Name: _____ Andrew Id: _____

15-121 Sample Assessment 4

Up to 50 minutes. No calculators, no notes, no books, no computers. Show your work!

1. (5 points) **Binary Search Tree Construction**

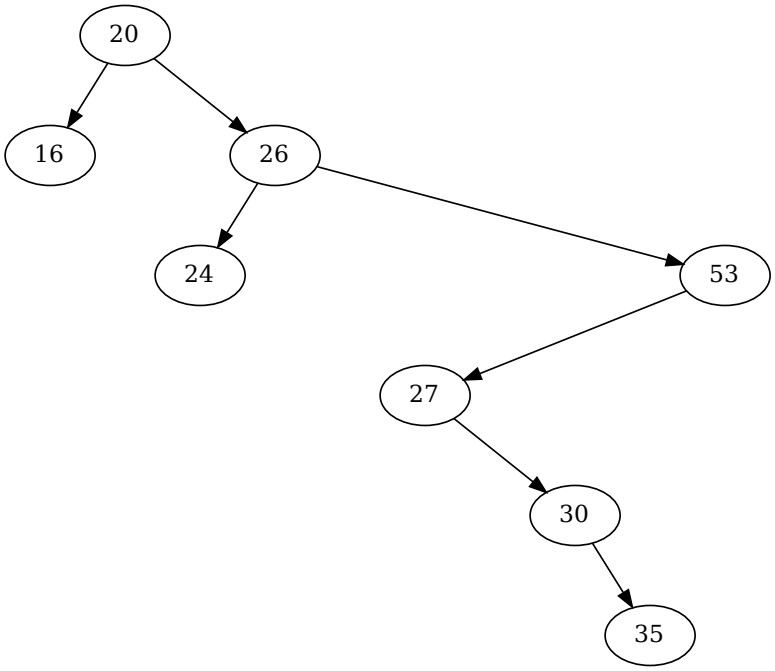
   Imagine you are constructing a binary search tree of integers, and the following integers are added in the following order:

   ```
   16, 67, 85, 55, 11, 43, 71, 87, 3, 44
   ```

   Draw the resulting binary search tree.

2. (4 points) **Binary Search Tree Removal**

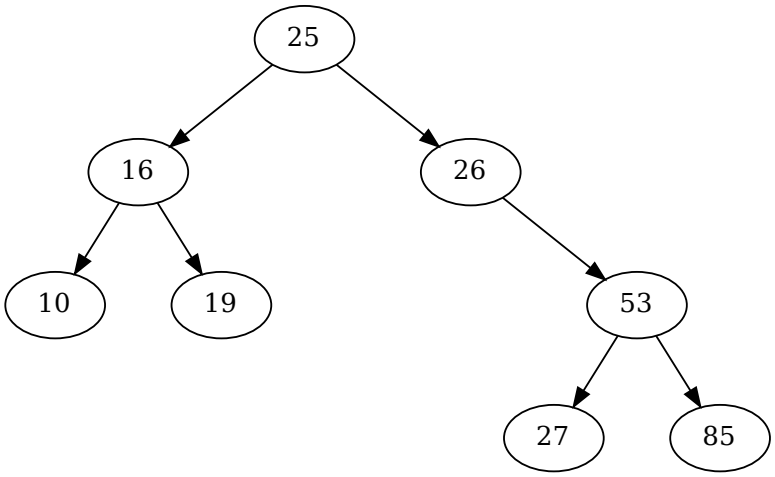
Consider the following binary search tree:



Assuming you are using the in-order successor removal technique discussed in class, draw the state of the tree from after 26 has been removed from it.

3. **Binary Search Tree Traversal**

Consider the following tree:



(a) (3 points) Assuming the tree is traversed *in-order* and the nodes printed, what is the resulting sequence? (Assume that left is followed before right.)

(b) (3 points) Assuming the tree is traversed *pre-order* and the nodes printed, what is the resulting sequence? (Assume that left is followed before right.)

(c) (3 points) Assuming the tree is traversed *post-order* and the nodes printed, what is the resulting sequence? (Assume that left is followed before right.)

4. (10 points) **Binary Search Tree Free Response**

Consider the following code for a binary search tree of integers. (There is nothing special here, the code is provided just in case you forgot how a binary tree is built.)

```
public class BinarySearchTree {
    private TreeNode root;

    private class TreeNode {
        private int data;
        private TreeNode left;
        private TreeNode right;

        private TreeNode(int data) {
            this.data = data;
        }
    }

    public BinarySearchTree() {
        this.root = null;
    }

    public void add(int item) {
        this.root = add(root, item);
    }

    private TreeNode add(TreeNode node, int item) {
        if (node == null) {
            return new TreeNode(item);
        }

        if (item < node.data) {
            node.left = add(node.left, item);
        } else {
            node.right = add(node.right, item);
        }

        return node;
    }
}
```

The rest of the question is on the next page.

Write the code for a new method in this class called `largestEven()`, which returns the largest, positive, even number in the tree. If there are no positive, even numbers in the tree, then return `-1`. You may write additional helper methods, but you may not modify existing methods or add any new instance variables to `BinarySearchTree`. You also may not use any other data structures, such as an array or an `ArrayList`.

5. **Binary Heap**

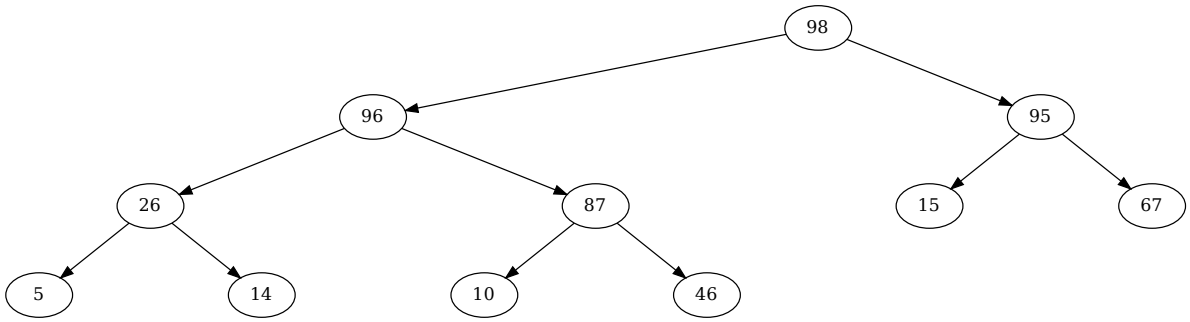
Consider the following array representation of a binary heap:

56	55	39	52	50	3	9	2	49	5	32			

(a) (3 points) Draw the heap represented by this array.

(b) (3 points) Give the array after adding 45 to the heap. Write your final answer in the boxes below.

6. (a) (3 points) Consider the following heap:



Write this heap in array form, assuming that the root is stored in location 0. Write your final answer in the boxes below.

(b) (3 points) Building on your answer from part a, give the array after calling `removeMax()` on the heap. Write your final answer in the boxes below.
