NCERT Mathematics Formula Book
Classes 11 & 12

Compiled from NCERT Textbooks

Contents

Mathematical Constants and Symbols

Important Mathematical Constants

Constant	Symbol	Value
Pi	π	3.141592653589793
Euler's number	e	2.718281828459045
Golden ratio	ϕ	1.618033988749895
Imaginary unit	i	$\sqrt{-1}$

Chapter 1

Class 11 Mathematics Formulas

1.1 Sets

Union of Sets: $A \cup B = \{x : x \in A \text{ or } x \in B\}$
Definition: Set containing all elements from both sets.

Intersection of Sets: $A \cap B = \{x : x \in A \text{ and } x \in B\}$
Definition: Set containing only common elements.

Complement of Set: $A' = \{x : x \in U \text{ and } x \notin A\}$
Definition: Set of all elements not in A but in universal set.

Difference of Sets: $A - B = \{x : x \in A \text{ and } x \notin B\}$
Definition: Set of elements in A but not in B.

De Morgan's Laws:

$$(A \cup B)' = A' \cap B'$$
$$(A \cap B)' = A' \cup B'$$

Definition: Complement of union equals intersection of complements and vice versa.

1.2 Relations and Functions

Relation: $R \subseteq A \times B$
Definition: Subset of Cartesian product of two sets.

Function: $f : A \to B$
Definition: Relation where each element of A maps to exactly one element of B.

Domain: Set of all possible input values
Range: Set of all possible output values

One-one Function (Injective): $f(x_1) = f(x_2) \Rightarrow x_1 = x_2$
Definition: Function where different inputs give different outputs.

Onto Function (Surjective): Range = Codomain
Definition: Function where every element of codomain is mapped.

Bijective Function: Both one-one and onto
Definition: Function that is both injective and surjective.

1.3 Trigonometric Functions

Basic Identities:

$$\sin^2\theta + \cos^2\theta = 1$$
$$1 + \tan^2\theta = \sec^2\theta$$
$$1 + \cot^2\theta = \csc^2\theta$$

Definition: Fundamental Pythagorean identities.

Sum and Difference Formulas:

$$\sin(A \pm B) = \sin A\cos B \pm \cos A\sin B$$
$$\cos(A \pm B) = \cos A\cos B \mp \sin A\sin B$$
$$\tan(A \pm B) = \frac{\tan A \pm \tan B}{1 \mp \tan A\tan B}$$

Definition: Formulas for trigonometric functions of sum/difference of angles.

Double Angle Formulas:

$$\sin 2\theta = 2\sin\theta\cos\theta$$
$$\cos 2\theta = \cos^2\theta - \sin^2\theta = 2\cos^2\theta - 1 = 1 - 2\sin^2\theta$$
$$\tan 2\theta = \frac{2\tan\theta}{1 - \tan^2\theta}$$

Definition: Formulas for trigonometric functions of double angles.

Product to Sum Formulas:

$$\sin A\cos B = \frac{1}{2}[\sin(A+B) + \sin(A-B)]$$
$$\cos A\cos B = \frac{1}{2}[\cos(A+B) + \cos(A-B)]$$
$$\sin A\sin B = \frac{1}{2}[\cos(A-B) - \cos(A+B)]$$

Definition: Conversion of products to sums.

Law of Sines: $\dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C} = 2R$
Definition: Ratio of side length to sine of opposite angle is constant.

Law of Cosines:

$$a^2 = b^2 + c^2 - 2bc\cos A$$
$$b^2 = a^2 + c^2 - 2ac\cos B$$
$$c^2 = a^2 + b^2 - 2ab\cos C$$

Definition: Relates sides and angles of any triangle.

1.4 Complex Numbers

Complex Number: $z = a + ib$ where $i^2 = -1$
Definition: Number with real and imaginary parts.

Modulus: $|z| = \sqrt{a^2 + b^2}$
Definition: Distance from origin in complex plane.

Argument: $\arg(z) = \theta = \tan^{-1}\left(\frac{b}{a}\right)$
Definition: Angle with positive real axis.

Polar Form: $z = r(\cos\theta + i\sin\theta) = re^{i\theta}$
Definition: Complex number in polar coordinates.

De Moivre's Theorem: $(\cos\theta + i\sin\theta)^n = \cos n\theta + i\sin n\theta$
Definition: Powers of complex numbers in polar form.

1.5 Linear Inequalities

Linear Inequality: $ax + b > 0$ (or $<, \geq, \leq$)
Definition: Inequality of first degree.

Solution Set: Set of all values satisfying the inequality
Graphical Representation: Half-plane in coordinate system

1.6 Permutations and Combinations

Factorial: $n! = n \times (n-1) \times \cdots \times 2 \times 1$
Definition: Product of all positive integers up to n.

Permutation: ${}^nP_r = \frac{n!}{(n-r)!}$
Definition: Arrangements of r objects from n distinct objects.

Combination: ${}^nC_r = \frac{n!}{r!(n-r)!}$
Definition: Selections of r objects from n distinct objects.

Circular Permutation: $(n-1)!$
Definition: Arrangements around a circle.

1.7 Binomial Theorem

Binomial Theorem:

$$(a+b)^n = \sum_{k=0}^{n} \binom{n}{k} a^{n-k} b^k$$

Definition: Expansion of binomial raised to positive integer power.

General Term: $T_{r+1} = \binom{n}{r} a^{n-r} b^r$
Definition: (r+1)th term in binomial expansion.

Middle Term:

- When n is even: $\left(\frac{n}{2} + 1\right)$th term
- When n is odd: $\left(\frac{n+1}{2}\right)$th and $\left(\frac{n+3}{2}\right)$th terms

1.8 Sequence and Series

Arithmetic Progression (AP):

$$
\begin{aligned}
&n^{th} \text{ term: } a_n = a + (n-1)d \\
&\text{Sum: } S_n = \frac{n}{2}[2a + (n-1)d] = \frac{n}{2}(a + l) \\
&\text{Common difference: } d = a_n - a_{n-1}
\end{aligned}
$$

Definition: Sequence with constant difference between terms.

Geometric Progression (GP):

$$
\begin{aligned}
&n^{th} \text{ term: } a_n = ar^{n-1} \\
&\text{Sum: } S_n = a\left(\frac{1-r^n}{1-r}\right) \quad (r \neq 1) \\
&\text{Sum to infinity: } S_\infty = \frac{a}{1-r} \quad (|r| < 1) \\
&\text{Common ratio: } r = \frac{a_n}{a_{n-1}}
\end{aligned}
$$

Definition: Sequence with constant ratio between terms.

Harmonic Progression (HP): Reciprocals form AP
Definition: Sequence where reciprocals of terms form AP.

Arithmetic Mean: $AM = \frac{a+b}{2}$
Geometric Mean: $GM = \sqrt{ab}$
Harmonic Mean: $HM = \frac{2ab}{a+b}$

Relation: $AM \geq GM \geq HM$

1.9 Straight Lines

Distance Formula: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
Definition: Distance between two points in Cartesian plane.

Section Formula:

$$\text{Internal: } P = \left(\frac{mx_2 + nx_1}{m+n}, \frac{my_2 + ny_1}{m+n} \right)$$
$$\text{External: } P = \left(\frac{mx_2 - nx_1}{m-n}, \frac{my_2 - ny_1}{m-n} \right)$$

Definition: Coordinates of point dividing line segment in given ratio.

Slope of Line: $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \tan\theta$
Definition: Tangent of angle made with positive x-axis.

Equation of Line:

$$\text{Slope-intercept: } y = mx + c$$
$$\text{Two-point: } \frac{y - y_1}{y_2 - y_1} = \frac{x - x_1}{x_2 - x_1}$$
$$\text{Intercept: } \frac{x}{a} + \frac{y}{b} = 1$$
$$\text{Normal: } x\cos\alpha + y\sin\alpha = p$$

Definition: Different forms of straight line equation.

Distance from Point to Line: $d = \dfrac{|ax_1 + by_1 + c|}{\sqrt{a^2 + b^2}}$
Definition: Perpendicular distance from point to line $ax + by + c = 0$.

Angle between Lines: $\tan\theta = \left| \dfrac{m_1 - m_2}{1 + m_1 m_2} \right|$
Definition: Acute angle between two lines with slopes m_1 and m_2.

1.10 Conic Sections

Circle: $(x-h)^2 + (y-k)^2 = r^2$
Definition: Locus of points equidistant from center.

Parabola: $y^2 = 4ax$ (standard form)
Definition: Locus of points equidistant from focus and directrix.

Ellipse: $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$
Definition: Locus of points where sum of distances to two foci is constant.

Hyperbola: $\dfrac{x^2}{a^2} - \dfrac{y^2}{b^2} = 1$
Definition: Locus of points where difference of distances to two foci is constant.

1.11 Introduction to 3D Geometry

Distance Formula: $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$
Definition: Distance between two points in 3D space.

Section Formula:

$$\text{Internal: } P = \left(\frac{mx_2 + nx_1}{m+n}, \frac{my_2 + ny_1}{m+n}, \frac{mz_2 + nz_1}{m+n} \right)$$
$$\text{External: } P = \left(\frac{mx_2 - nx_1}{m-n}, \frac{my_2 - ny_1}{m-n}, \frac{mz_2 - nz_1}{m-n} \right)$$

Definition: Coordinates in 3D space.

Centroid of Triangle: $G = \left(\frac{x_1 + x_2 + x_3}{3}, \frac{y_1 + y_2 + y_3}{3}, \frac{z_1 + z_2 + z_3}{3} \right)$

1.12 Limits and Derivatives

Limit: $\lim_{x \to a} f(x) = L$
Definition: Value function approaches as input approaches some point.

Standard Limits:

$$\lim_{x \to 0} \frac{\sin x}{x} = 1$$
$$\lim_{x \to 0} \frac{1 - \cos x}{x} = 0$$
$$\lim_{x \to 0} \frac{e^x - 1}{x} = 1$$
$$\lim_{x \to 0} \frac{\log(1+x)}{x} = 1$$

Definition: Important limit results.

Derivative: $f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$
Definition: Instantaneous rate of change of function.

Standard Derivatives:

$$\frac{d}{dx}(x^n) = nx^{n-1}$$
$$\frac{d}{dx}(\sin x) = \cos x$$
$$\frac{d}{dx}(\cos x) = -\sin x$$
$$\frac{d}{dx}(\tan x) = \sec^2 x$$
$$\frac{d}{dx}(\cot x) = -\csc^2 x$$
$$\frac{d}{dx}(\sec x) = \sec x \tan x$$
$$\frac{d}{dx}(\csc x) = -\csc x \cot x$$
$$\frac{d}{dx}(e^x) = e^x$$
$$\frac{d}{dx}(a^x) = a^x \ln a$$
$$\frac{d}{dx}(\ln x) = \frac{1}{x}$$
$$\frac{d}{dx}(\log_a x) = \frac{1}{x \ln a}$$

Definition: Derivatives of common functions.

1.13 Statistics

Mean: $\bar{x} = \dfrac{\sum x_i}{n}$
Definition: Average of data.

Median: Middle value of ordered data
Mode: Most frequent value

Variance: $\sigma^2 = \dfrac{\sum (x_i - \bar{x})^2}{n}$
Definition: Average of squared deviations from mean.

Standard Deviation: $\sigma = \sqrt{\text{Variance}}$
Definition: Measure of data dispersion.

1.14 Probability

Probability: $P(A) = \dfrac{\text{Number of favorable outcomes}}{\text{Total number of outcomes}}$
Definition: Measure of likelihood of event.

Addition Rule: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
Definition: Probability of union of two events.

Multiplication Rule: $P(A \cap B) = P(A) \cdot P(B|A)$
Definition: Probability of intersection of two events.

Chapter 2

Class 12 Mathematics Formulas

2.1 Relations and Functions

Types of Relations:

- Reflexive: $(a, a) \in R$ for all a
- Symmetric: $(a, b) \in R \Rightarrow (b, a) \in R$
- Transitive: $(a, b) \in R$ and $(b, c) \in R \Rightarrow (a, c) \in R$
- Equivalence: Reflexive, symmetric and transitive

Inverse Function: $f^{-1}(f(x)) = x$
Definition: Function that reverses the mapping.

Composite Function: $(g \circ f)(x) = g(f(x))$
Definition: Application of one function to result of another.

Binary Operations: $* : A \times A \to A$
Definition: Operation that combines two elements to form another.

2.2 Inverse Trigonometric Functions

Principal Values:

$$\sin^{-1} x \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$$
$$\cos^{-1} x \in [0, \pi]$$
$$\tan^{-1} x \in \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$$

Definition: Ranges of inverse trigonometric functions.

Basic Formulas:

$$\sin^{-1} x + \cos^{-1} x = \frac{\pi}{2}$$
$$\tan^{-1} x + \cot^{-1} x = \frac{\pi}{2}$$
$$\sec^{-1} x + \csc^{-1} x = \frac{\pi}{2}$$

Definition: Complementary relationships.

2.3 Matrices

Matrix: Rectangular array of numbers
Order: $m \times n$ (m rows, n columns)

Matrix Addition: $[A + B]_{ij} = A_{ij} + B_{ij}$
Definition: Element-wise addition.

Matrix Multiplication: $[AB]_{ij} = \sum_{k=1}^{n} A_{ik}B_{kj}$
Definition: Dot product of rows and columns.

Transpose: $[A^T]_{ij} = A_{ji}$
Definition: Rows become columns and vice versa.

Determinant:

$$\text{2x2: } \begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

$$\text{3x3: } \begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = a(ei - fh) - b(di - fg) + c(dh - eg)$$

Definition: Scalar value for square matrices.

Inverse: $A^{-1} = \frac{1}{|A|}\text{adj}(A)$
Definition: Matrix that when multiplied gives identity.

2.4 Determinants

Properties:

- $|AB| = |A||B|$
- $|A^T| = |A|$
- $|kA| = k^n|A|$ for n×n matrix
- If two rows/columns identical, $|A| = 0$

Cramer's Rule: Solution of system $AX = B$ is $x_i = \frac{|A_i|}{|A|}$
Definition: Method to solve linear equations using determinants.

2.5 Continuity and Differentiability

Continuity: $\lim_{x \to c} f(x) = f(c)$
Definition: Function is continuous at point if limit equals function value.

Product Rule: $\frac{d}{dx}(uv) = u\frac{dv}{dx} + v\frac{du}{dx}$
Definition: Derivative of product of two functions.

Quotient Rule: $\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{v\frac{du}{dx} - u\frac{dv}{dx}}{v^2}$
Definition: Derivative of quotient of two functions.

Chain Rule: $\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}$
Definition: Derivative of composite function.

Implicit Differentiation: Differentiate both sides w.r.t x
Definition: Method when y is not explicitly expressed in terms of x.

Parametric Differentiation: $\frac{dy}{dx} = \frac{dy/dt}{dx/dt}$
Definition: When x and y are expressed in terms of parameter t.

Second Order Derivative: $\frac{d^2y}{dx^2} = \frac{d}{dx}\left(\frac{dy}{dx}\right)$
Definition: Derivative of the derivative.

2.6 Applications of Derivatives

Rate of Change: $\frac{dy}{dx}$ represents rate of change
Definition: How one quantity changes with respect to another.

Tangent: $y - y_1 = m(x - x_1)$ where $m = f'(x_1)$
Definition: Line touching curve at one point.

Normal: $y - y_1 = -\frac{1}{m}(x - x_1)$
Definition: Line perpendicular to tangent at point of contact.

Increasing Function: $f'(x) > 0$
Decreasing Function: $f'(x) < 0$

Local Maxima/Minima: $f'(x) = 0$ and check sign change
Definition: Highest/lowest points in neighborhood.

2.7 Integrals

Indefinite Integral: $\int f(x)dx = F(x) + C$ where $F'(x) = f(x)$
Definition: Anti-derivative of function.

Definite Integral: $\int_a^b f(x)dx = F(b) - F(a)$
Definition: Area under curve between limits a and b.

Standard Integrals:

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C \quad (n \neq -1)$$
$$\int \frac{1}{x} dx = \ln|x| + C$$
$$\int e^x dx = e^x + C$$
$$\int a^x dx = \frac{a^x}{\ln a} + C$$
$$\int \sin x dx = -\cos x + C$$
$$\int \cos x dx = \sin x + C$$
$$\int \sec^2 x dx = \tan x + C$$
$$\int \csc^2 x dx = -\cot x + C$$
$$\int \sec x \tan x dx = \sec x + C$$
$$\int \csc x \cot x dx = -\csc x + C$$

Definition: Integrals of common functions.

Integration by Parts: $\int udv = uv - \int vdu$
Definition: Method to integrate product of functions.

Integration by Substitution: $\int f(g(x))g'(x)dx = \int f(u)du$
Definition: Method using change of variable.

Partial Fractions: Decompose rational function
Definition: Express as sum of simpler fractions.

2.8 Applications of Integrals

Area under Curve: $A = \int_a^b f(x)dx$
Definition: Area between curve and x-axis.

Area between Curves: $A = \int_a^b [f(x) - g(x)]dx$
Definition: Area between two curves.

Volume of Revolution: $V = \pi \int_a^b [f(x)]^2 dx$
Definition: Volume when curve rotated about x-axis.

2.9 Differential Equations

Order: Highest derivative present

Degree: Power of highest derivative

Variable Separable: $\frac{dy}{dx} = f(x)g(y)$
Solution: $\int \frac{dy}{g(y)} = \int f(x)dx$

Homogeneous: $\frac{dy}{dx} = f\left(\frac{y}{x}\right)$
Solution: Substitute $y = vx$

Linear: $\frac{dy}{dx} + Py = Q$
Solution: $y \cdot e^{\int P dx} = \int Q \cdot e^{\int P dx} dx + C$

2.10 Vector Algebra

Vector: Quantity with magnitude and direction
Scalar: Quantity with only magnitude

Dot Product: $\vec{a} \cdot \vec{b} = |a||b| \cos\theta$
Definition: Scalar product of two vectors.

Cross Product: $\vec{a} \times \vec{b} = |a||b| \sin\theta \ \hat{n}$
Definition: Vector product perpendicular to both vectors.

Scalar Triple Product: $[\vec{a}\ \vec{b}\ \vec{c}] = \vec{a} \cdot (\vec{b} \times \vec{c})$
Definition: Volume of parallelepiped.

2.11 Three Dimensional Geometry

Direction Cosines: $l = \cos\alpha$, $m = \cos\beta$, $n = \cos\gamma$
Definition: Cosines of angles with coordinate axes.

Equation of Line:

$$\text{Vector: } \vec{r} = \vec{a} + \lambda\vec{b}$$
$$\text{Cartesian: } \frac{x - x_1}{a} = \frac{y - y_1}{b} = \frac{z - z_1}{c}$$

Definition: Different forms of line equation in 3D.

Equation of Plane:

$$\text{Vector: } \vec{r} \cdot \vec{n} = d$$
$$\text{Cartesian: } ax + by + cz = d$$

Definition: Different forms of plane equation.

Distance from Point to Plane: $d = \frac{|ax_1 + by_1 + cz_1 + d|}{\sqrt{a^2 + b^2 + c^2}}$
Definition: Perpendicular distance in 3D.

2.12 Probability

Conditional Probability: $P(A|B) = \dfrac{P(A \cap B)}{P(B)}$
Definition: Probability of A given that B has occurred.

Multiplication Theorem: $P(A \cap B) = P(A) \cdot P(B|A)$
Definition: Probability of both events occurring.

Independent Events: $P(A \cap B) = P(A)P(B)$
Definition: Occurrence of one doesn't affect the other.

Bayes' Theorem: $P(A|B) = \dfrac{P(B|A)P(A)}{P(B)}$
Definition: Relates conditional probabilities.

Random Variable: Variable whose values are numerical outcomes
Probability Distribution: List of probabilities for each value

Binomial Distribution: $P(X = r) = \binom{n}{r} p^r (1-p)^{n-r}$
Definition: Probability of r successes in n independent trials.

Mean: $E(X) = \sum x_i p_i$
Variance: $Var(X) = E(X^2) - [E(X)]^2$

2.13 Linear Programming

Objective Function: $Z = ax + by$
Definition: Function to be maximized or minimized.

Constraints: $a_1x + b_1y \leq c_1$, $a_2x + b_2y \leq c_2$, etc.
Definition: Limitations on variables.

Feasible Region: Area satisfying all constraints
Definition: Set of all possible solutions.

Corner Point Method: Evaluate objective function at vertices
Definition: Optimal solution occurs at corner points.