Graduate Comprehensive Exam: Data Structures and Algorithms (Fall 2004)

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

1. **(25 points)** Consider inserting G,M,T,D,P,U,V,Z,W in these order into an AVL tree. Draw the structure of an AVL tree after the insertion of each character element.

2. **(15 points)** Using the big-O notation, give the WORST case scenario for each algorithm below (you only need to provide order, no proof is necessary). Make sure that you indicate what your "variable" is. For instance if you say the order of an algorithm is O(n) you have to say what "n" represents.

   (a) Sorting Algorithms
   - Merge Sort
   - Quick Sort
   - Insertion Sort

   (b) Trees and Graphs
   - Search in a Binary Search Tree
   - Search in a Balanced Binary Search Tree
   - Depth First Search in a Dense Graph
   - Depth First Search in a Sparse Graph

3. **(10 points)** Describe TWO mechanisms, and demonstrate with an exmaple, used for collision resolution in Hash Tables.

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

4. **(25 points)** A *palindrome* is a word that reads the same forward and backward. For example, "1991", "level", "BOB", and "ABBA". Write a function `isPal` that returns true if a character string (parameter) is a palindrome and false otherwise:

   (a) iteratively (no recursion)
   (b) recursively (with recursion)

5. **(25 points)** A heap can be represented by an array. Assuming a heap with integer values.

   (a) given a node as a parameter, write different functions that return the parent, left child, and right child nodes.
   (b) describe when a parent and two children are not in proper order and a promotion operation is needed.
   (c) use the functions in (a) to detect the need and, if necessary, perform the "promotion" operation.