Computer Science 477/677 Spring 2001 Final Examination, May 7, 2001

Name:_____

No books, notes, scratch paper, or calculators. Use pen or pencil, any color. Use the rest of this page and the backs of the pages for scratch paper. If you need more scratch paper, it will be provided.

The entire examination is 200 points.

1. Fill in the blanks. [5 points each blank.]

   (a) **Binary search** on an array of size n takes _____ time. (Give an answer using asymptotic notation.)

   (b) **Linear search** on a linked list of size n takes _____ time. (Give an answer using asymptotic notation.)

   (c) **Depth first search** normally uses a _____ to hold unfulfilled obligations, while _____ **first search** normally uses a _____ instead.

   (d) If a binary tree has height h, then it cannot have more than _____ leaves. (Exact answer, please).

   (e) An acyclic graph has 10 nodes and 4 components. It thus must have exactly _____ edges. (Exact answer, please).

   (f) If a directed acyclic graph has 6 nodes, then it cannot have more than _____ edges. (Exact answer, please).

   (g) If n distinct items are inserted into a binary search tree in random order, the expected height of the tree will be _____. (Give an answer using asymptotic notation.)

2. List the names of three kinds of **priority queue** we have discussed this semester. [15 points.]

3. List the names of three kinds of **search structures** we have discussed this semester. [15 points.]

4. Solve each recurrence. Express the answer in asymptotic notation, using O, Ω, or Θ, whichever is most appropriate. [10 points each.]

   (a) $f(n) = 2f(\frac{n}{2}) + 1$

   (b) $f(n) \leq 2f(\frac{n}{2}) + 2n + 1$

   (c) $f(n) = f(\sqrt{n}) + 1$

5. The following algorithm determines whether a number **n** is prime. Write its time complexity, using asymptotic notation. Assume that each arithmetic operation takes $O(1)$ time. [15 points.]

```
i = 2;
while (i*i <= n and n%i > 0)
 i = i+1;
if (i*i > n) return 1;
else return 0;
```

6. Classify each of the following algorithms either a greedy algorithm, a dynamic programming algorithm, or as a divide-and-conquer algorithm. [15 points]

   - Quicksort
   - Kruskal's Algorithm
   - The Bellman-Ford Algorithm

7. Explain the difference between **open hashing** and **chaining**. Be sure to include a discussion of **probe sequences**. [15 points.]

8. On one or more pieces of blank paper, write pseudocode for Quicksort. Assume that the items are in an array. Use the stapler at the front of the room to staple those pages to your exam, but write your name on each page, just to make sure.

   There are several versions of Quicksort. You will get full credit for correctly giving any one of them. [25 points.]

9. On one or more pieces of blank paper, write pseudocode for Dijkstra's algorithm for solving the single source minimal path problem for a weighted directed graph with no negative weight edges. Use the stapler at the front of the room to staple those pages to your exam, but write your name on each page, just to make sure.

   You do not have to write pseudocode for the data structures that will be needed. Just assume that you can execute the operators. For example, if you are using a stack, you can just write "push" and forget about writing the pseudocode needed to implement push. [25 points.]