Maths Formula Sheet

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

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CHAPTER 8

Matrices and Determinants

Matrix basics

TRANSPOSE

$$(A^T)^T = A, \qquad (AB)^T = B^T A^T$$

SYMMETRIC / SKEW

$$A^T = A \text{ symmetric}; \qquad A^T = -A \text{ skew-symmetric}; \qquad A = \tfrac{1}{2}(A + A^T) + \tfrac{1}{2}(A - A^T)$$

TRACE

$$\mathrm{tr}(A + B) = \mathrm{tr}A + \mathrm{tr}B, \qquad \mathrm{tr}(AB) = \mathrm{tr}(BA)$$

SPECIAL MATRICES

$$A^2 = A \text{ idempotent}, \qquad A^k = O \text{ nilpotent}, \qquad A^2 = I \text{ involutory}, \qquad AA^T = I \text{ orthogonal}$$

Determinants

PROPERTIES

$$|A^T| = |A|, \qquad |AB| = |A||B|, \qquad |kA| = k^n|A| \ (A \text{ is } n \times n)$$

ROW OPERATIONS

$$\text{swap two rows: sign changes; two equal rows: } |A| = 0; \ R_i \to R_i + kR_j : \text{no change}$$

AREA OF A TRIANGLE

$$\Delta = \frac{1}{2}\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}$$

Adjoint and inverse

INVERSE

$$A^{-1} = \frac{\operatorname{adj} A}{|A|}, \qquad |A| \neq 0$$

ADJOINT

$$A(\operatorname{adj} A) = (\operatorname{adj} A)A = |A|I, \qquad |\operatorname{adj} A| = |A|^{n-1}, \qquad \operatorname{adj}(\operatorname{adj} A) = |A|^{n-2}A$$

RULES

$$(AB)^{-1} = B^{-1}A^{-1}, \qquad |A^{-1}| = \frac{1}{|A|}, \qquad \operatorname{adj}(AB) = \operatorname{adj} B \operatorname{adj} A$$

Systems of linear equations

CRAMER'S RULE

$$x = \frac{\Delta_1}{\Delta},\ y = \frac{\Delta_2}{\Delta},\ z = \frac{\Delta_3}{\Delta}$$

CONSISTENCY

$$\Delta \neq 0 : \text{unique solution}; \qquad \Delta = 0, \text{ some } \Delta_i \neq 0 : \text{no solution};$$

$$\Delta = \Delta_1 = \Delta_2 = \Delta_3 = 0 : \text{infinitely many or none}$$

HOMOGENEOUS

$$AX = O :\ \Delta \neq 0 \Rightarrow \text{only } X = O; \qquad \Delta = 0 \Rightarrow \text{non-trivial solutions}$$

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