

## Programming Assignment 1: Quadratic Equation Verification with Complex Number Operations

The **complex number**  $a+bi$ , contains two real numbers, the *real part*  $a$  and the *imaginary part*  $b$ . Write a C **project**, `Quadratic_Equation_Verifier_DXXXXXXX.dev`, that defines a data type `complex` and complex operations:

```
typedef struct {
    float re; // real part;
    float im; // imaginary part;
} complex;

complex add(complex, complex); // complex addition.
complex minus(complex, complex); // complex subtraction.
complex time(complex, complex); // complex multiplication.
complex divide(complex, complex); // complex division.
float absComplex(complex); // Absolute value of a complex number.
complex r2c(float); // Convert a real number to a complex number
void printComplex(); // Print a complex number.
```

The complex arithmetic operations are given as the following:

1. Complex addition:  $(a+bi)+(c+di) = (a+c)+(b+d)i$
2. Complex subtraction:  $(a+bi)-(c+di) = (a-c)+(b-d)i$
3. Complex multiplication:  $(a+bi) \times (c+di) = (a \times c - b \times d) + (a \times d + b \times c)i$
4. Complex division:  $(a+bi) \div (c+di) = ((a \times c + b \times d) + (-a \times d + b \times c)i) \div (c^2 + d^2)$
5. Complex absolute value:  $|a+bi| = (a^2 + b^2)^{1/2}$

Use file name `complex_DXXXXXXX.h` and `complex_DXXXXXXX.c` for the specification and implementation of `complex` type and complex operations.

Consider the quadratic equation  $ax^2 + bx + c = 0$  of real coefficients  $a$ ,  $b$ , and  $c$ , where  $a \neq 0$ .

The solution of the quadratic equation is given as  $\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ . Use type `complex` to write an application program, `quadratic_equation_verifier.c`, to solve a quadratic equation and verify the two roots. In your output, print a real numeral four digits after the decimal point. When verify the two roots, consider the precision error up to six digits after the decimal point, *i.e.*, the absolute value the result of substituting a root to the quadratic equation is less than 0.000001.

Write a report, **report\_DXXXXXXX.pdf**, to explain how you develop your assignment solution, where **DXXXXXXX** is your student ID. Homework assignment 2 is due by **23:59 pm, Wednesday, March 6**. Submit five files **Quadratic\_Equation\_Verifier\_DXXXXXXX.dev**, **complex\_DXXXXXXX.h**, **complex\_DXXXXXXX.c**, **quadratic\_equation\_verifier.c**, and **report\_DXXXXXXX.pdf** to iLearn.

Examples of program execution:

Enter coefficients a, b, and c for quadratic equation  $a x^2 + b x + c = 0$ : 1 0 9  
The quadratic equation is:  $X^2 + 9.0000 = 0$ .

The two roots of the quadratic equation are: 3.0000 i and -3.0000 i

Quadratic equation solution is a pair of valid roots. Verification succeeds.

Enter coefficients a, b, and c for quadratic equation  $a x^2 + b x + c = 0$ : 4 -12 9  
The quadratic equation is:  $4.0000 X^2 - 12.0000 X + 9.0000 = 0$ .

The two roots of the quadratic equation are: 1.5000 and 1.5000

Quadratic equation solution is a pair of valid roots. Verification succeeds.

Enter coefficients a, b, and c for quadratic equation  $a x^2 + b x + c = 0$ : 3 -4 5  
The quadratic equation is:  $3.0000 X^2 - 4.0000 X + 5.0000 = 0$ .

The two roots of the quadratic equation are: 0.6667+1.1055 i and 0.6667-1.1055 i

Quadratic equation solution is a pair of valid roots. Verification succeeds.