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B.Sc. Engg. / HD CSE 4th Semester **26 August 2019 (Afternoon)**

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
Department of Computer Science and Engineering (CSE)

MID SEMESTER EXAMINATION **SUMMER SEMESTER, 2018-2019**

DURATION: 1 Hour 30 Minutes **FULL MARKS: 75**

CSE 4403: Algorithms

Programmable calculators are not allowed. Do not write anything on the question paper.

There are **4 (four)** questions. **Question no 3 & 4 are Mandatory to answer.**

Answer any **1 (one)** from the remaining.

Figures in the right margin indicate marks.

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1. a) ***INSERTION_SORT (A)*** 13

```
for j = 2 to A. length
    key = A[j]
    // insert A[j] into sorted sequence A [1...j - 1]
    i = j – 1
    while i > 0 and A[i] > key
        A [i + 1] = A[i]
        i = i – 1
    A [i + 1] = key
```

By showing proper mathematical steps, find out the running time of the above-mentioned algorithm in the following cases:

i. Input array(A) has 'n' elements in Ascending order.

ii. Input array(A) has 'n' elements in Descending order.

b) Insert the following elements in a Red-Black tree. 12

$$\{25, 15, 20, 18, 10, 16, 29, 19, 27, 17\}$$

Design a sorting algorithm which will show all the elements stored of this tree in Descending order. What will be the time complexity of the process?

2. a) Show that, 'Merge-Sort algorithm requires $O(n)$ auxiliary space to sort an array of size n.' 7

b) Write the steps to develop any Divide-and-Conquer algorithm. Explain those steps in the context of Merge-Sort algorithm. 8

c) Use a recursion tree to determine a good asymptotic upper bound on the recurrence: 10

$$T(n) = 8T\left(\frac{n}{2}\right) + n^2$$

[Mandatory]

3. a) i. $f(n) = O(g(n))$ *and* $g(n) = O(h(n))$. *Thus* $f(n) =$ ___$(h(n))$. (Fill in the blank with justification.) 3×6

ii. If the input data is almost sorted, Merge sort will perform better than Insertion sort. (True or False? Justify.)

iii. Given an unsorted array of size n, '1-D peak finding algorithm' can find the Global-peak in $O(\log(n))$ time. (True or False? Justify.)

iv. Will the following algorithm successfully Build a Max-heap from a given array? Justify your answer.

BUILD_MAX_HEAP(A)

```
A. heap_size = A. length
for i = 1 upto (A. length / 2)
    MAX-HEAPIFY (A, i)
```

v. Binary Search Trees guarantees to find the maximum element of the tree in

O(____) time. (Fill in the blank with justification.)

vi. Determine the average processing time $T(n)$ of the following algorithm:

```
int myTest (int n) {
   if (n <= 0) return 0;
   else {
      return myTest (n - 1);
   }
}
```

b) Design a function which will take a node of a *Binary Search Tree* as input and show all of it's *Ancestors*. The algorithm should be able to produce output even if the node doesn't have any ancestor or the node is not present in the tree. 7

[Mandatory]

4. Lately, Bill Gates is thinking of opening a restaurant! Being one of the smartest guys on the planet, obviously he is planning to digitalize it. Each customer will have a membership card which will have information about him/her along with the transactions made so far. Based on that information, a rating is given to the customers. 25

Whenever a customer enters the restaurant, s/he needs to scan the membership card by which the authority tracks who are present at the moment. A big screen is placed in front of the counter where the information is being shown about the current customer being served, the next customer to be served and the total number of customers present at the moment. While choosing the next customer to be served, the system looks for the highest rated customer present at that moment.

As this is Bill Gate's restaurant, a huge number of customers are expected to come every day! To handle the data, he wants to store it in the best possible way! His employees came up with different solutions to store the information so that the information on the big screen can be shown efficiently. Some of the proposed ways are:

i. Array
ii. Linked list
iii. Heap
iv. Binary Search Tree
v. AVL Tree
vi. Red Black Tree

Provide Arguments about the worst-case time complexity for each of the solutions to perform the required operations and choose the best one. Justify your choice.