Maths Formula Sheet

Chapter by chapter, topic by topic. Written by the PadhoNa team for quick revision.

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CHAPTER 4

Complex Numbers

Basics, conjugate and modulus

FORM

$$z = x + iy, \qquad i^2 = -1, \qquad \bar{z} = x - iy, \qquad |z| = \sqrt{x^2 + y^2}$$

CONJUGATE

$$z\bar{z} = |z|^2, \qquad \overline{z_1 \pm z_2} = \bar{z}_1 \pm \bar{z}_2, \qquad \overline{z_1 z_2} = \bar{z}_1 \bar{z}_2, \qquad \mathrm{Re}(z) = \frac{z + \bar{z}}{2}$$

MODULUS

$$|z_1 z_2| = |z_1||z_2|, \qquad \left|\frac{z_1}{z_2}\right| = \frac{|z_1|}{|z_2|}, \qquad |z_1 + z_2|^2 = |z_1|^2 + |z_2|^2 + 2\,\mathrm{Re}(z_1 \bar{z}_2)$$

POWERS OF I

$$i^{4k} = 1,\ i^{4k+1} = i,\ i^{4k+2} = -1,\ i^{4k+3} = -i$$

Polar form and argument

POLAR / EULER FORM

$$z = r(\cos\theta + i\sin\theta) = re^{i\theta}, \qquad r = |z|,\ \theta = \arg z \in (-\pi, \pi]$$

ARGUMENT RULES

$$\arg(z_1 z_2) = \arg z_1 + \arg z_2, \qquad \arg\frac{z_1}{z_2} = \arg z_1 - \arg z_2 \pmod{2\pi}, \qquad \arg\bar{z} = -\arg z$$

De Moivre's theorem and roots of unity

DE MOIVRE

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

CUBE ROOTS OF UNITY

$$1,\ \omega,\ \omega^2; \qquad \omega = \frac{-1 + i\sqrt{3}}{2}, \qquad 1 + \omega + \omega^2 = 0, \qquad \omega^3 = 1$$

NTH ROOTS OF UNITY

$$z_k = e^{\frac{2\pi ik}{n}},\ k = 0, 1, \ldots, n-1; \qquad \sum z_k = 0,\ \prod z_k = (-1)^{n-1}$$

Geometry and rotation

DISTANCE AND SECTION

$$|z_1 - z_2| = \text{distance}; \qquad z = \frac{mz_2 + nz_1}{m+n}$$

ROTATION

$$\frac{z_3 - z_1}{z_2 - z_1} = \frac{|z_3 - z_1|}{|z_2 - z_1|} e^{i\theta}$$

θ is the angle from $z_2 - z_1$ to $z_3 - z_1$ (anticlockwise).

CIRCLE

$$|z - z_0| = r; \qquad \left|\frac{z - z_1}{z - z_2}\right| = k\ (k \neq 1) \text{ is a circle},\ k = 1 \text{ a line}$$

COLLINEAR POINTS

$$\frac{z_3 - z_1}{z_2 - z_1} \in \mathbb{R}$$

TRIANGLE INEQUALITY

$$\big||z_1| - |z_2|\big| \leq |z_1 + z_2| \leq |z_1| + |z_2|$$

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