

# COMPLEX NUMBERS REFERENCE

Advanced Mathematics Cheat Sheet & Learning Tool

## Fundamental Definition

$$z = a + bi$$

- Imaginary Unit:  $i^2 = -1$
- Real Part:  $\text{Re}(z) = a$
- Imaginary Part:  $\text{Im}(z) = b$
- Complex Conjugate:  $\bar{z} = a - bi$

## Polar & Exponential Forms

$$z = r(\cos \theta + i \sin \theta) = re^{i\theta}$$

- Modulus (Magnitude):  $r = |z| = \sqrt{a^2 + b^2}$
- Argument (Phase):  $\theta = \arg(z) = \tan^{-1}(b/a)$
- Euler's Identity:  $e^{i\pi} + 1 = 0$

## Operations (Rectangular)

- Addition:  $(a+bi) + (c+di) = (a+c) + (b+d)i$
- Subtraction:  $(a+bi) - (c+di) = (a-c) + (b-d)i$
- Multiplication:  $(a+bi)(c+di) = (ac-bd) + (ad+bc)i$
- Division: Multiply by  $\bar{z}$ , /  $\bar{z}$ ,

## De Moivre's Theorem

$$[r(\cos \theta + i \sin \theta)]^n = r^n(\cos n\theta + i \sin n\theta)$$

- Powers:  $z^n = r^n e^{in\theta}$
- n-th Roots:  $w_k = r^{1/n} e^{i(\theta + 2k\pi)/n}$

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