No. of Printed Pages : 4

Sl. No.

# C4-R4 : ADVANCED ALGORITHMS

**DURATION : 03 Hours** **MAXIMUM MARKS : 100**

**Roll No. :** | | | | | | |

**Answer Sheet No. :** | | | | | | |

**Name of Candidate :** _____ ; **Signature of Candidate :** _____

**INSTRUCTIONS FOR CANDIDATES :**

- Carefully read the instructions given on Question Paper, Answer Sheet.
- Question Paper is in English language. Candidate has to answer in English Language only.
- **Question paper contains Seven questions. The Question No. 1 is compulsory. Attempt any FOUR Questions from Question No. 2 to 7.**
- **Parts of the same question should be answered together and in the same sequence.**
- **Questions are** to be answered in the **ANSWER SHEET** only, supplied with the Question Paper.
- **Candidate cannot leave the examination hall/ room without signing on the attendance sheet and handing over his/her Answer Sheet to the Invigilator. Failing in doing so, will amount to disqualification of Candidate in this Module/Paper.**
- After receiving the instruction to open the booklet and before answering the questions, the candidate should ensure that the Question Booklet is complete in all respects.

**DO NOT OPEN THE QUESTION BOOKLET UNTIL YOU ARE TOLD TO DO SO.**

**1.** (a) Solve following recurrence :

$T(n) = 1 \quad \text{if } n = 1$

$= 2T(n-1) \quad \text{if } n > 1$

(b) Why does Dijkstra's algorithm to find the shortest paths from source to all the other vertices fail for the graphs having negative edges ? Explain it with an example.

(c) Use aggregate analysis to determine the amortized cost per operation for a sequence of n operations on a data structure in which the $i^{th}$ operation costs i, if i is an exact power of 2, and 1 otherwise.

(d) In context of matchings in graphs, discuss the stable roommate problem using an example. Also compare this problem with stable marriage problem.

(e) Let us consider that there are 10000 edges in a graph. Also consider that the edge weights are unique and lie in the range between 1 and 10000. Which algorithm, Kruskal's or Prim's, will be suitable to find the Minimum Spanning Tree faster in the given graph. Justify your answer.

(f) In context of strings, briefly discuss proper prefix and proper suffix using an example.

(g) Highlighting the advantages and disadvantages of Heap sort, briefly discuss, why Heap Sort is not stable. **(7x4)**

**2.** (a) Define and differentiate the worst case, best case, and average case efficiency of an algorithm.

(b) In terms of big-theta, analyse the time complexity of the algorithm A1 given as follows :

```
Algorithm A1 (int N)
{
    int K = N;
    while (K ≥ 1)
    {
    K = K / 2;
    }
}
```

(c) A problem to connect ropes is defined as follows: Given N ropes of different lengths, we need to connect these ropes to make a single rope. We can do it by repeatedly connecting two ropes at a time where cost to connect two ropes is equal to sum of their lengths. We need to connect all the ropes to make single rope with minimum cost. Propose a greedy algorithm-based approach to connect the N ropes in minimum cost. Also, use the proposed approach to compute the minimum cost to connect 6 ropes of following lengths: 6, 8, 3, 5, 2, and 7 to make a single rope. **(5+4+9)**

**3.** (a) Propose divide and conquer based scheme to multiply large integers. Apply the proposed scheme to multiply 2345 and 678.

(b) Briefly discuss the steps to build Huffman Tree.

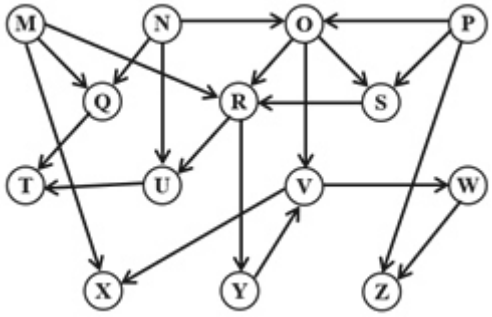
(c) The coin change problem is defined as follows: you have been given unlimited coins of different denominations and it is desired to change an amount, A using minimum number of coins. Propose a dynamic programming-based scheme to solve the coin change problem. Considering the unlimited coins of following denominations: 1, 4, and 6, apply the proposed scheme to change the amount 8 (*i.e.* $A = 8$) using minimum number of coins. **(9+3+6)**

**4.** (a) There are two ways to implement a dynamic-programming approach :
(i) top-down with memorization
(ii) bottom-up approach. Briefly discuss both of them.

(b) Amortized analysis can be perfomed by Aggregate method, accounting method (Banker's method), and potential method. Compare the three methods.

(c) Quick sort is a well-known divide and conquer based scheme to sort the elements in an array. Write down the steps of quick sort. **(6+6+6)**

**5.** (a) Show the ordering of vertices produced by TOPOLOGICAL-SORT when it is run on the directed acyclic graph given below. While showing the order, assume that the DFS procedure considers the vertices in alphabetical order, and assume that each adjacency list is ordered alphabetically.




(b) How can the number of strongly connected components of a graph change if a new edge is added ? Briefly discuss.

(c) In context of Knuth-Morris-Pratt string-matching algorithms, compute the prefix function, $\pi$ for following pattern : abababaca. Also, write the algorithmic steps of the Knuth-Morris-Pratt string matching algorithm. **(6+4+8)**

**6.** (a) Write the algorithm for Merge sort. Show the intermediate steps to sort the array having elements {12, 31, 25, 8, 32, 17, 40, 42} using Merge sort.

(b) What is primality test ? Discuss different methods for primality test. **(9+9)**

**7.** (a) Briefly discuss the 2-Approximation algorithm for the vertex cover problem along with its proof. Also, present an example to explain its different steps.

(b) Briefly discuss the basic and extended Euclid's (Euclidian) algorithm for GCD with examples. Discuss the utility of extended Euclidian algorithm. **(9+9)**

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**SPACE FOR ROUGH WORK**