

DESIGN & ANALYSIS OF ALGORITHM

Full Marks – 70

Time : 3 Hours

*The figures in the right-hand margin indicate marks.*

*Answer six questions including Question No. 1  
which is compulsory.*

1. Answer the following questions : 2×10
- (a) What do you mean by *time complexity* and *space complexity* of an algorithm ? Suppose it is known that the running time of one algorithm is  $O(N \log N)$  and that the running time of another algorithm is  $O(N^3)$ . What does this say about the relative performance of algorithms ?

P.T.O.

- (b) What is the purpose of Big Oh notation ? Arrange the following function into increasing order ;  $n \log n$ ,  $(\log n)^3$ ,  $2^n$ ,  $\log n$ .
- (c) What is  $\omega$  notation ? Compare order of growth of  $n!$  and  $2^n$ .
- (d) On what input data does QUICK SORT algorithm for sorting exhibit its worst-case behavior ? Justify with an example of 8 elements.
- (e) Define and differentiate between NP and NP-complete problems with example.
- (f) Is the running time of Merge sort depends on the value of the keys in the input file ? Explain your answer.
- (g) In Kruskal's method for finding a minimum spanning tree, how does the algorithm know when the addition of an edge will generate a cycle ?

- (h) What is the minimum number of keys that must be moved during a "remove the largest" operation in a max-heap ? Use a heap of size 15 to explain your answer.

- (i) Solve the following recurrence relation

$$T(n) = n \quad ; \text{ if } n = 0 \text{ or } n = 1$$

$$T(n) = 5T(n-1) - 6T(n-2) \quad ; \text{ otherwise}$$

- (j) Show that the following equations are correct ?

$$n! = O(n^n)$$

$$33n^3 + 4n^2 = \Omega(n^2)$$

2. (a) Develop a Huffman code for the input string "a fast runner need never be afraid of the dark". Explain how the greedy-choice property used in this algorithm ? 5
- (b) Write an algorithm for merge sort. Show that running time is  $O(n \log n)$ . 5

3. (a) Explain the process of Heap sort. Write an algorithm to construct a min heap. Construct max-heap from the following list. Sketch the heap after deleting 76. What is the time complexity of the whole process? 5

{21, 6, 56, 61, 44, 7, 9, 76, 75, 32, 34, 4, 49}

(b) What is the principle of Optimality that is used in Dynamic Programming paradigm? Explain with an example how *use of table* is found to be efficient instead of using *recursion*? 5

4. (a) Give the algorithm of Binary search. Explain how it functions? Show that the algorithm is of same order for both average and worst case i.e.  $O(\log_2 n)$ . 5

(b) Define lower bound of a problem. What is the difference between worst case lower bound and average case lower bound? Find out the lower bound of heap sort algorithm. 5

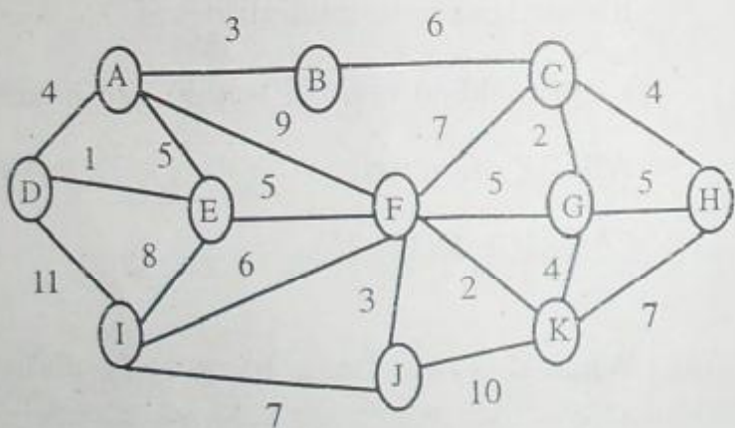
5. (a) Show how to use dynamic programming to compute the longest common subsequence between the two strings "babbabab" and "bbabbaaab"? What is the complexity of the LCS finding algorithm? 5

(b) Explain the principle of ordering Matrix multiplication in the light of dynamic programming. Show that the number of ways that  $n$  matrices can be multiplied is of  $O(4^n/n^{3/2})$ . Hence find an optimal way to find product ABCD of matrices  $A(30 \times 1)$ ,  $B(1 \times 40)$ ,  $C(40 \times 10)$ ,  $D(10 \times 25)$ . 5

6. (a) What do you mean by greedy choice property? Suggest a greedy algorithm to solve 0/1 knapsack problem. Comment on data structure to be used for implementation. What

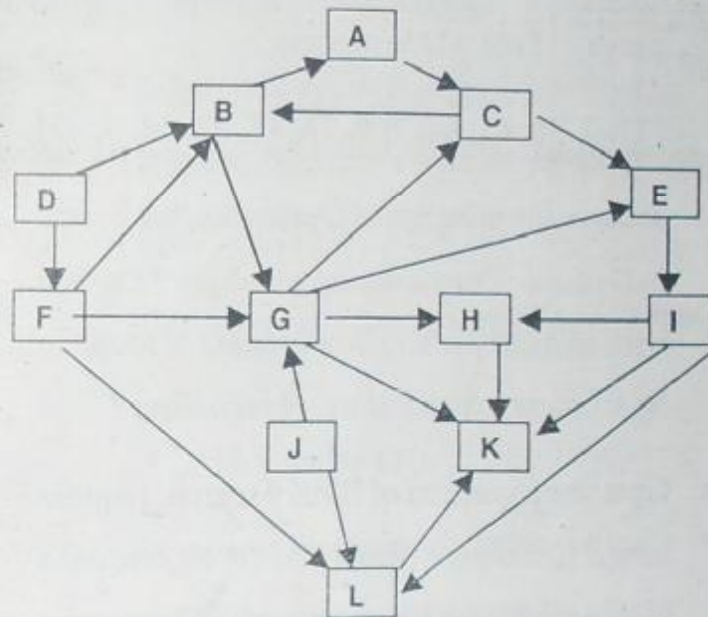
is average case time complexity of your greedy algorithm ? 5

(b) Find a minimum spanning tree for a given graph using Kruskal's algorithms. What is the time complexity of this algorithms ? Explain the reason why Kruskal's algorithm always yields optimal spanning tree. 5



7. (a) Write an algorithm to perform DFS on a graph. Find out the path from A to L using DFS. What

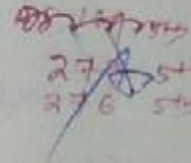
is the complexity of your algorithm? Does this algorithm always yields optimal solution ? 5



(b) What is the basic objective of Robin Crap pattern matching algorithm ? Write the Robin Crap pattern-matching algorithm and explain the use of rolling hash function ? What is the worst case running time of Robin Crap search ? 5

8. (a) How the Greedy paradigm of Algorithm differs from that of DYNAMIC PROGRAMMING ? What is Single Source Shortest Path Problem ? Suggest the greedy algorithm to find shortest paths from the designated vertex start to all of the other vertices in a connected weighted,  $n$  vertex graph. 5
- (b) Define and differentiate between P, NP and NP-complete problems with examples. Explain why input size is an important consideration for algorithm complexity ? 5

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