CMSC 341 Data Structures
Red-Black Tree Review

These questions will help test your understanding of the Red-Black tree material discussed in class and in the text. These questions are only a study guide. Questions found here may be on your exam, although perhaps in a different format. Questions NOT found here may also be on your exam. The rotation diagrams for red-black trees may be provided with your exam. Check with your instructor.

1. Define Red-Black tree. List all Red-Black tree properties

2. Define the black height of a node, x.

3. What is the “Big-Oh” performance (in terms of the number of nodes in the tree) for the operations find, insert and remove for a red-black tree in the best, worst and averages cases?

4. What property of red-black trees is most significant in explaining the “Big-Oh” performance for the operations find, insert and remove?

5. Prove that in any red-black tree with root x, there are at least \( n = 2^{bh(x)} - 1 \) internal nodes where \( bh(x) \) is the black-height of x.

6. Prove that in any red-black tree, at least half the nodes on any path from the root to a leaf must be black.

7. Prove that in any red-black tree, no path from any node, N, to a leaf is more than twice as long as any other path from N to any other leaf.

8. Prove that if a black node has just one child, that child must be red.

9. Show the tree that results from inserting the values 2, 1, 4, 5, 9, 3, 6, 7 into an initially empty red-black tree. Show the tree after each insertion.
10. Given the following Red-Black Tree, show the tree that results after deleting the node with value 68 using bottom-up deletion.