

Complex Numbers

Topics : [Computer engineering](#)

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1. Definition:

- A complex number is a number that can be expressed in the form $a + bi$, where a and b are real numbers, and i is the imaginary unit with the property $i^2 = -1$.
- The real part of the complex number is a , and the imaginary part is bi .

2. Operations:

- **Addition and Subtraction:** Complex numbers are added or subtracted by adding or subtracting their real and imaginary parts separately.
- **Multiplication:** To multiply complex numbers $(a + bi)$ and $(c + di)$, distribute and combine like terms, then simplify using $i^2 = -1$.
- **Division:** To divide complex numbers, multiply the numerator and denominator by the complex conjugate of the denominator, then simplify.

3. Complex Conjugate:

- The complex conjugate of a complex number $a + bi$ is $a - bi$.
- When multiplied together, a complex number and its conjugate yield a real number: $(a + bi)(a - bi) = a^2 + b^2$.

4. Polar Form:

- Complex numbers can also be represented in polar form as $r(\cos \theta + i \sin \theta)$, where r is the magnitude (or modulus) of the complex number and θ is the argument (or angle) measured counterclockwise from the positive real axis.
- The magnitude of a complex number $a + bi$ is $\sqrt{a^2 + b^2}$, and the argument is $\arctan(b/a)$.

5. Euler's Formula:

- Euler's formula relates complex numbers, trigonometric functions, and the exponential function: $e^{i\theta} = \cos \theta + i \sin \theta$.
- This formula allows complex numbers to be expressed in terms of exponentials, facilitating operations like exponentiation and finding roots.

6. Applications:

- Complex numbers have applications in various fields, including electrical engineering, signal processing, quantum mechanics, and fluid dynamics.

- They are used to represent alternating current (AC) circuits, analyze oscillatory motion, solve differential equations, and more.

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