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 i-th element from the list by moving all the elements following the i-th 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).

\[ THEGRASCOMNDIVFXYL \]

(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 $\pi$ using a constant macro definition. (Your answer will have two lines – one for the definition of macro and one for the definition of $\pi$). 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.