Name: ______________________________________
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CSE 373 Sample Midterm #1

(closed book, closed notes, calculators o.k.)

Instructions Read the directions for each question carefully before answering. We may give partial credit based on the work you **write down**, so if time permits, show your work! Use only the data structures and algorithms we have discussed in class or which were mentioned in the book so far.

Note: For questions where you are drawing pictures, please circle your final answer for any credit. There is one extra page at the end of the exam that you may use for extra space on any problem. If you detach this page it must still be turned in with your exam when you leave.

Advice You have 50 minutes, **do the easy questions first**, and work quickly!

1. (16 pts) Big-Oh and Run Time Analysis:

a. (10 points total) Describe the running time of the following pseudocode in Big-Oh notation in terms of the variable `n`. Assume all variables used have been declared. ***Show your work for partial credit***.

```
int foo(int k) {
      int cost;
      for (int i = 0; i < k; ++i)
            cost = cost + (i * k);
      return cost;
}

I. answ = foo(n);

II.   int sum;
      for (int i = 0; i < n; ++i)
      {
            if (n < 1000)
                  sum++
            else
                  sum += foo(n);
      }

III.  for (int i = 0; i < n + 100; ++i)
      {
            for (int j = 0; j < i * n ; ++j)
            {
                  sum = sum + j;
            }

            for (int k = 0; k < n + n + n; ++k)
            {
                  c[k] = c[k] + sum;
            }
      }

IV.   for (int j = 4; j < n; j=j+2) {
            val = 0;
            for (int i = 0; i < j; ++i)
            {
                  val = val + i * j;
                  for (int k = 0; k < n; ++k)
                  {
                        val++;
                  }
            }
      }

V.    for (int i = 0; i < n * 1000; ++i)
      {
            sum = (sum * sum)/(n * i);
            for (int j = 0; j < i; ++j)
            {
                  sum += j * i;
            }
      }
```

1. (cont.) Big-Oh and Run Time Analysis

b. (6 pts) Consider the following function:

```
int mystery(int n)
{
     int answer;
     if (n > 0)
     {
          answer =(mystery(n-2)+3*mystery(n/2) + 5);
          return answer;
     }
     else
          return 1;
}
```

Write down the complete recurrence relation, T(n), for the running time of `mystery(n).` Be sure you include a base case T(0). **You do not have to actually solve this relation, just write it down.**

2. (9 points) Trees – (3 points each)

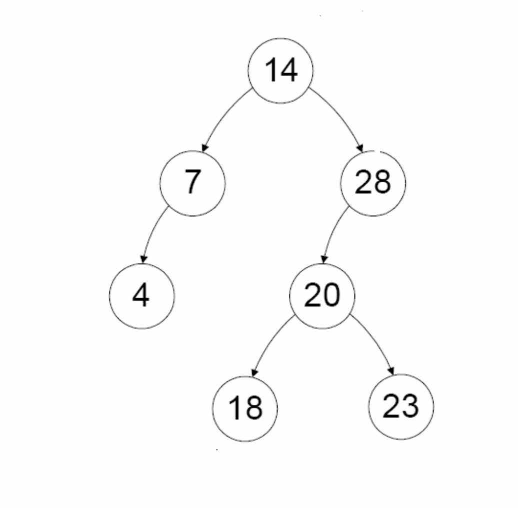
a) What is the minimum and maximum number of nodes in a *complete* binary tree of height h?

b) What is the minimum and maximum number of nodes in a *perfect* binary tree of height h?

c) What is the AVL balance property?

3. (20 pts)

a.) (10 pts) Mark the height for each node of the tree below.



b.) (10 pts) Also, circle **yes** or **no** to indicate whether the tree above might represent each of the following data structures. If you circle **no,** give **one specific reason** why the tree could **not** be that data structure.

- AVL tree `yes no`

- Splay tree `yes no`

- Binary search tree `yes no`

- Binary tree `yes no`

4. (16 pts) Running Time Analysis

Give an O-bound on the *worst case* running time for each of the following in terms of *n*. **No explanation is required**, but an explanation may help for partial credit. Assume that all keys are distinct.

(a) insert in a *Binary Search Tree* of size *n*

(a) insert in an *AVL tree* of size *n*

(b) insert in a *splay tree* of size *n*

5. (20 pts)

a. (8 pts) Draw the AVL tree that results from inserting the keys 4, 10, 3, 8, 5, 6, 25 in that order into an initially empty AVL tree. You are only required to show the final tree, although if you draw intermediate trees, ***please circle your final result for ANY credit.***

b. (2 pts) Give a *preorder* traversal of your final AVL tree you created in part a.

c. (8 pts) Draw the Splay tree that results from inserting the keys 4, 9, 3, 7, 5, 6 in that order into an initially empty Splay tree. You are only required to show the final tree, although if you draw intermediate trees, ***please circle your final result for ANY credit.*** You may continue your answer to this problem on the next page if needed.

d. (2 pts) Give a *postorder* traversal of your final Splay tree you created in part c.

6. Binary search trees (9 pts)

a) (5 points) Insert the following values into a binary search tree in this order: 5, 9, 2, 1, 4, 8, 3, 7, 10. You are only required to show the final tree, although if you draw intermediate trees, ***please circle your final result for ANY credit*.**

b) (4 points) Show the tree you created above after deleting the value 2 using one of the (two) methods described in lecture. (do not use lazy deletion)

7. More Big-O – True or false (10 pts, 2 pts each)

- $3000N + 36 = O(N)$
- $N \log N + N/5 = O(N^2)$
- $N \log N + N^2 = O(N \log N)$
- $N^2 \log N + N^2 = O(N^2)$
- $N^{1/2} + \log N = O(\log N)$