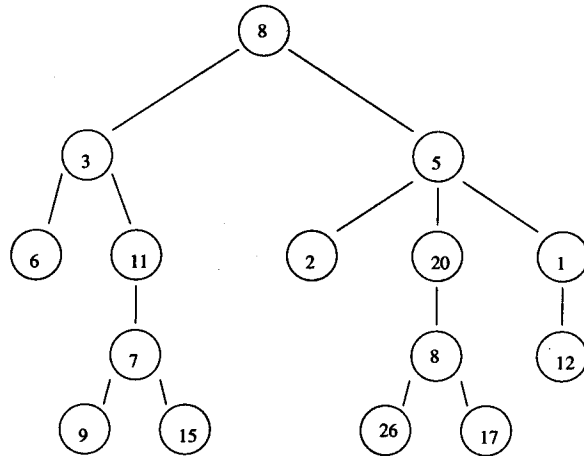


**Homework 3 – Due via Electronic Turnin Tuesday, February  
24 at 8:00 pm  
133 points possible**

**NOTE - Homework must be turned in as either a postscript or pdf file.**

1. (10 pts) Write a function to perform a linear search for a given key in an array of sorted items. What are the best case, worst case, and average case running times for your algorithm?
2. (10 pts) Write a function to perform a binary search for a given key in an array of sorted items. What are the best case, worst case, and average case running times for your algorithm?
3. (7 pts) Write the Big-Oh notation for the following functions:
  - a.  $4n^2 + 2n + 5$
  - b.  $2n(3n^2 + 5n(6n + 4))$
  - c.  $n^2 + 5$
  - d.  $3n^2 + 6n$
  - e.  $(n + 7)(n - 2)$
  - f.  $100n + 12$
  - g.  $7n + 2n^2$
4. (5 pts) Let A and B be two programs that perform the same task. Let  $t_A(n)$  and  $t_B(n)$ , respectively, denote their running times. Find the range of n values for which program A runs faster than program B. Specify the Big Oh notation for each function.  
 $t_A(n) = 2^n$                        $t_B(n) = 100n$
5. (5 pts) Is  $2^{n+1} = O(2^n)$ ? (Show why or why not?)
6. (21 pts) Given the following numbers, 160, 8, 34, 110, 19, 212, 22, 55, 389, 48, 3, show the array at each pass or phase for each of the specified sorting techniques. Give the Big-Oh notation running time of each sorting algorithm.
  - a. Insertion Sort
  - b. Selection Sort
  - c. Bubble Sort
  - d. Shell sort using an increment sequence of  $h_k = N/2$  and  $h_{k+1} = h_k / 2$
  - e. Radix Sort
  - f. Merge Sort
  - g. Quick Sort using the first element of each array/subarray as the pivot



7. (16 pts) Answer the following questions about the tree shown above:
- Which nodes are leaves?
  - Which node is the root?
  - What is the parent of node 5?
  - Which node are children of node 5?
  - Which nodes are ancestors of node 5?
  - Which nodes are descendants of node 11?
  - What is the depth of node 5?
  - What is the height of node 5?
8. (3 pts) List the nodes of the above tree in preorder traversal.
9. (3 pts) List the nodes of the above tree in inorder traversal.
10. (3 pts) List the nodes of the above tree in postorder traversal.
11. (10 pts) Show that the maximum number of nodes in a binary search tree of height  $h$  is  $(2^{h+1} - 1)$ . A binary tree of height  $h$  with the maximum number of nodes is called a full binary tree.
12. (10 pts) A full node in a binary tree is a node with two children. Prove that the number of full nodes plus one is equal to the number of leaves in a full binary tree.
13. (10 pts) Draw an expression tree corresponding to the following expression:  
 $(a + b) / (c - d * e) + f + g * h / i$
14. (10 pts) Insert the integers 7, 2, 9, 0, 5, 6, 8, 1 into an initially empty binary search tree. Show the final tree.
15. (10 pts) Show the result of deleting 7 from the tree in question 14. Use the same remove algorithm as we have been covering class (this is also the same remove algorithm used for home programming assignment 4.)