Department of Computer Science

Graduate Exam in Programming

Spring 2018

You must write Java or C++ on the first page of your answers!! You may answer the questions using either Java or C++, but you must use the same language for each question on the exam.

1. **(2 pts)** Write a function pattern to output the pattern below: a $ on the diagonal, and + signs before/below the diagonal, and - signs after/above the diagonal. Your function should have one parameter, x, which denotes the number of rows (and columns) to be printed. The pattern below is for x=5.

```
$----
+$---
++$--
+++$-
++++$
```

The next question uses the following class, which represents a binary tree:

```cpp
// C++
class Tree {
private:
    struct TreeNode {
        int value;
        TreeNode *left;
        TreeNode *right;
    };
    //points to the top node
    TreeNode *root;
public:
    Tree() {root=NULL;}
    void inorder();
};
```

2. **(2 pts)** Define the public member function inorder() that displays the elements of the tree by visiting the nodes following an in-order traversal. In this traversal method, the left subtree is visited first, then the root and later the right sub-tree (see the example below, and note that the tree is not required to
be a binary search tree). You may add new private functions to the class as needed.

3. (2 pts) Write a recursive function named \texttt{minimum} that takes two arguments: an array of integers and its size, and returns the smallest value in the list. You may assume the size will always be greater than 0. For example: \texttt{minimum} given \{11,5,2,4,3\} and 5 is 2. \textbf{Do not use loops, extra parameters, or global or static variables.}

4. (4 pts) Declare and implement a class to represent a list of integers, called \texttt{IntList}. Include the following functions in your class:
   • a no-argument constructor that sets up an empty list.
   • a void function \texttt{add(x)} that adds a new value, \(x\), to the end of the list. If adding the element would exceed the list’s capacity, this function should output an error message.
   • a function \texttt{mean()} that returns the mean of the list. The mean is the sum of the values divided by the number of values in the list. Note that the mean might not be an integer. The mean of \{2,4,8,5\} is 4.75.
   • A function \texttt{allPositive()} that returns true if all of the elements in the list are greater than 0. If any of the elements are not positive, it returns false. If the list is empty, it returns true.

Use an \texttt{array of integers} of size 100 to store the values in the list. Use an integer variable named \texttt{num} to store the number of elements currently in the list.