CSCI 3333 Practice Midterm #1

- Do not start until instructed to do so.
- Write your UTRGV ID only in the space provided at the top of this page.
- The midterm is closed - no books, notes, computers, cell phones, calculators, etc.
- The time allotted for the exam is 70 minutes.
- There are 7 questions worth 28 points total; each problem is worth 4 points.
- These are not the actual midterm questions.

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**Problem 1.** Complete the following implementation of a function that returns the number of elements in a BST (containing strings) that come lexicographically after s.

```cpp
int after(Node* root, string s) {
    if (root->s < s)
        return after(root->_____ , s);
    int lc = after(root->left, _____ );
    int rc = after(root->right, _____ );
    if (root->s _____ s)
        return lc + rc + _____ ;
    return lc + rc;
}
```

**Problem 2.** Determine the truth of the following statements about binary trees with $n$ nodes.

Every binary tree is a BST.  
□ True  □ False

A binary tree can have height $[\log_2(n)]$.  
□ True  □ False

Inserting into a BST takes $\Theta(\log(n))$ best-case time.  
□ True  □ False

In a BST, the node with the smallest value is always a leaf.  
□ True  □ False
**Problem 3.** Determine the truth of the following statements about AVL trees.

Every AVL tree is balanced. □ True □ False

The *erase* operation on an AVL tree with *n* nodes has $\Theta(\log(n))$ worst-case running time. □ True □ False

The minimum number of rotations done in an AVL tree *insert* is 1. □ True □ False

The minimum number of nodes in an AVL tree of height 5 is 20. □ True □ False

**Problem 4.** Fill in the blanks with answers based on the AVL tree in Figure 1.

If *insert*(22) were called, the right child of ________ would change to ________ during the first rotation.

If *insert*(2) were called, ________ rotations would occur during the call.

If *insert* was called 4 times, at least ________ rotations would occur during the calls.

If *insert* was called twice, up to ________ rotations would occur during the calls.

![AVL tree for Problem 4](image)

**Figure 1:** The AVL tree for Problem 4.
Problem 5. Determine the truth of the following statements about the running times of linear probing hash tables with load factor $\alpha$.

If $\alpha > 1/2$, then a collision has occurred. □ True □ False

The worst-case running time of \texttt{insert} is $\Theta(\alpha)$. □ True □ False

The best-case running time of \texttt{search} is $\Theta(1/(1 - \alpha))$. □ True □ False

The worst-case running time of \texttt{search} is $\Theta(1/(1 - \alpha))$. □ True □ False

Problem 6. Suppose you’re given a class \texttt{HashTable} implementing a chaining hash table and containing the following instance variables:

- An array $A$ containing $\text{list<int>}$s.
- A capacity variable storing the length of $A$.

Note: there is no instance variable that stores how many elements are in the table.

Write a method that returns the load factor of the hash table and has the following prototype:

```
int HashTable :: load_factor()
```

Give the worst-case and best-case running time of this method in terms of $n$ (the number of elements in the table) and $L$ (the length of $A$). Assume that the worst-case running time of \texttt{list::size} is $O(1)$.
Problem 7. Suppose you’re given a class `Heap` implementing a min-heap and containing the following instance variables:

- An array `A` containing floats.
- A `capacity` variable storing the length of `A`.
- A `count` variable storing the number of elements in the heap.

Write a method that returns the largest element in the heap and has the following prototype:

```cpp
float Heap :: max()
```

Give the worst-case and best-case running times of this method in terms of `n` (the number of elements in the heap).