NCERT CLASS XII MATHEMATICS

FORMULAS & CONCEPTS

Chapter 1: Relations and Functions

Relation:	*subset of* $A \times B$
Domain, Codomain, Range	
Types of relations:	• Reflexive, Symmetric, Transitive • Equivalence relation
Types of functions:	□ One–one (injective) □ Onto (surjective) □ Bijective
Important Results • **Composite function:**	$(f \circ g)(x) = f(g(x))$
• **Invertible function:** *Exists if the function is bijective*	$f^{-1}(f(x)) = x$
Binary Operation Properties	□ Closure □ Associativity □ Identity □ Inverse □ Commutativity

Chapter 2: Inverse Trigonometric Functions

Principal Value Ranges

Function	Range
$\sin^{-1} x$	$[-\pi/2, \pi/2]$
$\cos^{-1} x$	$[0, \pi]$
$\tan^{-1} x$	$(-\pi/2, \pi/2)$
$\cot^{-1} x$	$(0, \pi)$
$\sec^{-1} x$	$[0, \pi] \setminus \{\pi/2\}$
$\csc^{-1} x$	$[-\pi/2, \pi/2] \setminus \{0\}$

Standard Identities

$$\sin^{-1} x + \cos^{-1} x = \frac{\pi}{2}$$

$$\tan^{-1} x + \cot^{-1} x = \frac{\pi}{2}$$

Difficult-Problem Identities

$$\tan^{-1} x + \tan^{-1} y = \begin{cases} \tan^{-1}\left(\frac{x+y}{1-xy}\right), & xy < 1 \\ \pi + \tan^{-1}\left(\frac{x+y}{1-xy}\right), & xy > 1 \end{cases}$$

$$\tan^{-1} x - \tan^{-1} y = \tan^{-1}\left(\frac{x-y}{1+xy}\right)$$

Chapter 3: Matrices

Types of Matrices	• Row, Column • Square • Diagonal • Scalar • Identity • Symmetric: $A^T = A$ • Skew-symmetric: $A^T = -A$
Matrix Operations	$(A+B)_{ij} = A_{ij} + B_{ij}$ $(AB)_{ij} = \sum A_{ik}B_{kj}$
Transpose Properties	$(A^T)^T = A$ $(AB)^T = B^T A^T$
Inverse of Matrix	$A^{-1} = \frac{1}{\|A\|} \mathrm{adj}(A)$ (Exists iff $\|A\| \neq 0$)

Chapter 4: Determinants

Determinant of 2×2	$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$
Determinant of 3×3	$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = a(ei - fh) - b(di - fg) + c(dh - eg)$
Properties	• Interchange two rows → determinant changes sign • Two identical rows → determinant = 0 • Factor common term from row/column • $\|A\| = \|A^T\|$
Area of Triangle	$\text{Area} = \frac{1}{2} \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}$
Adjoint	$A \cdot \text{adj}(A) = \|A\| I$

Chapter 5: Continuity and Differentiability

Limits	$\lim_{x \to a} f(x)$
Continuity at x=a	$\lim_{x \to a^-} f(x) = \lim_{x \to a^+} f(x) = f(a)$
Differentiability	Differentiable ⇒ Continuous (not vice versa)
Standard Derivatives	$\frac{d}{dx}(x^n) = nx^{n-1}$ $\frac{d}{dx}(\sin x) = \cos x$ $\frac{d}{dx}(\cos x) = -\sin x$ $\frac{d}{dx}(e^x) = e^x$ $\frac{d}{dx}(\ln x) = \frac{1}{x}$
Chain Rule	$\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$
Product Rule	$\frac{d}{dx}(uv) = u\frac{dv}{dx} + v\frac{du}{dx}$
Quotient Rule	$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v\,du/dx - u\,dv/dx}{v^2}$

Chapter 6: Applications of Derivatives

Key Concepts

- Rate of change
- Increasing / decreasing functions
- Local maxima and minima
- Optimization problems

Increasing / Decreasing Functions	$f'(x) > 0 \Rightarrow f(x)$ is increasing $f'(x) < 0 \Rightarrow f(x)$ is decreasing
Critical Points	$f'(x) = 0$ or undefined
Second Derivative Test	• $f''(x) < 0 \Rightarrow$ Local maximum • $f''(x) > 0 \Rightarrow$ Local minimum
Points of Inflection	$f''(x) = 0$ and changes sign

Chapter 7: Integrals

Indefinite Integrals	$\int x^n dx = \frac{x^{n+1}}{n+1} + C \quad (n \neq -1)$ $\int e^x dx = e^x + C$ $\int \frac{1}{x} dx = \ln\|x\| + C$ $\int \sin x dx = -\cos x + C$ $\int \cos x dx = \sin x + C$
Standard Trigonometric Integrals	$\int \sec^2 x dx = \tan x + C$ $\int \csc^2 x dx = -\cot x + C$
Integration by Substitution	$\int f(g(x))g'(x) dx = \int f(u) du$
Integration by Parts	$\int u\, dv = uv - \int v\, du$
Definite Integrals	$\int_a^b f(x) dx = F(b) - F(a)$
Properties of Definite Integrals	$\int_0^a f(x) dx = \int_0^a f(a-x) dx$ $\int_{-a}^a f(x) dx = \begin{cases} 0, & f(x) \text{ odd} \\ 2\int_0^a f(x) dx, & f(x) \text{ even} \end{cases}$

Chapter 8: Applications of Integrals

Area Under Curve	$\text{Area} = \int_a^b f(x)dx$
Area Between Two Curves	$\text{Area} = \int_a^b [f(x) - g(x)]dx$
Area w.r.t y-axis	$\text{Area} = \int_c^d [x_2(y) - x_1(y)]dy$

Chapter 9: Differential Equations

Order and Degree

- Order: highest derivative
- Degree: power of highest derivative

General Differential Equation	$\frac{dy}{dx} = f(x)$
Solution by Variable Separation	$\frac{dy}{dx} = g(x)h(y) \Rightarrow \int \frac{1}{h(y)}dy = \int g(x)dx$
Linear Differential Equation	$\frac{dy}{dx} + Py = Q$
Integrating Factor (IF)	$\text{IF} = e^{\int P dx}$
Solution	$y(\text{IF}) = \int Q(\text{IF})dx + C$

Chapter 10: Vector Algebra

Vector Basics	$\lvert\vec{a}\rvert = \sqrt{a_x^2 + a_y^2 + a_z^2}$
Unit Vector	$\hat{a} = \dfrac{\vec{a}}{\lvert\vec{a}\rvert}$
Dot Product	$\vec{a} \cdot \vec{b} = \lvert\vec{a}\rvert\lvert\vec{b}\rvert \cos\theta$ **Perpendicular vectors → dot product = 0**
Cross Product	$\vec{a} \times \vec{b} = \lvert\vec{a}\rvert\lvert\vec{b}\rvert \sin\theta \, \hat{n}$ **Parallel vectors → cross product = 0**
Properties	$\vec{a} \cdot (\vec{b} \times \vec{c}) = \text{scalar triple product}$ $\lvert\vec{a} \times \vec{b}\rvert = \text{Area of parallelogram}$
Properties	$\vec{r} = \vec{a} + \lambda\vec{b}$
Angle Between Vectors	$\cos\theta = \dfrac{\vec{a} \cdot \vec{b}}{\lvert\vec{a}\rvert\lvert\vec{b}\rvert}$

Chapter 11: Three-Dimensional Geometry

Key Concepts

- Coordinates in 3D: (x, y, z)
- Distance, direction ratios, direction cosines
- Equation of line
- Equation of plane
- Angle between lines/planes
- Shortest distance

Distance Between Two Points	$\text{Distance} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$
Direction Ratios (DRs)	$\text{DRs} = (a, b, c)$
Direction Cosines (DCs)	$l = \cos\alpha,\ m = \cos\beta,\ n = \cos\gamma$ $l^2 + m^2 + n^2 = 1$
Equation of Line **Vector Form**	$\vec{r} = \vec{a} + \lambda\vec{b}$
Equation of Line **Cartesian Form**	$\frac{x - x_1}{a} = \frac{y - y_1}{b} = \frac{z - z_1}{c}$
Angle Between Two Lines	$\cos\theta = \frac{a_1a_2 + b_1b_2 + c_1c_2}{\sqrt{a_1^2 + b_1^2 + c_1^2}\sqrt{a_2^2 + b_2^2 + c_2^2}}$
Shortest Distance Between Two Skew Lines	$\text{S.D.} = \frac{\lvert(\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 \times \vec{b}_2)\rvert}{\lvert\vec{b}_1 \times \vec{b}_2\rvert}$
Equation of Plane **Vector Form**	$(\vec{r} - \vec{a}) \cdot \vec{n} = 0$
Equation of Plane **Cartesian Form**	$ax + by + cz + d = 0$
Distance of a Point from a Plane	$D = \frac{\lvert ax_1 + by_1 + cz_1 + d\rvert}{\sqrt{a^2 + b^2 + c^2}}$
Angle Between Line and Plane	$\sin\theta = \frac{\lvert al + bm + cn\rvert}{\sqrt{a^2 + b^2 + c^2}}$
Angle Between Two Planes	$\cos\theta = \frac{\lvert a_1a_2 + b_1b_2 + c_1c_2\rvert}{\sqrt{a_1^2 + b_1^2 + c_1^2}\sqrt{a_2^2 + b_2^2 + c_2^2}}$

Chapter 12: Linear Programming

Key Concepts

- Linear inequalities
- Feasible region
- Objective function
- Constraints
- Optimal solution

Linear Inequality	$ax + by \leq c, \quad ax + by \geq c$
Objective Function	$Z = ax + by$

Chapter 13: Probability

Key Concepts

- Conditional probability
- Independent events
- Bayes' theorem
- Total probability theorem

Conditional Probability	$P(A\|B) = \dfrac{P(A \cap B)}{P(B)}, \quad P(B) \neq 0$
Multiplication Theorem	$P(A \cap B) = P(A)P(B\|A)$
Independent Events	$P(A \cap B) = P(A)P(B)$
Total Probability Theorem If $A_1, A_2, \ldots, A_n$ form a partition:	$P(B) = \sum_{i=1}^{n} P(A_i)P(B\|A_i)$
Bayes' Theorem	$P(A_i\|B) = \dfrac{P(A_i)P(B\|A_i)}{\sum P(A_j)P(B\|A_j)}$

Important Exam Results

- $P(A) + P(\bar{A}) = 1$
- If events independent → conditional probability equals original probability
- Always define events clearly before applying Bayes