CS19001: Programming and Data Structures Laboratory

Assignment No. 1 (Data Types and Operators in C)

Date: 09-August-2019

Problem Statement:

The city of Wonderland is situated in the Argand plane of the Wonder-planet where each locations can be characterized by a complex number, say $z = (a + bi)$, when the real part a denotes the latitude and the imaginary part b denotes the longitude. In the city of Wonderland, Alice Liddell resides at the geographic location marked as, $z_1 = (a_1 + b_1 i)$ and her elder sister Lorina Liddell resides at the geographic location marked as, $z_2 = (a_2 + b_2 i)$. Mathematically, a_1, b_1, a_2, b_2 all are real numbers (may be negative as well). God, before creating this Wonder-planet, had experimented many geographical arithmetics over every location points. You job is to write a C-program to visualize these arithmetics over locations. Your program will do the following:

- Take from user two complex numbers (locations of Alice and Lorina), $z_1 = (a_1 + b_1 i)$ and $z_2 = (a_2 + b_2 i)$, by asking user to enter the real (the latitude) and the imaginary (the longitude) part (both in `double` format) separately.
- Print the two complex numbers (locations) in proper format, that is, like $z = (a + bi)$.
- Compute the following operations over/with each of these two complex numbers and Print the result:
  - Find MODULUS for both z_1 and z_2 [*Hint*: $|z| = \sqrt{a^2 + b^2}$]
  - Find CONJUGATE for both z_1 and z_2 [*Hint*: $\bar{z} = a - bi$]
  - Find ARGUMENT for both z_1 and z_2 [*Hint*: $arg(z) = tan^{-1}(\frac{b}{a})$]
  - Perform ADDITION of z_1 and z_2 [*Hint*: $z_1 + z_2 = (a_1 + a_2) + (b_1 + b_2)i$]
  - Perform SUBTRACTION of z_2 from z_1 [*Hint*: $z_1 - z_2 = (a_1 - a_2) + (b_1 - b_2)i$]
  - Perform MULTIPLICATION of z_1 with z_2 [*Hint*: $z_1 \times z_2 = (a_1 a_2 - b_1 b_2) + (a_1 b_2 + a_2 b_1)i$]
  - Perform DIVISION of z_1 by z_2 [*Hint*: $\frac{z_1}{z_2} = \left(\frac{a_1 a_2 + b_1 b_2}{a_2^2 + b_2^2}\right) + \left(\frac{a_2 b_1 - a_1 b_2}{a_2^2 + b_2^2}\right)i$]
  - Find SQUARE for both z_1 and z_2 [*Hint*: $z^2 = (a^2 - b^2) + (2ab)i$]
  - Find CUBE for both z_1 and z_2 [*Hint*: $z^3 = (a^3 - 3ab^2) + (3a^2 b - b^3)i$]
  - Find SQUARE-ROOT for both z_1 and z_2 [*Hint*: $\sqrt{z} = \left(\sqrt{\frac{a + \sqrt{a^2 + b^2}}{2}}\right) + \texttt{sign(b)}\left(\sqrt{\frac{-a + \sqrt{a^2 + b^2}}{2}}\right)i$]
  - Find RECIPROCAL for both z_1 and z_2 [*Hint*: $\frac{1}{z} = \left(\frac{a}{a^2 + b^2}\right) + \left(\frac{-b}{a^2 + b^2}\right)i$]
  - Find EXPONENTIATION for both z_1 and z_2 [*Hint*: $e^z = (e^a cos(b)) + (e^a sin(b))i$]

Example Execution Details:

Compilation and Running:

```
gcc <<Your-Program-FileName.c>> -lm
./a.out
```

Sample Test-case:

```
++ Enter Complex Number-1 ++
    -- Real Part: 3
    -- Imaginary Part: 4
++ Enter Complex Number-2 ++
    -- Real Part: -2.5
    -- Imaginary Part: -4.8

** Complex Number-1: C1 = (3.000000) + (4.000000)i
** Complex Number-2: C2 = (-2.500000) + (-4.800000)i
** MODULUS of Complex Number-1: |C1| = 5.000000
** MODULUS of Complex Number-2: |C2| = 5.412024
** CONJUGATE of Complex Number-1: ~C1 = (3.000000) + (-4.000000)i
** CONJUGATE of Complex Number-2: ~C2 = (-2.500000) + (4.800000)i
** ARGUMENT of Complex Number-1: ARG(C1) = 0.927295
** ARGUMENT of Complex Number-2: ARG(C2) = 1.090621
** Complex Number after ADDITION: (C1 + C2) = (0.500000) + (-0.800000)i
** Complex Number after SUBTRACTION: (C1 - C2) = (5.500000) + (8.800000)i
** Complex Number after MULTIPLICATION: (C1 x C2) = (11.700000) + (-24.400000)i
** Complex Number after DIVISION: (C1 / C2) = (-0.911574) + (0.150222)i
** SQUARE of Complex Number-1: C1^2 = (-7.000000) + (24.000000)i
** SQUARE of Complex Number-2: C2^2 = (-16.790000) + (24.000000)i
** CUBE of Complex Number-1: C1^3 = (-117.000000) + (44.000000)i
** CUBE of Complex Number-2: C2^3 = (157.175000) + (20.592000)i
** SQUARE ROOT of Complex Number-1: SQRT(C1) = (+/-) [(2.000000) + (1.000000)i]
** SQUARE ROOT of Complex Number-2: SQRT(C2) = (+/-) [(1.206653) + (-1.988973)i]
** RECIPROCAL of Complex Number-1: 1/C1 = (0.120000) + (-0.160000)i
** RECIPROCAL of Complex Number-2: 1/C2 = (-0.085353) + (0.163878)i
** EXPONENTIATION of Complex Number-1: e^C1 = (-13.128783) + (-15.200784)i
** EXPONENTIATION of Complex Number-2: e^C2 = (0.007182) + (0.081770)i
```

Submit a single C source file. Do not use *conditional-statements* and global/static variables.