Instructions: Clearly write your name on this sheet. Answer each problem in the space provided. If you need extra space, clearly write your name and the problem number on an extra sheet of paper, write “on extra sheet” in the answer space on the exam paper, and turn in the extra sheet with your exam.

Write legibly. If the person grading the homework cannot read something, s/he will simply assume that you meant the illegible portion as a note to yourself and they will ignore it. If you lose points because part of your answer could not be read, you will not be given the opportunity to explain what it says.

Be clear and concise. The answers to most questions should be short. If you find yourself writing an excessively long response, you may want to think more carefully about the question. Long rambling answers generally get fewer points than short ones do because there are more opportunities to mark something wrong. **The purpose of short-answer questions is to determine if you know what you are talking about, a few key words can usually communicate this.**

You may not ask questions of other students, look at another student’s responses, use a textbook, use a phone or calculator, or seek any other form of assistance. In summary: do not cheat. Persons caught cheating will be subject to disciplinary action.

Each question is marked with a number of points. There are 50 points total.

If something isn’t clear, ask!

Good luck

1. (0 pts) **Name:** ________________________________

2. (0 pts) **GL Login:** ________________________________
3. (10 pts) **Recurrences**: Solve the recurrence for binary search: \( T(n) = T(n/2) + 1. \)
4. (15 pts) **Trees:** Perform the following traversals of the tree in Figure 1.

- **pre-order:**
- **post-order:**
- **in-order:**
- **level-order:**

List the ancestors of 55:

List the children of 80:

List the siblings of 80:

List the parents of 40?

What is the height of 75?

What is the depth of 90?

What is the size of the subtree rooted at 60?
5. (10 pts) **Binary Search Trees:** Perform the following operations on an initially empty Binary Search Tree:

- `insert(50)`, `insert(25)`, `insert(10)`, `insert(5)`, `remove(25)`, `insert(75)`, `insert(60)`, `insert(80)`, `remove(50)`, `remove(5)`. 
6. (15 pts) **AVL Trees**: Remove 15 from the tree in Figure 2.