CS 225 **Data Structures and Problem Solving** Test 3
Name: Maximum Points: 83

Important: This is an open book test. You can use any books, notes, or paper. *Do not log into the computer during the test.* Any calculations and rough work can be done on the back side of the test pages. If there is a syntax error in any program segment, just write it down and you will get full credit for the problem.

1. [10 pt] Write a function to concatenate two linked lists of characters.

2. [10 pt] Consider an array-based implementation of a linked list. `#define`.

```
#define N 1000
typedef struct
{
    int nelements;                /* Number of elements in the list */
    list_element_type data[N];
} list_type;

list_type list;
```

Write a function to delete ith element from the list by moving all the elements following the ith element one step down. You can use a `for`-loop to achieve the same. Also give the O-notation for the average deletion time.

3. [10 pts] Write a function to recursively find the length of a linked list, L, where the length of L is defined to be the number of nodes in L.

4. [10 pts] Suppose you are given a pointer to a node `N` in a one-way linked list, `L`, and suppose you know `N` is neither `NULL` nor a pointer to the last node of `L`. How could you delete node `N` from list `L` without being able to access the predecessor node on `L` pointing to `N`?

5. [4 pt] Draw a binary search tree with the following nodes (received in that order).

T H E G R A S C O M N D I V F X Y L

(a) [2 pt] List the ancestors of the node N.

(b) [2 pt] List the descendants of the node I.

(c) [2 pt] How many nodes in the tree have no ancestors?

(d) [2 pt] How many nodes in the tree have no descendants?

(e) [2 pt] List the internal nodes in your tree.

(f) [2 pt] List the leaf nodes in your tree.

(g) [4 pt] Show the tree after deleting the node labeled `E`.

(h) [2 pt] Write the order in which the nodes will be visited using pre-order traversal.

(i) [2 pt] Write the order in which the nodes will be visited using in-order traversal.

(j) [2 pt] Write the order in which the nodes will be visited using post-order traversal.

6. [6 pt] How many nodes are possible in a binary tree with n levels? How many of these are internal nodes? How many of these are leaves?

7. [6 pt] Write a macro in C to compute the volume of a sphere. The macro should take the radius of the sphere as an argument and output the volume. Define π using a constant macro definition. (Your answer will have two lines – one for the definition of macro and one for the definition of π). The volume of the sphere is given by

$$\frac{4}{3}\pi r^3$$

8. [5 pt] Write a program to print the command line arguments given to it – one argument on each line.