**HOMEWORK-9**
**Total Points: 62**

1. [12 Points] Insert 1, 2, 3, 4, 5, 6, 7, 9, 8, 10, 11, 13, 12 one by one in a max-heap. Show the max-heap after every insertion.

2. [12 Points] Build a max-heap from the given numbers 1, 2, 3, 4, 5, 6, 7, 9, 8, 10, 11, 13, 12 using an O(n) algorithm. All the numbers are already given to you in an array starting at index 1. Show all intermediate steps.

3. [20 Points] We want to store (key, value) pairs of type “struct pair” in a data structure called priority-queue. The priority-queue supports three operations: insert, find, and delete. The insert operation inserts a (key, value) pair in O(log n) operations. The find operation returns a (key, value) pair corresponding to the largest key. If multiple pairs contain the largest key, find returns the one that was inserted first. The time-complexity of the find operation is O(1). The delete operation deletes a pair that contains the largest key. If multiple pairs contain the largest key, the one that was inserted first is deleted. The time complexity of the delete operation is O(log n). Give a pseudocode for the insert, find, and delete operations. What is the type of node in the priority-queue? The type “struct pair” is as follows.

   ```
   struct pair {
     int key, value;
   };
   ```

4. [6 Points] Create a max-heap containing 15 numbers 1, 2, 3, …, 15 in such a way that the post-order traversal of the max-heap gives us a sorted sequence in increasing order.

5. [4 Points] Give an algorithm to find the minimum element from a max-heap of integers. What is the time complexity of your algorithm?

6. [4 Points] What are the minimum and maximum number of connected components in a graph with n vertices? Justify your answer.

7. [4 Points] What are the minimum and maximum number of edges in a simple undirected graph with n vertices? Justify your answer.