Graduate Comprehensive Exam
Data Structures and Algorithms
Spring 2000

Answer all questions on the exam. You may use the back for additional space. Total: 100 points. Good Luck.

1. (15 pts) Using the big-O notation, estimate the running time of `proc(N)` in terms of `N` which is a positive integer. Explain your answer.

```
void proc(int x)
  {
    int i;

    if (x >= 1)
       {
          proc(x/2);
          for (i = 0; i < x; i++)  // loop x times
             /* constant-time operation */
       }
  }
```

2. (15 pts) Use BNF (Backus-Naur Form) to specify floating-point constants such as 1.5, -0.5, -.7, .7 (you may exclude considering those with exponents like 1e5).

3. (50 pts) C, C++, Ada, or pseudocode with **sufficient** details can be used for this question:

   (a) Specify the language you are using.

   (b) Give a collection of type declarations for a binary tree.

   (c) Using your declarations from (b), give a function for calculating the height of a given tree. For this question you may assume that an empty tree (one containing no nodes) has height 0, and a tree containing a single node has height 1.

   (d) Using you declarations from (b), give a function for determining the total number of nodes in a tree.

4. (20 pts) On the number of comparisons of array elements in Quicksort:
   (a) Describe when the best case occurs.
   (b) Explain the run-time complexity for the best case and state it in big-O.
   (c) Describe when the worst case occurs.
   (d) Explain the run-time complexity for the worst case and state it in big-O.