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MMTE-002

MASTER OF SCIENCE (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE) M. Sc. (MACS)

Term-End Examination

June, 2019

MMTE-002 : DESIGN AND ANALYSIS OF ALGORITHMS

Time : 2 Hours *Maximum Marks : 50*

***Note :** Attempt any four questions from Question Nos. 1 to 5. Q. No. 6 is compulsory.*

1. (a) Sort the following numbers using insertion sort method and showing all the steps used : 5

$$< 35, 22, 11, 73, 26, 82 >$$

(b) Build a max-heap tree on the following list of numbers : 5

15, 19, 10, 7, 17, 16

Show all the stages of your construction.

2. (a) Illustrate the steps of the Rabin-Karp matches algorithm on the text :

4 2 7 6 5 6 3 2 9 7 8 3

for the pattern $p = 65$, when working with $q = 11$. Indicate all the spurious hits. 3

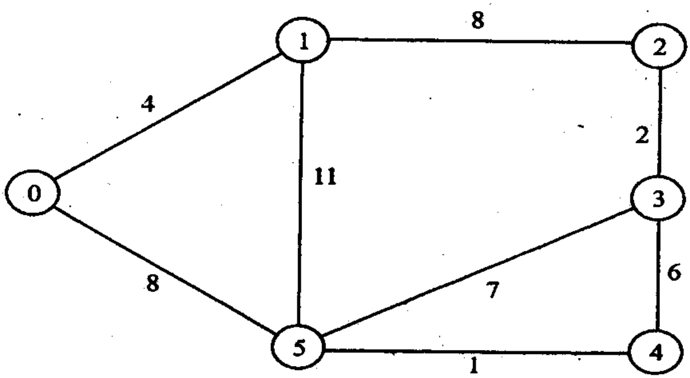
(b) Sort the following numbers using the Merge-Sort algorithm, showing all the steps you have used : 5

75, 22, 11, 34, 86, 49, 56, 28

(c) We are given a sequence of 1000 numbers in increasing order. Ten of these numbers are picked and their positions shuffled. Which of insertion-sort or quick-sort algorithms would be more efficient for putting the sequence in sorted order and why ? 2

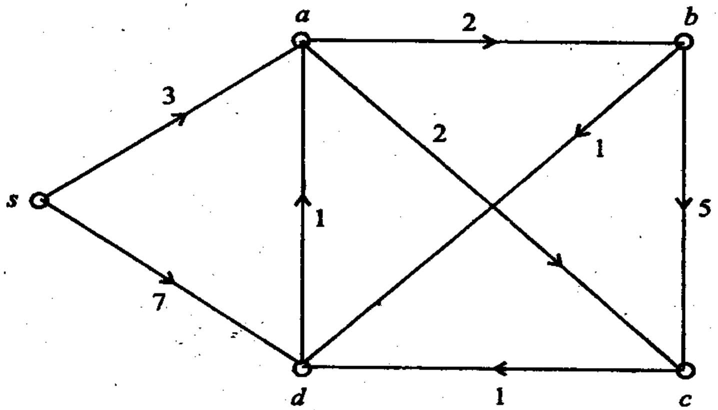
3. (a) Find an optimal parenthesization of a matrix-chain product whose sequence of dimensions is 10, 25, 10, 5, 17. 5

(b) Find the minimum spanning tree for the following graph, using Kruskal's algorithms. Show the steps you have used for doing so. 5



4. (a) Compute the DFT of the polynomial $3 + 2x + x^3$. 5

(b) Apply Dijkstra's algorithm to the graph below. Assume s is the vertex. Show each stage of the execution of the algorithm. 5



5. (a) Consider the implementation of disjoint sets using forests. Assume the union is done by weight, i.e., the root of the tree with lesser nodes points to the root of the tree with more nodes. The following operations are applied on an initial set of elements $\{x_1, x_2, x_3, x_4, x_5\}$: union (x_1, x_2); union (x_1, x_3); union (x_4, x_5); union (x_4, x_1). Show the forest after each operation. 5

(b) Let $a = 352$, $b = -671$. Find s and t such that $as + bt = \gcd(a, b)$. Show the steps you have used for doing so. 5

6. Which of the following statements are true ? Give reasons for your answers in the form of a short proof or a counter-example. 10

(i) $n^2 = O(n^{\log_2 3}), n \in \mathbf{N}$

(ii) A binary search tree on n nodes has height $O(\log_2 n)$.

(iii) The Huffman algorithm is an example of a Greedy algorithm.

(iv) Increasing the capacity of any edge in a network leads to an increase in the maximum flow between the source and sink of the network.

(v) A polynomial $p(x)$ of degree n can be evaluated at a point x_0 in $O(n)$ time.