannot be applied to solve 0-1 knapsack problem?
f) Formulate Longest Common Subsequence (LCS) as a dynamic programming.
g) Write the recurrence equation to represent the time complexity of merge sort and solve it using Master method.
h) What do you mean by heuristic approach?
i) Define Max Clique problem.
j) What is the difference between decision problem and optimization problem? Give an example of optimization problem and write its equivalent decision problem.

Part-II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 × 8)**

a) Solve the following recurrence equation: T(n) = 5T(n/5) + $\sqrt{n}$, T(1) = 1, T(0) = 0.
b) Consider two strings A = "qpqrr" and B = "pqprqrp". Let x be the length of the longest common subsequence (not necessarily contiguous) between A and B and let y be the number of such longest common subsequences between A and B. Then compute the value of $x + 10y$. Adopt dynamic programming to find the longest common subsequence.
c) Let A1, A2, A3, and A4 be four matrices of dimensions 10 x 5, 5 x 20, 20 x 10, and 10 x 5, respectively. Calculate the minimum number of scalar multiplications required to find the product A1A2A3A4 using the basic matrix multiplication method. **Note** : Use dynamic programming for optimal parenthesization.

d) A networking company uses a compression technique to encode the message before transmitting over the network. Suppose the message contains the following characters with their frequency:

character	*a*	*b*	*c*	*d*	*e*	*f*
Frequency	*5*	*9*	*12*	*13*	*16*	*45*

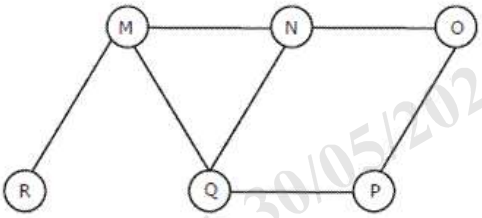
Note : Each character in input message takes 1 byte.

If the compression technique used is Huffman Coding, how many bits will be saved in the message?

e) Give asymptotic upper bounds for T(n) in each of the following recurrences. Assume that T(n) is constant for sufficiently small n.

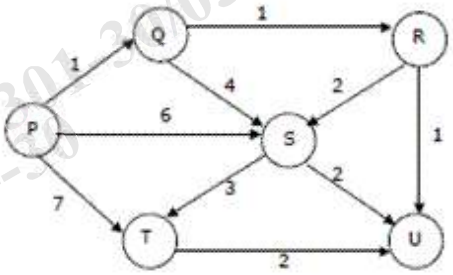
(i) T(n) = T(n/2) + T(n/4) + T(n/8) + n (ii) T(n) = 3T(n/4) + n^2

f) Apply Breadth First Search and Depth First Search algorithm to find all possible order of visiting the nodes of the following graph by taking M as the source vertex.



Let G be a graph with n vertices and m edges. What is the tightest upper bound on the running time on Breadth First Search and Depth First Search of G? Assume that the graph is represented using adjacency matrix.

g) Suppose we run Dijkstra's single source shortest-path algorithm on the following edge weighted directed graph with vertex P as the source. In what order do the nodes get included into the set of vertices for which the shortest path distances are finalized? Show all steps.



h) Write the steps of solving a recurrence equation using the master method. Can the master method be applied to the recurrence *T(n) = 4T(n/2) + n^2 log n* ? Why or why not? Give an asymptotic upper bound for this recurrence.

i) Apply dynamic programming technique in solving the travelling salesman problem.

j) Write the solution of n-queen problem using the branch-and- bound technique.

k) What do you mean by randomization? Write randomized quick sort algorithm and compare it with quick sort algorithm.

l) Assume 3-SAT problem as an NP-complete problem, reduce Node cover decision problem to 3-SAT problem.

Part-III

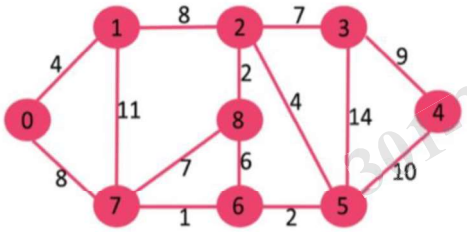
Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 **a** Using recurrence tree method, argue that the solution to the recurrence relation $T(n) = T(n/3) + T(2n/3) + cn$, where $c > 0$, is $\Omega(n \log n)$. **(8+8)**

b Show that the solution to $T(n)=2T(n/2)+n$ is $O(n \log n)$ using substitution method.

Q4 Write the general steps of dynamic-programming paradigm to solve a problem. How is it different from the divide and conquer approach? Write pseudo code for dynamic-programming algorithm to solve 0-1 knapsack problem. What is the complexity of your algorithm? **(4+4+4+4)**

Q5 What is a spanning tree? Write the pseudo code for finding the minimum spanning tree of a given graph using Prim's algorithm. Derive the time complexity of the algorithm. Use the algorithm to find the minimum spanning tree of the following graph. **(2+6+2+6)**



Q6 **a** Discuss the P, NP, NP-Hard and NP-Complete class of problems with suitable examples. **(8+8)**

b Define the node cover problem. Discuss a 2-approximation algorithm for node cover problem on the following graph.