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MMTE–002

M. SC. (MATHEMATICS WITH APPLICATION IN COMPUTER SCIENCE [M. SC. (MACS)]

Term-End Examination

December, 2024

MMTE–002 : DESIGN AND ANALYSIS OF ALGORITHMS

Time : 2 Hours *Maximum Mark : 50*

Note : *Attempt any* ***four*** *questions from Question Nos.* ***1*** *to* ***5****. Question No.* ***6*** *is compulsory. Use of calculator is not allowed.*

1. (a) Construct the MAXHEAP tree on the following list of numbers : 5

25, 32, 7, 8, 53, 22, 13, 16

(b) Sort the following numbers using Merge sort algorithm : 3

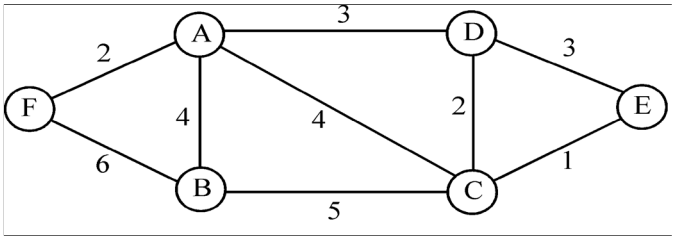
25, 11, 22, 15, 10, 13, 21, 33

(c) Define the big O-notation. Show that $n^2 + 3x$ is $O(n^2)$. 2

2. (a) Sort the following numbers using Radix Sort algorithm : 5

181, 289, 370, 121, 145, 130, 170

(b) Find the minimum spanning tree for the following graph using Prim's algorithm with A as the root vertex : 5

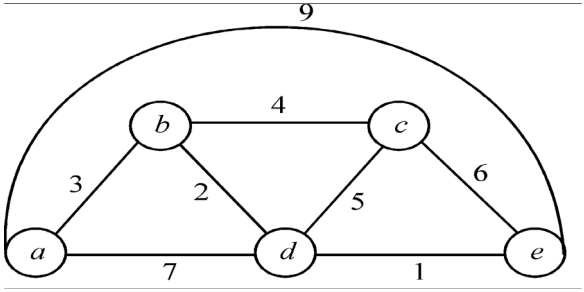


3. (a) Explain with steps, the algorithm for finding longest common subsequence of the following sequences : 5

$$X = \langle B, C, D, C, E, B, C \rangle$$

and $$Y = \langle C, E, D, B, C, B \rangle$$

(b) Apply Dijkstra's algorithm to the following graph to find the single source shortest paths with *a* as the starting vertex : 5



4. (a) Find all the solutions to the equation $15x \equiv 10 \pmod{35}$ using extended Euclidean algorithm. 5

   (b) Construct the binary search tree with the following keys, inserting them in the given order : 5

   10, 8, 19, 6, 9, 14, 42

   Explain the procedure for removing the key 8.

5. (a) Describe the Divide and Conquer algorithm for finding the closest pair of points in a finite subset of the plane. 4

   (b) Compute Discrete Fourier Transform (DFT) of the vector (1, 2, 0, 3). 4

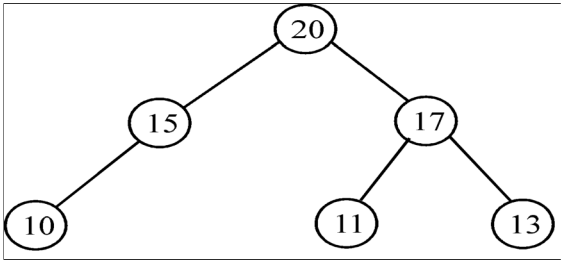
   (c) Rank the following functions by order of growth :

   That is, find an ordering g_1, g_2 and g_3 of the functions satisfying $g_1 = O(g_2)$, $g_2 = O(g_3) : n^2, e^n, n \log \log n$. 2

6. Which of the following statements are true and which are false ? Justify your answers with a short proof or a counter-example whichever is appropriate : 10

   (i) Merge sort algorithm is a stable sorting algorithm.

(ii) The following is an example of max-heap :



(iii) The dynamic programming approach always gives a better solution to any problem in comparison to the Greedy approach.

(iv) If a weighted graph has a unique spanning tree, the weights of the graph are distinct.

(v) $\phi(n)$ is always even for any natural number $n > 2$, where ϕ is the Euler phi-function.

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