Answer all questions in a separate document and email that document to abrahamsonk@ecu.edu as an attachment. You can attach graphics files for hand-written answers, but be sure that they are readable. Make all file names begin with your last name, followed by your first name. Write your name in your answer file. Make your answers clear, concise and precise.

For the multiple-choice questions (marked [MC]), just write the letter of your choice in your solution page.

Read each question twice. Be sure that you are answering the question that is asked. Check your answers.

1. [MC] If \( x = \log_2(130) \), then
   (a) \( 7 < x < 8 \)
   (b) \( 8 < x < 16 \)
   (c) \( 16 < x < 32 \)
   (d) \( 32 < x < 65 \)
   (e) \( 65 < x < 130 \)

2. [MC] Only one of the following is true. Which one?
   (a) \( n^2 \) is \( \Theta(n) \)
   (b) \( n^3 \) is \( \Theta(n^2 + 10n) \)
   (c) \( n^2 + 5n \) is \( \Theta(n^2) \)
   (d) \( n \) is \( \Theta(\log(n)) \).

3. [MC] How long does it take, in the worst case, to insert a value into a height-balanced binary search tree that has \( n \) values in it?
   (a) \( \Theta(1) \)
   (b) \( \Theta(\log_2(n)) \)
   (c) \( \Theta(n) \)
   (d) \( \Theta(n \log_2(n)) \)
   (e) \( \Theta(n^2) \)
4. [MC] How long does it take, on the average, to look up a value in a hash table that uses chaining to resolve collisions, when the hash table has $n$ values in it.
   (a) $\Theta(1)$
   (b) $\Theta(\log_2(n))$
   (c) $\Theta(n)$
   (d) $\Theta(n \log_2(n))$
   (e) $\Theta(n^2)$

5. [MC] How long does it take to add a value to the end of a linked list whose length is $n$?
   (a) $\Theta(1)$
   (b) $\Theta(\log_2(n))$
   (c) $\Theta(n)$
   (d) $\Theta(n \log_2(n))$
   (e) $\Theta(n^2)$

6. [MC] Suppose that you start with an empty linked list and successively insert $n$ values, adding each value to the end of the linked list. How much time does it take, in the worst case, to do all of those insertions? Give the cumulative time for all insertions, not just the time for one of them.
   (a) $\Theta(1)$
   (b) $\Theta(\log_2(n))$
   (c) $\Theta(n)$
   (d) $\Theta(n \log_2(n))$
   (e) $\Theta(n^2)$
Consider the following binary search tree, $T_0$.

![Binary Search Tree](image)

7. Show the tree that you get if you insert 37 into tree $T_0$, using the algorithm that performs rotations to keep the tree height-balanced. Circle your answer tree.

Check that your result tree is a binary search tree and is height-balanced. You will receive no credit if your answer tree is not a binary search tree or if it is not height-balanced.

8. Show the tree that you get if you insert 29 into tree $T_0$, using the algorithm that performs rotations to keep the tree height-balanced. Start with the original tree $T_0$, which does not contain 37. Circle your answer tree.

Check that your result tree is a binary search tree and is height-balanced. You will receive no credit if your answer tree is not a binary search tree or if it is not height-balanced.
Question 9 refers to the following type definition, which defines a type of nodes in binary trees.

```cpp
struct Node
{
    int    item;
    Node*  left;
    Node*  right;

    Node(int i, Node* L, Node* R)
    {
        item = i;
        left = L;
        right = R;
    }
};
```

9. Write a C++ definition of function sameTree(A, B), which returns true if trees A and B are the same.

(Two empty trees are the same. Nonempty trees A and B are the same if they have the same item in their roots, the left subtree of A is the same as the left subtree of B and the right subtree of A is the same as the right subtree of B. It is not necessary for A and B to be the same pointer for A and B to be the same tree.)

A heading is given.

```cpp
bool sameTree(const Node* A, const Node* B)
```