October 21, 2009 Name _____

EECS 311 Data Structures
Midterm Exam
Don't Panic!

1. (10 pts) In the boxes below, show the **red-black** trees that result from the successive addition of the given values. Use doubled-lines for red links. Clearly indicate recoloring and rotations, if any, with intermediate trees and "left" or "right" for direction of rotation.

1. After adding 62 to a tree with 58.	2. After adding 48 to the previous tree.
3. After adding 96 to the previous tree.	4. After adding 34 to the previous tree.
5. After adding 104 to the previous tree.	6. After adding 85 to the previous tree.

2. (10 pts) In the boxes below, show the **binary heaps** in tree form that result from the successive additions of the given values, where larger values beat lower values. Clearly indicate what swaps occur to maintain the heap.

1. After adding 62 to a tree with 58.	2. After adding 48 to the previous tree.
3. After adding 96 to the previous tree.	4. After adding 34 to the previous tree.
5. After adding 104 to the previous tree.	6. After adding 101 to the previous tree.

3. (5 pts) Using the heap generated in question 2 as a priority queue, show the swaps that would occur after the first item in the queue is removed.

4. (20 pts) The function getWinner() is supposed to take a vector of names representing votes for candidates and return the name that appears strictly more than half the time, if any, or the empty string. Examples:

{ "A", "B", "C", "B", "A", "B", "B", "C", "B" } – winner is "B"
{ "A", "A", "A", "C", "C", "B", "B", "C", "C", "C", "B", "C", "C" } – winner is "C"
{ "A", "B", "C", "B", "A", "B", "C", "B" } – no winner ""

Three correct definitions are below. For each, give the computational complexity with a reasoned justification.

a)

```
string getWinner1( const vector<string> &ballots ) {
  int len = ballots.size();
  for ( int i = 0; i < len; ++i )
    if ( count( ballots.begin(), ballots.end(), ballots[i] )
         > len / 2 )
      return ballots[i];
  return "";
}
```

b)

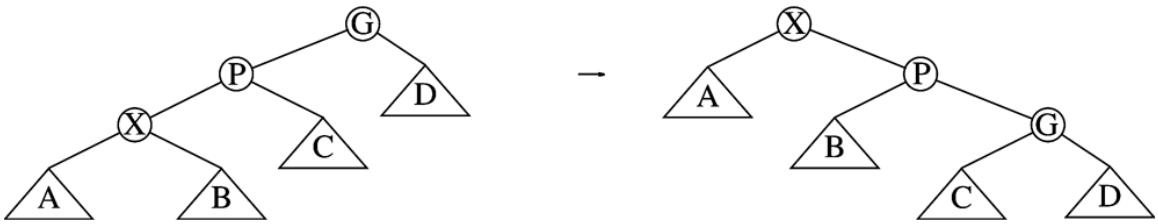
```
string getWinner2( const vector<string> &ballots ) {
  int len = ballots.size();
  map<string, int> votes;
  for ( int i = 0; i < len; ++i ) ++votes[ ballots[i] ];
  for ( map<string, int>::iterator iter = votes.begin();
        iter != votes.end();
        ++iter )
    if ( iter->second > len / 2 ) return iter->first;
  return "";
}
```

c)

```
string getWinner3( const vector<string> &ballots ) {
  int len = ballots.size();
  string winner = "";
  int tally = 0;
  for ( int i = 0; i < len; ++i ) {
    if ( tally == 0 ) winner = ballots[i];
    if ( winner == ballots[i] ) ++tally; else --tally;
  }
  if ( count( ballots.begin(), ballots.end(), winner )
       > len / 2 )
    return winner;
  else
    return "";
}
```

d) Give an argument for the correctness of `getWinner3()`. Hint: a vote for one candidate cancels a vote for another candidate.

5. (10 pts) Using the C++ tree class below, implement `zigzigRight( Node *&node )` so that `zigzigRight(node->left)` or `zigzigRight(node->right)` inside a `Tree` member function would do the rotation shown to the specified subtree:




```
template <typename T> class Tree {
  private:
    struct Node {
      Node *left, *right;
      T data;
      ...
    };
  public:
    Node * root;
    void zigzigRight(Node *&node)
    {









    }
};
```