Student ID: _____

Graduate Comprehensive Exam: Data Structures and Algorithms (Fall 2003)

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

1. (10 points) Demonstrate the insertion of the keys: 6,34,12,12,54,18,17,10,11,44 into a hash table with collisions resolved by chaining. Let the table have 9 slots, and let the hash function be `hash(key) = key mod 9`.

2. (20 points) Show the asymptotic bounds (using big-O notation) for the following recurrences and explain your answer:

   (a) $T(n) = T(n-1) + n$, T(1) = 1

   (b) $T(n) = 2T(n/2) + n^2$, T(1) = 1

3. (20 points) Dijkstra algorithm is known to work only with graphs containing only positive-weight edges. Give a simple example of a directed graph with negative-weight edges for which Dijkstra algorithm produces incorrect answers. To demonstrate the answer is incorrect, it is expected that you explain how the answer was computed.

For Questions 4 and 5, you may use pseudocode or a high-level programming language (like C, C++, or Ada) to *write* a function.

4. (20 points) Consider a binary tree of integers

   (a) using pointers, define how you represent a tree and a tree node.

   (b) implement the function `evenCount(tree)`, which returns the number of even integers in the tree.

5. (30 points) Consider a heap of integers

   (a) state the properties of a heap.

   (b) when a new integer is inserted into a heap, where is it inserted?

   (c) using an array, define how you represent a heap.

   (d) assume an integer is inserted into `heap` at array index `loc`, implement the procedure `heapify(heap, loc)`, which rearranges the integers in `heap` to satisfy the properties stated above.