Student Name: ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯ Student ID # ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯

UOSA Statement of Academic Integrity

On my honor I affirm that I have neither given nor received inappropriate aid in the completion of this exercise.

Signature: ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯ Date: ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯

Notes Regarding this Examination

Open Book(s) You may consult any printed textbooks in your immediate possession during the course of this examination.

Open Notes You may consult any printed notes in your immediate possession during the course of this examination.

No Electronic Devices Permitted You may not use any electronic devices during the course of this examination, including but not limited to calculators, computers, and cellular phones. All electronic devices in the student's possession must be turned off and placed out of sight (for example, in the student's own pocket or backpack) for the duration of the examination.

Violations Copying another's work, or possession of electronic computing or communication devices in the testing area, is cheating and grounds for penalties in accordance with school policies.

Question 1: Combining Features (25 points)

A. Explain one advantage of balanced binary search trees over arrays.

B. Using the concept of Big O, explain one advantage of balanced binary search trees over vectors.

C. Using the concept of Big O, explain one advantage of balanced binary search trees over linked lists.

Question 2: Binary Search Trees (10 points)

Explain how many comparisons will be carried out in searching for the given keys in the following binary search tree.
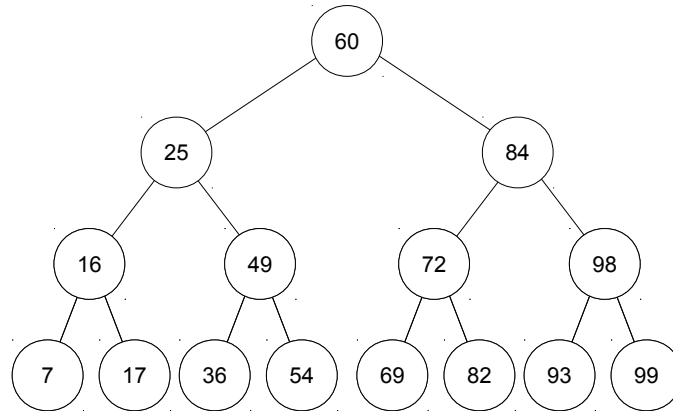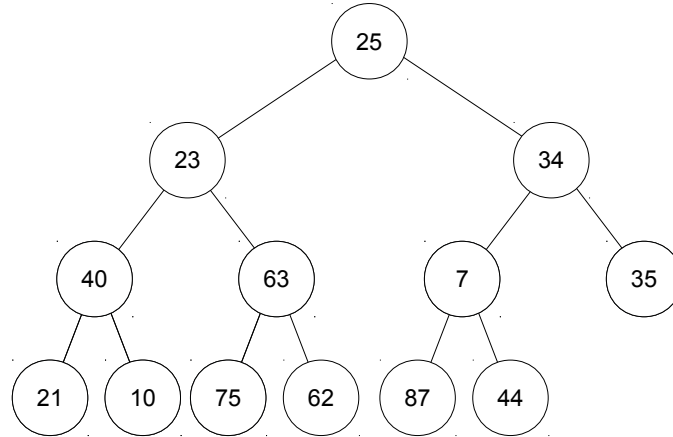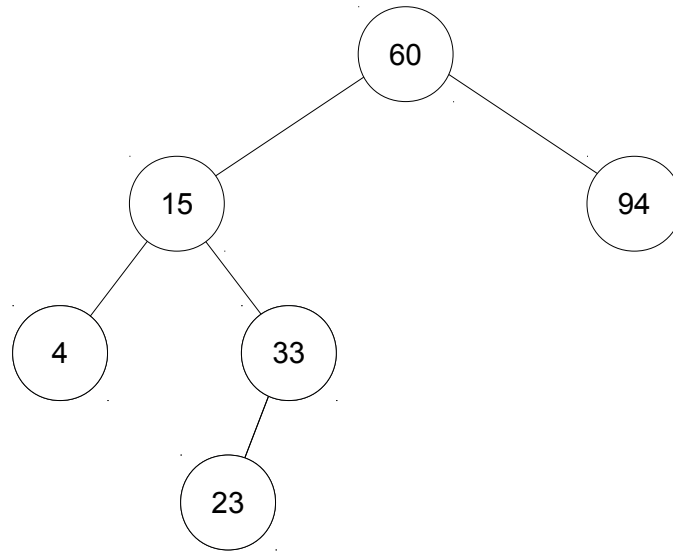

A. Key: 54

B. Key: 8

Question 3: Self-Modifying Trees (15 points)

A. Show the result of performing a zig operation on the tree rooted at the key "34" on the following binary tree.

```
                        25
                   /          \
                23              34
              /    \          /    \
            40      63       7      35
           /  \    /  \     /  \
          21  10  75  62   87  44
```

B. Explain how applying a zigzag operation on the following unbalanced binary tree can balance the tree. Show your work.

Question 4:   AVL Trees (30 points)

A. Explain the result of inserting an item with the key "62" in the following AVL tree. Show your work.
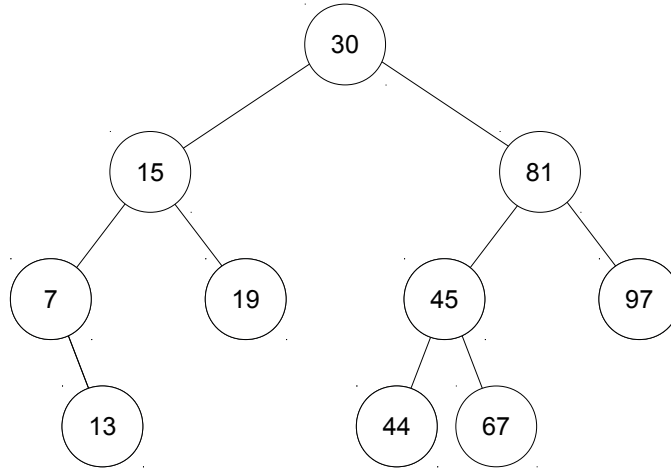
B. Given an AVL tree with n nodes, explain the Big O running time of removing an item with a given key from the tree in the "best case" (with the fewest operations). Be sure to explain when the best case would happen.

C. Given an AVL tree with n nodes, explain the Big O running time of removing an item with a given key from the tree in the "worst case" (with the most operations). Be sure to explain when the worst case would happen.

Question 5: 2-3 Tree and Binary Trees (5 points)

2-3 trees have the property that they always have all of their leaves at the same depth regardless of the number of items present in the tree. Explain why this is property is possible for 2-3 trees but not for binary trees.

Question 6: Heaps (20 points)

A. Show the set of steps required to add the key "88" to the following maximum heap.
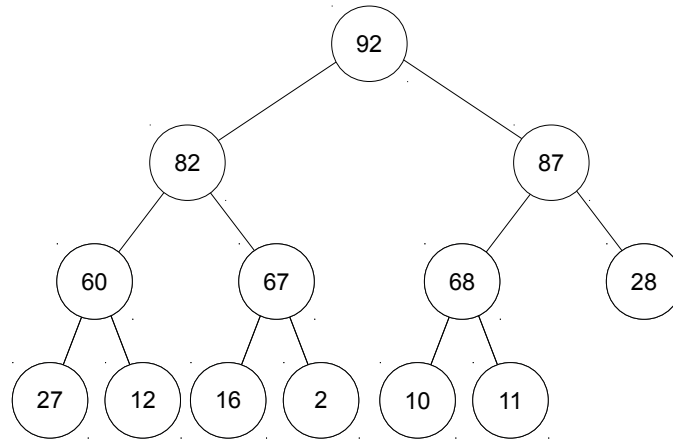
B. Show the set of steps required to remove from the following maximum heap.