CSCI 4631/5631

Homework Two – Class ComplexNumber – some C++ practice

As you know we have data types for basic numbers; we have integers and we have decimal numbers (doubles and floats). We can accomplish quite a bit with these numbers, but what if we were engineers? Engineers often have to use complex numbers in their calculations to build airplanes, bridges, buildings, power plants, …things. Complex numbers do not exist as a primitive type in Java, but we can add them to our set of types. For this assignment, you will be writing class that models complex numbers.

Submission:

You will need to create a new directory within your repository. Name this directory homework1. Once you have finished writing the program, add, commit, and push your file to the remote repository on the GitLab server.

Assignment Statement:

This assignment will consist of two parts: first a class that defines an object for a complex number and **this class will be fully documented using comments** - Second, a tester, with a "main" method, to show that your code performs exactly as one would expect - I will expect extensive testing and that the tester also has documentation explaining the point of each test.

Writing class ComplexNumber:

First, the class that defines a complex number: See below for a refresher on complex numbers. Your class will have a constructor that accepts two floats as input arguments. The two floats will represent the *a* and *b* parts of the complex number.

Your class will have seven methods. Four of the methods will implement complex number addition, subtraction, multiplication, and division. Each will accept an argument being the other complex number to be added to, subtracted from, multiplied by, or divided into this complex number. Each of these methods will return a new complex number that is the result of the operation.

You will also need two getter methods to return the *a* and *b* parts of the complex number. You will also be overriding the "==" operator (assume that two complex numbers are equal if their a and b parts are different by less than 0.00001. I also

would like to provide an implementation of the “<<” operator so that a complex number can be directly sent to std::cout.

Here is a sketch of the class with the method for addition completed for you (You’re welcome!).

```
class ComplexNumber{
     public:


          ComplexNumber(); // default constructor
          ComplexNumber(float _a, float _b);

          // copy constructor
          ComplexNumber(const ComplexNumber& _rhs);

          ComplexNumber operator+ (const
                         ComplexNumber& otherNumber);


          //...
          /* Provide overloaded -, /, and * operators */
          //...

     // The instance variables a and b representing
     // the real parts of the complex number
     private:
           float a;
           float b;

};

// << operator needs to be defined outside of class
ostream& operator<< ( ostream& os,
                      const ComplexNumber& s );
```

Writing the Tester

In a separate file, ComplexNumberTest.cc, implement a test for your ComplexNumber class. You should provide at least one tester method for each of the public methods in ComplexNumber. Each test method should verify the correctness of the method it is testing using multiple ComplexNumber instances as input. Compile and run the test class to verify that all your tests pass. Be sure to test for a wide variety of input combinations to ensure adequate testing.

Tip: when testing your program to make sure your calculations are correct, use

www.wolframalpha.com to verify your calculations.

About Complex Numbers:

Recall that a complex number is a number

$$a + bi$$

where $i = \sqrt{-1}$

and a and b are real numbers.

To add two complex numbers:

$$(a + bi) + (c + di) = (a + c) + (b + d)i$$

Similarly, to subtract two complex numbers:

$$(a + bi) - (c + di) = (a - c) + (b - d)i$$

To multiply two complex numbers:

$$(a + bi)(c + di) = (ac - bd) + (bc + ad)i$$

Finally, to divide two complex numbers:

$$\frac{a + bi}{c + di} = \left(\frac{ac + bd}{c^2 + d^2}\right) + \left(\frac{bc - ad}{c^2 + d^2}\right) i$$

Due Date

You need to complete this assignment and have it pushed to the remote repository on the Git server by the date/time specified on Moodle.

There should be a README.txt file stating exactly how to compile, run, and test your code. You should also provide a Makefile. Bonuses, if you chose to do them, should be separate (in subdirectories labeled bonus1, etc.) and fully complete implementations beyond the required one (in other words, start working from a fully implemented original copy in the subdirectory to do the bonus).

BONUS 1 (20 points): (Required for Graduate Students) - Define a class RealNumber (a number without the imaginary part) and define methods in ComplexNumber that allow all the above operations on mixtures of RealNumbers and ComplexNumbers. Comment and test as above.

BONUS 2 (10 points): (Required for Graduate Students) Can code duplication be reduced by using inheritance and having a common abstract superclass and/or interface? Implement and test this....