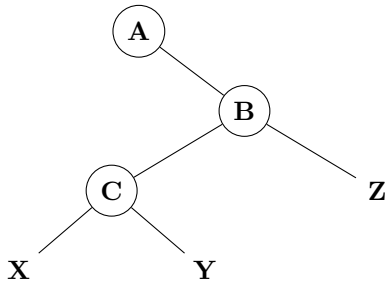
Name: _____

Write all of your responses on these exam pages. If you need extra space please use the backs of the pages.

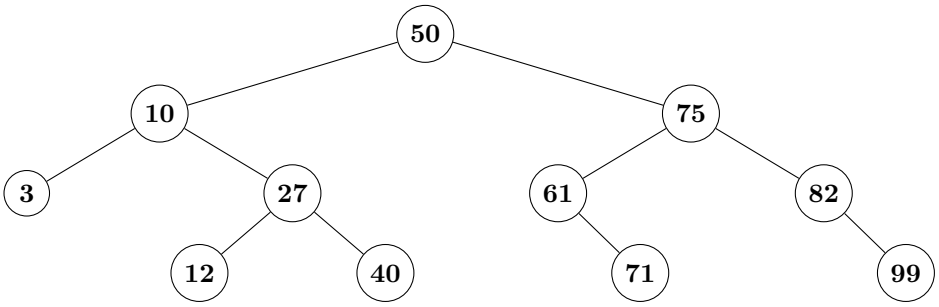
1. (*10 points*) Draw the result of the following segment of a tree after a right rotation has been done around B. The labels X, Y, and Z are to be considered subtrees, possibly empty.



2. (*10 points*) Create a templated function that will take in one parameter, a pointer to the node that you are rotating about. It is to preform a right rotation around the parameter pointer and adjust the pointer to still point to the resulting (parent) node of the rotation.

3. (*5 points*) What is the criterion for a binary search tree to be an AVL tree?

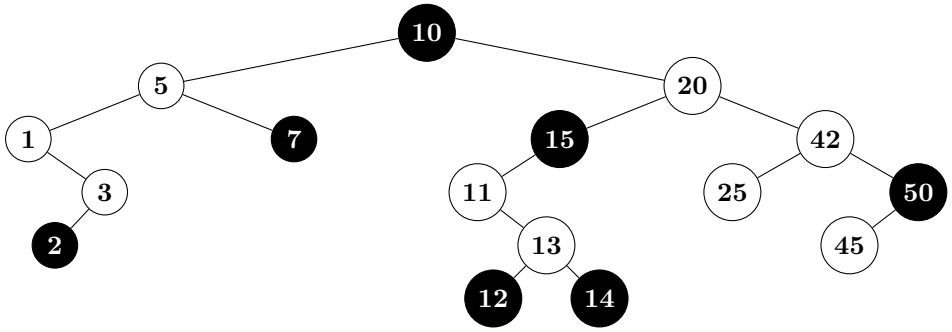
4. (*10 points*) Given the following AVL tree, draw the tree after the node 30 is inserted and the tree is rebalanced.



5. (*10 points*) What are the two phases to the DSW Algorithm? Explain what they do and how they work. Make the explanation detailed enough so that someone could reproduce the method on paper.

6. (*10 points*) What is the criterion for a binary search tree to be a Red-Black tree?

7. (*10 points*) Is the following a Red-Black Tree? If not, state all of the violations that are in the tree and then draw a fixed red-black tree. Non-filled circles are red and filled circles are black. In your fix, if you have one, shade the black nodes and do not shade the red nodes. Also, if fixing this tree, you are not to add any nodes or change the node positioning, just alter the node colors.



8. (*10 points*) Draw the expression tree for each of the following mathematical expressions. Then rewrite the expression in postfix form.

   (a) $(x^2 + 4)/(7x - 9) + 2$

   (b) $(x + y + z)(x - yz)$

9. (*15 points*) Write three functions for the AVL tree.

   (a) A recursive function height that will take a pointer to a node and return the height of the subtree pointed to.

(b) A getBalanceFactor function will take a pointer to a node and determine the balance factor at that node. It will return the integer balance factor for the node.

(c) The isBalanced function will take a pointer to a node and determine if the tree is AVL balanced from the node on down. This is to be a recursive function. The isBalanced function will return true if the subtree is balanced and false is not.

10. (*10 points*) Write a templated recursive function that makes a copy of a binary tree.