ABV- Indian Institute of Engineering Technology & Management Gwalior
Major Examination - Even Semester
(Subject Code: BCCS/ITIT-1201)

Class: BCS/IMG (II Sem)

Subject: Data Structures
Time: 3 hrs

Max. Marks: 50
Date: June 24, 2023

INSTRUCTIONS TO CANDIDATES

1. Attempt **ALL** questions and assume missing data, if any.
2. The **MARKS** for each question are indicated at the beginning of each question.
3. Answer each question beginning on a **FRESH** page of the answer book.
4. No **DOUBT** will be cleared during exam.

Question 1. (5 marks)
Create an AVL tree using the following data entered as a sequential set. Show the balance factors in the resulting tree: 4, 10, 2, 1, 0, -3

Question 2. (5 marks)
For the set of 4, 5, 10, 16, 17, 21 of keys, draw binary search trees of heights 2, 3, 4, 5, and 6.

Question 3. (5 marks)
A binary tree has 10 nodes. The preorder and inorder traversals of the tree are shown below. Draw the tree. *Preorder*: 35, 15, 10, 5, 20, 25, 30, 50, 40, 60; *Inorder*: 5, 10, 15, 20, 25, 30, 35, 40, 50, 60

Question 4. (5 marks)
What would be the contents of queue `Q1` and queue `Q2` after the sample code, written in Algorithm 1, is executed and the following data are entered? The data are 5, 7, 12, 4, 0, 4, 6.

```
Algorithm 1: Sample Code
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1 Q1 = createQueue;
2 Q2 = createQueue;
3 while (not end of file) do
4     read number;
5     enqueue (Q1, number) ;
6     enqueue (Q2, number);
7     while (not empty Q1) do
8       dequeue (Q1, x);
9       enqueue (Q2, x);
10    end while
11 end while
```

Question 5. (5 marks)
Show that the height of an AVL tree constructed using n keys is logarithmic, specifically $\mathcal{O}(logn)$.

Question 6. (5 marks)
An airport is developing a computer simulation of air-traffic control that handles events such as landings and takeoffs. Each event has a time-stamp that denotes the time when the event occurs. The simulation program needs to efficiently perform the following two fundamental operations:

- Insert an event with a given time-stamp (that is, add a future event)
- Extract the event with smallest time-stamp (that is, determine the next event to process)

Which data structure should be used for the above operations? Why?

Question 7. (10 marks)
Consider a hash table of size 8, implemented using linear probing for collision resolution. The hash function used maps keys to indices in the range [0, 7]. Initially, the hash table is empty. Perform a series of $put(k, v)$ operations with the following keys: 4, 12, 20, 28, 36, 44, 52, 60. After inserting all the elements, perform a $remove(k)$ operation for the key 28. Calculate the final state of the hash table after the removal operation and determine the total number of probes required for successful removal.

Question 8. (10 marks)
Write down the pseudo code to build a max heap from a given set of n keys, and prove that the time complexity for building the heap is $\mathcal{O}(n)$.