

[IIT-JEE MATHEMATICS]

JEE MAIN 2026 TO 2028

2026

COMPLETE *Syllabus*

CLASS 11 AND 12

MATHEMATICS

UNIT WISE

IN THIS SYLLABUS

PAPER	MATHEMATICS
UNITS	THIRTEEN
SCOPE	FULL JEE MAIN SYLLABUS
ALSO CARRIES	FORMULA BANKS · PRO TIPS
APPLIES TO	JEE MAIN 2026 TO 2028
PAIRED WITH	THE TWO YEAR COURSE PLANNER

[JEE MAIN]

How to read this syllabus

This is the Mathematics paper of JEE Main, set out unit by unit, in the order the examination itself lists them. It is the whole of what may be asked. Nothing here is optional, and nothing outside it is examinable.

Two kinds of card sit between the units. A gold card carries results worth committing to memory, the formula banks and the counting identities that save time in the hall. A dark card carries method, the approach to take when a question of that type appears. Neither is a substitute for the unit list above it.

Read this beside the course planner. The planner says when each of these units is taught and which lectures cover it; this document says what the examination expects of you once it has been.

[UNIT-WISE BREAKDOWN]

The Main syllabus *in full*

UNIT 01 Sets, Relations and Functions

- **Sets:** Representation and classification (Finite, Infinite, Empty, Singleton); Subsets and Power Set $P(A)$ containing 2^n elements; Universal set and Venn Diagrams.
- **Set Operations:** Laws of Algebra of Sets (Distributive, De Morgan's Laws, Idempotent, and Identity laws); Cardinality involving $n(A \cup B)$ and $n(A \cup B \cup C)$.
- **Relations:** Cartesian product of sets; Definition of Relation, Domain, and Range; Types: Reflexive, Symmetric, Transitive, and Anti-symmetric.
- **Equivalence:** Equivalence relations and Equivalence classes (Partitioning of a set into disjoint subsets).
- **Functions (Mapping):** Definition and conditions for a relation to be a function; Domain, Co-domain, and Range calculations.
- **Classification of Functions:** One-one (Injective), Onto (Surjective), Bijective functions; Into and Many-one mappings.
- **Composite & Inverse:** Composition of functions $f(g(x))$; Condition for existence of $f^{-1}(x)$ (Function

must be Bijjective).

HIGH-PRIORITY · RELATION COUNTING

Formula Bank: For a set with n elements:

- Total number of relations: 2^{n^2}
- Number of Reflexive relations: 2^{n^2-n}
- Number of Symmetric relations: $2^{\frac{n(n+1)}{2}}$

NTA often asks for the “smallest equivalence relation” (the Identity relation) or the “largest” (the Cartesian product $A \times A$).

PRO-TIP · MAPPING & CALCULUS LINK

The Derivative Test: To check if a function is One-One (Injective) in a given domain, check its monotonicity using $f'(x)$. If $f'(x) > 0$ or $f'(x) < 0$ strictly throughout the domain, the function is Injective.

Onto Check: Always compare the calculated **Range** with the given **Co-domain**. If $\text{Range} = \text{Co-domain}$, it is Surjective. This is a favorite for Section B numerical questions.

UNIT 02 Complex Numbers and Quadratic Equations

- **Complex Numbers:** Definition as ordered pairs (a, b) ; Algebraic operations (Addition, Multiplication, Division); Conjugate, Modulus, and Argument of complex numbers.
- **Geometric Representation:** Argand plane; Polar and Exponential ($re^{i\theta}$) forms; Triangle Inequality: $|z_1 + z_2| \leq |z_1| + |z_2|$ and $|z_1 - z_2| \geq ||z_1| - |z_2||$.
- **De Moivre's Theorem:** Roots of Unity (n -th roots); Properties of Cube Roots of Unity ($1, \omega, \omega^2$); Sum and Product of roots.
- **Quadratic Equations:** Standard form $ax^2 + bx + c = 0$; Nature of roots (Discriminant D); Relation between roots (α, β) and coefficients.
- **Advanced Theory:** Formation of equations with given roots; Common roots (One common vs. Both common); Transformation of equations.
- **Condition for Roots:** Real, Imaginary, and Rational roots; Range of Quadratic Expressions; Sign of Quadratic expressions in various intervals.

HIGH-PRIORITY · GEOMETRY OF Z

Locus Problems:

- $|z - z_1| = |z - z_2|$ represents the perpendicular bisector of the segment joining z_1 and z_2 .
- $|z - z_1| = k|z - z_2|$ represents a **Circle** if $k \neq 1$ (Apollonius Circle).
- $\arg(z - z_1) = \theta$ represents a ray starting from z_1 .

NTA frequently tests the distance of a point from a line in the complex plane and rotation of vectors using $e^{i\theta}$.

PRO-TIP · QUADRATIC & LOCATION OF ROOTS

Location of Roots Strategy: For problems where roots lie in a specific interval (k_1, k_2) , always check three conditions: 1. $D \geq 0$ (Real roots) 2. $a \cdot f(k) > 0$ (Function value at boundary) 3. $k_1 < -\frac{b}{2a} < k_2$ (Vertex position)

Newton's Sums: Use $aS_n + bS_{n-1} + cS_{n-2} = 0$ for expressions involving $\alpha^n + \beta^n$. This is a massive time-saver for JEE Main Section B.

UNIT 03 Matrices and Determinants

- **Matrices:** Definition, Order, and Types (Identity, Diagonal, Scalar, Upper/Lower Triangular, Nilpotent, Idempotent, Involutory).
- **Matrix Algebra:** Addition, Scalar multiplication, and Matrix multiplication (non-commutative); Properties of Transpose $(AB)^T = B^T A^T$.
- **Symmetry:** Symmetric and Skew-symmetric matrices ($A = -A^T$); Every square matrix can be expressed as the sum of a symmetric and skew-symmetric matrix.
- **Determinants:** Evaluation of 2×2 and 3×3 determinants; Properties of determinants (Scaling, Row /- Column operations, Product rule $|AB| = |A||B|$).
- **Adjoint & Inverse:** Singular and Non-singular matrices; Adjoint properties: $A(\text{adj } A) = |A|I$; Inverse formula $A^{-1} = \frac{1}{|A|}\text{adj } A$.
- **System of Equations:** Consistency and solutions using **Cramer's Rule** and **Matrix Inverse Method**; Trivial vs. Non-trivial solutions for homogeneous systems.

HIGH-PRIORITY · ADJOINT PROPERTIES

The "NTA Specials": For a matrix of order n :

- $|\text{adj } A| = |A|^{n-1}$
- $|\text{adj}(\text{adj } A)| = |A|^{(n-1)^2}$
- $\text{adj}(kA) = k^{n-1}\text{adj } A$

These are frequently tested in "Multiple Correct" or "Numerical" type questions to check speed with power laws.

PRO-TIP · SYSTEM OF EQUATIONS

Cramer's Shortcut: If $\Delta \neq 0$, the system is Consistent with a **Unique Solution**.

If $\Delta = 0$:

1. If $\Delta_x = \Delta_y = \Delta_z = 0$, the system has **Infinite Solutions** (usually).
2. If at least one of $\Delta_x, \Delta_y, \Delta_z \neq 0$, the system is **Inconsistent** (No Solution).

Always check if the planes are parallel before concluding infinite solutions.

UNIT 04 Permutations and Combinations

- **Fundamental Principle:** Addition Principle (OR) and Multiplication Principle (AND); Factorial notation $n!$ and its properties.
- **Permutations ($P(n, r)$):** Arrangement of n distinct objects taken r at a time; Circular permutations $(n - 1)!$.
- **Restricted Permutations:** Arrangement when certain objects are always included, excluded, or kept together (String method vs. Gap method).
- **Combinations ($C(n, r)$):** Selection of n objects taken r at a time; Relationship $nPr = r! \cdot nCr$.
- **Identical Objects:** Permutations of n objects where p are of one kind, q of another: $\frac{n!}{p!q!}$.
- **Divisions & Distributions:** Division of objects into groups of equal or unequal sizes; Distribution of n identical objects into r distinct boxes (Beggar's Method).

HIGH-PRIORITY · COMBINATORIAL IDENTITIES

The "NTA Favorites": Ensure mastery of these results for simplification:

- $\binom{n}{r} + \binom{n}{r-1} = \binom{n+1}{r}$ (Pascal's Rule)
- $\binom{n}{r} = \binom{n}{n-r}$
- $\sum_{r=0}^n \binom{n}{r} = 2^n$

NTA often frames questions using the **Pascal's Rule** in summation series.

PRO-TIP · ADVANCED COUNTING

The Beggar's Method: The number of non-negative integer solutions to $x_1 + x_2 + \cdots + x_r = n$ is:

$$\binom{n+r-1}{r-1}$$

Constraint Handling: If $x_i \geq 1$ (positive integers), the formula becomes:

$$\binom{n-1}{r-1}$$

Derangements: For problems where “no object goes to its original place,” use the formula: $D_n = n! \left[\frac{1}{2!} - \frac{1}{3!} + \cdots + \frac{(-1)^n}{n!} \right]$. (Note: $1 - \frac{1}{1!}$ cancels out to zero.)

UNIT 05 Binomial Theorem and Its Simple Applications

- **Expansion:** Binomial theorem for a positive integral index: $(a+b)^n = \sum_{r=0}^n nCr \cdot a^{n-r} b^r$.
- **General Term:** The $(r+1)^{th}$ term formula: $T_{r+1} = nCr \cdot x^{n-r} y^r$.
- **Middle Term:** Finding the middle term(s) based on n being even ($n/2 + 1$) or odd ($\frac{n+1}{2}$ and $\frac{n+3}{2}$).
- **Greatest Term:** Finding the Numerically Greatest Term (NGT) in an expansion for a given value of x .
- **Properties of Coefficients:** Relations between binomial coefficients: $C_0 + C_1 + \cdots + C_n = 2^n$ and $C_0 - C_1 + C_2 - \cdots = 0$.
- **Applications:** Finding remainders and last digits; Fractional part of $(a + \sqrt{b})^n$; Binomial series for any index (basic concepts).

HIGH-PRIORITY · TERM INDEPENDENT OF X

The Quick Formula: In the expansion of $(ax^p + \frac{b}{x^q})^n$, the term independent of x is T_{r+1} where:

$$r = \frac{np}{p+q}$$

If r is not an integer, there is no term independent of x . This saves significant time over the manual general term method.

PRO-TIP · REMAINDER & DIVISIBILITY

Remainder Strategy: To find the remainder of a^n when divided by k , express a as $(mk \pm 1)$.

- **Example:** $7^{103} \div 25$. Write $7^2 = 49 = (50 - 1)$. Then $7^{103} = 7(49)^{51} = 7(50 - 1)^{51}$.
- Expand and focus only on the last term: $7(-1)^{51} = -7$.
- Remainder = $25 - 7 = 18$.

Always target the coefficient of x^n in multinomial expansions using $(x_1 + x_2 + \dots + x_k)^n = \sum \frac{n!}{n_1!n_2!\dots n_k!} x_1^{n_1} x_2^{n_2} \dots x_k^{n_k}$.

UNIT 06 Limit, Continuity and Differentiability

- **Functions:** Real-valued functions; Algebra of functions; Domain and Range of Polynomial, Rational, Trigonometric, Logarithmic, and Exponential functions.
- **Composite & Inverse:** Domain and Range of $f(g(x))$; Properties of Inverse functions; Graphs of standard functions and their transformations.
- **Limits:** Existence of limits (LHL = RHL); Standard limits ($\frac{\sin x}{x}$, $\frac{e^x - 1}{x}$, $\frac{\ln(1+x)}{x}$); Sandwich Theorem; L'Hôpital's Rule (for $\frac{0}{0}$ and $\frac{\infty}{\infty}$ forms); Evaluation of 1^∞ forms.
- **Continuity:** Continuity at a point and in an interval; Algebra of continuous functions; Continuity of composite functions; Intermediate Value Theorem (IVT) and its applications in root finding.
- **Differentiability:** Differentiability at a point and in an interval; Relation between continuity and differentiability (Differentiability $\implies$ Continuity); Geometrical meaning of the derivative.
- **Differentiation:** Chain rule; Derivatives of Inverse Trigonometric, Implicit, and Parametric functions; Logarithmic differentiation; Second and higher-order derivatives.
- **Applications (AOD):** Rate of change; Tangents and Normals; Rolle's and Lagrange's Mean Value Theorems (LMVT).
- **Monotonicity & Extremas:** Increasing/Decreasing functions; Maxima and Minima (First and Second derivative tests); Optimization problems.

PRO-TIP · LIMITS & DIFFERENTIABILITY

Limits Strategy: For 1^∞ forms, use the shortcut: $\lim_{x \rightarrow a} [f(x)]^{g(x)} = e^{\lim_{x \rightarrow a} g(x)[f(x)-1]}$. This is much faster than taking logs.

Continuity Check: In piecewise functions, always check the "junction points." For Differentiability, if $f(x)$ is continuous, check the Left-Hand Derivative (LHD) and Right-Hand Derivative (RHD) using the power rule unless the function involves a Modulus or GIF at that point.

HIGH-PRIORITY · ADVANCED AOD CONCEPTS

LMVT Application: If $f'(x) > 0$ for all $x \in (a, b)$, then $f(x)$ is strictly increasing. This is the foundation for solving “Number of Roots” problems.

Vertical Tangents: If $f'(a) \rightarrow \infty$, the function has a vertical tangent at $x = a$. Check this specifically for functions involving $\sqrt[3]{x}$ or similar fractional powers.

Point of Inflection: A point where $f''(x) = 0$ (and changes sign) is where the concavity changes. NTA frequently links this with the “Nature of Roots” of the cubic equation.

PRO-TIP · THE ‘SHARP CORNER’ RULE

For functions like $|f(x)|$, the points where $f(x) = 0$ are potential points of non-differentiability (“Sharp Corners”).

Quick Check: If $f(a) = 0$ and $f'(a) \neq 0$, then $|f(x)|$ is NOT differentiable at $x = a$. If $f(a) = 0$ and $f'(a) = 0$, then $|f(x)|$ IS differentiable at $x = a$.

UNIT 07 Integral Calculus

- Integral as an anti-derivative, Fundamental integrals involving algebraic, trigonometric, exponential and logarithmic functions.
- Integration by substitution, by parts and by partial fractions. Integration using trigonometric identities.
- **Standard Integral Forms:**

$$\int \frac{dx}{x^2 + a^2}, \int \frac{dx}{\sqrt{x^2 \pm a^2}}, \int \frac{dx}{a^2 - x^2}, \int \frac{dx}{\sqrt{a^2 - x^2}}, \int \frac{dx}{ax^2 + bx + c}, \int \frac{dx}{\sqrt{ax^2 + bx + c}}$$

$$\int \frac{(px + q)dx}{ax^2 + bx + c}, \int \frac{(px + q)dx}{\sqrt{ax^2 + bx + c}}, \int \sqrt{a^2 \pm x^2} dx, \int \sqrt{x^2 - a^2} dx$$

DEFINITE INTEGRALS & AREA

- Fundamental theorem of calculus; Calculation of definite integrals using substitution and properties.
- **Core Properties:** King’s Property, Queen’s Property, and Piecewise integration (Modulus/GIF functions).
- Evaluation of definite integrals as a limit of a sum.
- **Leibniz Rule:** Differentiation under the integral sign.
- **Area Under Curve:** Determining areas of regions bounded by simple curves (Parabolas, Circles, Ellipses) in standard forms and lines.

HIGH-PRIORITY · DEFINITE INTEGRAL STRATEGY

The “King” Rule: $\int_a^b f(x) dx = \int_a^b f(a+b-x) dx$ is used in nearly 70% of JEE Main definite integral problems. Use it whenever you see symmetric limits or complex denominators.

NTA Favorite: Always be prepared for the **Leibniz Rule** application in limit-based problems. For Area questions, always sketch the curves first to identify the correct points of intersection and the “Upper - Lower” curve logic.

Limit as Integral Sum: To solve $\lim_{n \rightarrow \infty} \sum f(r, n)$:

- Replace $\frac{r}{n}$ with x .
- Replace $\frac{1}{n}$ with dx .
- Replace $\lim_{n \rightarrow \infty} \sum$ with $\int$.
- Lower Limit: $\lim_{n \rightarrow \infty} \left(\frac{r_{\min}}{n}\right)$; Upper Limit: $\lim_{n \rightarrow \infty} \left(\frac{r_{\max}}{n}\right)$.

NTA frequently gives series where you must first factor out n to create the $\frac{r}{n}$ terms.

UNIT 08 Differential Equations

- **Basics:** Definition, Order, and Degree of ordinary differential equations (ODE); Formation of differential equations by eliminating arbitrary constants.
- **Variable Separable:** Solution by separating x and y terms; Equations reducible to variable separable form using substitution (e.g., $v = ax + by + c$).
- **Homogeneous ODE:** Identification and solution of $\frac{dy}{dx} = f\left(\frac{y}{x}\right)$ using the substitution $y = vx$.
- **Linear ODE:** Solution of first-order linear equations of the form $\frac{dy}{dx} + P(x)y = Q(x)$ using the **Integrating Factor:** $IF = e^{\int P(x)dx}$.
- **Exact Form:** Recognition of the form $f'(y)\frac{dy}{dx} + P(x)f(y) = Q(x)$ (Bernoulli’s Equation reducible to linear).

PRO-TIP · DIFFERENTIAL EQUATION SHORTCUTS

Variable Separable Check: If the equation is $\frac{dy}{dx} = f(ax + by + c)$, always substitute $t = ax + by + c$. This transforms the equation into a separable one instantly.

Integrating Factor (IF): Always simplify the IF before multiplying. Remember that $e^{\ln(f(x))} = f(x)$. This is the most common area where students make calculation errors in Section B.

UNIT 09 Co-ordinate Geometry

- **Basics:** Cartesian coordinate system; Distance formula; Section formula (Internal and External); Area of a triangle and condition for collinearity.
- **Locus:** Definition and method to find the equation of a locus; Translation and Rotation of axes (Shift of origin).
- **Straight Line:** Various forms: Slope-intercept ($y = mx + c$), Point-slope, Two-point, Intercept ($\frac{x}{a} + \frac{y}{b} = 1$), and Normal form ($x \cos \alpha + y \sin \alpha = p$).
- **Interactions:** Angle between two lines; Conditions for Parallelism ($m_1 = m_2$) and Perpendicularity ($m_1 m_2 = -1$); Distance of a point from a line; Distance between parallel lines.
- **Family of Lines:** Equation of a line passing through the intersection of two lines ($L_1 + \lambda L_2 = 0$); Condition for concurrence of three lines.
- **Triangle Centers:** Coordinates and properties of Centroid (G), Incentre (I), Orthocentre (H), and Circumcentre (O); Ex-centres of a triangle.
- **Circle:** Standard and General equations ($x^2 + y^2 + 2gx + 2fy + c = 0$); Radius and Centre; Equation of a circle in diameter form.
- **Circle Interactions:** Intersection of a line and a circle; Condition for tangency ($p = r$); Equation of tangent (Point form and Slope form).

HIGH-PRIORITY · TRIANGLE GEOMETRY

The Euler Line: In any non-equilateral triangle, the Orthocentre (H), Centroid (G), and Circumcentre (O) are collinear. G divides the segment HO in the ratio 2 : 1 (H - G - O).

Incentre Note: Unlike G , H , and O , the Incentre coordinates involve the lengths of the sides (a, b, c): $I = \left(\frac{ax_1 + bx_2 + cx_3}{a+b+c}, \frac{ay_1 + by_2 + cy_3}{a+b+c} \right)$. NTA often gives coordinates where side lengths are integers (Pythagorean triples).

PRO-TIP · CIRCLES & POWER OF POINT

Tangency Shortcut: For the circle $x^2 + y^2 = r^2$, the line $y = mx + c$ is a tangent if $c^2 = r^2(1 + m^2)$. This avoids solving the quadratic.

Length of Tangent: The length of the tangent from an external point (x_1, y_1) to the circle $S = 0$ is $\sqrt{S_1}$.

Common Tangents: For two circles with radii r_1, r_2 and distance between centers d :

- 4 tangents if $d > r_1 + r_2$ (External)
- 3 tangents if $d = r_1 + r_2$ (Touching externally)
- 2 tangents if $|r_1 - r_2| < d < r_1 + r_2$ (Intersecting)

- **Circle & Conics:** Standard and general form of circle, radius and centre, diameter endpoints, intersection of line and circle.

PRO-TIP · CIRCLES & TANGENCY

For “Line and Circle” problems, always check the perpendicular distance (p) from the center to the line. If $p < r$, it's a secant; if $p = r$, it's a tangent. This is much faster than solving quadratic equations.

- **Conic Sections:** Standard forms of Parabola, Ellipse and Hyperbola.

HIGH-PRIORITY · CONIC SECTIONS STRATEGY

Parametric Mastery: Use $(at^2, 2at)$ for the Parabola and $(a \cos \theta, b \sin \theta)$ for the Ellipse. Most “Shortest Distance” problems between a curve and a line are solved by finding a point where the tangent is parallel to the given line.

Focal Chord Property: Don't forget that for a Parabola $y^2 = 4ax$, the length of a focal chord with one end at ' t ' is $a(t + 1/t)^2$.

UNIT 10 Vector Algebra

- **Basics:** Scalars and Vectors; Types of vectors (Unit, Null, Parallel, Collinear, Coplanar, and Orthogonal); Position vector of a point; Section formula in vector form.
- **Components:** Addition and Subtraction of vectors; Multiplication by a scalar; Components of a vector in 2D and 3D space ($\vec{a} = x\hat{i} + y\hat{j} + z\hat{k}$).
- **Scalar Product (Dot):** Definition $\vec{a} \cdot \vec{b} = |\vec{a}||\vec{b}| \cos \theta$; Properties; Projection of a vector on another; Angle between two vectors.
- **Vector Product (Cross):** Definition $\vec{a} \times \vec{b} = |\vec{a}||\vec{b}| \sin \theta \hat{n}$; Properties; Geometrical interpretation as the area of a Parallelogram and Triangle.
- **Scalar Triple Product (STP):** Definition $[\vec{a} \vec{b} \vec{c}] = \vec{a} \cdot (\vec{b} \times \vec{c})$; Properties; Volume of a Parallelepiped; Condition for coplanarity of three vectors ($[\vec{a} \vec{b} \vec{c}] = 0$).
- **Vector Triple Product (VTP):** Expansion formula $\vec{a} \times (\vec{b} \times \vec{c}) = (\vec{a} \cdot \vec{c})\vec{b} - (\vec{a} \cdot \vec{b})\vec{c}$; Linear combination of vectors.

HIGH-PRIORITY · VECTOR TRIPLE PRODUCT (VTP)

The “abc-bac” Rule: Always remember the expansion:

$$\vec{a} \times (\vec{b} \times \vec{c}) = (\vec{a} \cdot \vec{c})\vec{b} - (\vec{a} \cdot \vec{b})\vec{c}$$

This vector always lies in the plane of $\vec{b}$ and $\vec{c}$. NTA often tests this by asking for a vector coplanar with $\vec{b}, \vec{c}$ but perpendicular to $\vec{a}$.

PRO-TIP · PROJECTION & GEOMETRICAL APPLICATIONS

Projection Strategy: The scalar projection of $\vec{a}$ on $\vec{b}$ is $\frac{\vec{a} \cdot \vec{b}}{|\vec{b}|}$. The vector projection is $\left(\frac{\vec{a} \cdot \vec{b}}{|\vec{b}|^2} \right) \vec{b}$.

Area of Quadrilaterals: If $\vec{d}_1$ and $\vec{d}_2$ are the diagonals of a quadrilateral, its area is given by $\frac{1}{2} |\vec{d}_1 \times \vec{d}_2|$.

Unit Vector Trick: To find a unit vector perpendicular to both $\vec{a}$ and $\vec{b}$, calculate $\pm \frac{\vec{a} \times \vec{b}}{|\vec{a} \times \vec{b}|}$. This is a standard opening step for many 4-mark questions.

UNIT 11 Three Dimensional Geometry

- **Basics:** Coordinates of a point in 3D space; Distance formula; Section formula; Direction Cosines (l, m, n) and Direction Ratios (a, b, c) ; Relation $l^2 + m^2 + n^2 = 1$.
- **Lines in Space:** Cartesian and Vector equations of a line passing through a point and parallel to a vector; Line passing through two given points.
- **Angle & Intersections:** Angle between two lines $\cos \theta = \frac{|a_1 a_2 + b_1 b_2 + c_1 c_2|}{\sqrt{a_1^2 + b_1^2 + c_1^2} \sqrt{a_2^2 + b_2^2 + c_2^2}}$; Condition for parallelism and perpendicularity.
- **Skew Lines:** Definition of skew lines (non-parallel, non-intersecting); Shortest distance (SD) between two skew lines.
- **Shortest Distance Formula:** $SD = \frac{|(\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 \times \vec{b}_2)|}{|\vec{b}_1 \times \vec{b}_2|}$; Distance between parallel lines.
- **Point & Line:** Coordinates of the foot of the perpendicular from a point to a line; Image of a point in a line; Reflection of a line in a plane (basic concepts).

HIGH-PRIORITY · SHORTEST DISTANCE STRATEGY

The “Coplanar” Condition: Two lines $\vec{r} = \vec{a}_1 + \lambda \vec{b}_1$ and $\vec{r} = \vec{a}_2 + \mu \vec{b}_2$ are **Coplanar** (intersecting) if their Shortest Distance is ZERO:

$$(\vec{a}_2 - \vec{a}_1) \cdot (\vec{b}_1 \times \vec{b}_2) = 0$$

In Cartesian form, this is the determinant $\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_2 - a_1 & b_2 - b_1 & c_2 - c_1 \\ d_2 - d_1 & e_2 - e_1 & f_2 - f_1 \end{vmatrix} = 0$ with D.R.s in the second and third rows. NTA often asks for the “Point of Intersection” of such lines, solve by equating the general points of both lines.

PRO-TIP · FOOT OF PERPENDICULAR & IMAGE

The Parametric Method: To find the foot of the perpendicular from point $P(x_1, y_1, z_1)$ to a line L :

- Assume a general point Q on the line in terms of parameter λ .
- Find the D.R.s of the vector $\vec{PQ}$.
- Use the dot product $\vec{PQ} \cdot \vec{b} = 0$ (where $\vec{b}$ is the D.R. of the line) to find λ .
- **Image Trick:** Once you have the Foot Q , the Image P' is simply $2Q - P$ (using the midpoint formula).

UNIT 12 Statistics and Probability

- **Measures of Central Tendency:** Calculation of Mean, Median, and Mode for ungrouped and grouped data; Relationship: $\text{Mode} = 3\text{Median} - 2\text{Mean}$.
- **Measures of Dispersion:** Range, Mean Deviation, Variance (σ^2), and Standard Deviation (σ); Variance of first n natural numbers: $\frac{n^2 - 1}{12}$.
- **Data Handling:** Calculation of variance for combined sets; Effects of “Change of Origin” and “Change of Scale” on Mean and Variance.
- **Probability Basics:** Random experiments, Sample space, and Events; Addition and Multiplication theorems; Conditional probability and Independent events.
- **Advanced Probability:** Total Probability Theorem; **Baye's Theorem** for inverse probability; Probability distribution of a random variable.
- **Binomial Distribution:** Bernoulli trials and Binomial distribution (Mean = np , Variance = npq); Problems involving “at least” and “at most” conditions.

HIGH-PRIORITY · VARIANCE & SCALE PROPERTY

The Property Table: If every observation x_i is changed to $ax_i + b$:

- **New Mean:** $\bar{x}_{new} = a\bar{x} + b$
- **New Variance:** $\sigma_{new}^2 = a^2\sigma^2$
- **New SD:** $\sigma_{new} = |a|\sigma$

Notice that the constant b (Change of Origin) **does not** affect Variance or SD. NTA often asks for the new variance after adding a constant to all observations, the answer remains unchanged!

PRO-TIP · BAYE'S THEOREM & BERNOULLI

Baye's Selection: Always identify the "Partition of Sample Space" ($E_1, E_2, \dots$) and the "Common Event" (A). The probability of E_i given A occurred is:

$$P(E_i|A) = \frac{P(E_i)P(A|E_i)}{\sum P(E_j)P(A|E_j)}$$

Bernoulli Shortcut: For "Probability of at least one success" in n trials, always use $1 - P(\text{No success}) = 1 - q^n$. This is the single most common probability question in JEE Main.

UNIT 13 Trigonometry

- **Identities:** Fundamental identities; Sum and Difference formulas: $\sin(A \pm B)$, $\cos(A \pm B)$, $\tan(A \pm B)$; Multiple and Sub-multiple angles ($2\theta, 3\theta$); Transformation formulas (Product to Sum and vice-versa).
- **Functions:** Domain, Range, and Periodicity of the six basic trigonometric functions; Graphs and their transformations.
- **Equations:** General solutions of trigonometric equations like $\sin \theta = \sin \alpha$, $\cos \theta = \cos \alpha$, and $\tan \theta = \tan \alpha$.
- **Inverse Trig (ITF):** Definition, Domain, and Principal Value Branch of $\sin^{-1} x$, $\cos^{-1} x$, $\tan^{-1} x, \dots$; Graphs of inverse functions.
- **Properties of ITF:** Relationship between different inverse functions; Sum and Difference of inverse functions (e.g., $\tan^{-1} x + \tan^{-1} y$); Composition of functions like $\sin(\sin^{-1} x)$ and $\sin^{-1}(\sin x)$.

HIGH-PRIORITY · ITF PRINCIPAL VALUES

The Range Trap: Always ensure the final result lies within the **Principal Value Branch**:

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

Critical Identity: $\sin^{-1}(\sin x) = x$ ONLY if $x \in [-\pi/2, \pi/2]$. If x is outside this range, use the graph or periodicity to shift x into the principal interval. This is a 100% guaranteed question type in JEE Main.

PRO-TIP · TRIGONOMETRIC SERIES & SUMS

Sine/Cosine Series: For angles in A.P. $(\alpha, \alpha + \beta, \dots)$:

$$\sum_{k=0}^{n-1} \sin(\alpha + k\beta) = \frac{\sin(n\beta/2)}{\sin(\beta/2)} \sin\left(\alpha + \frac{(n-1)\beta}{2}\right)$$

ITF Series: To sum a series of $\tan^{-1}$, use the **Method of Differences** (V-n method) by expressing the general term as:

$$\tan^{-1}\left(\frac{x_{n+1} - x_n}{1 + x_{n+1}x_n}\right) = \tan^{-1}x_{n+1} - \tan^{-1}x_n$$

Most terms will cancel out, leaving only the first and last.

FINAL STRATEGY · JEE MAIN 2026-2028 MASTER PLAN

Tier 1: The “Heavy Hitters” (Focus: 45-50% Weightage) Prioritize **Units 3, 6, 7, and 10**. These units (Matrices, Calculus, and Vectors) are the highest ROI topics. Mastery here guarantees a solid base score.

Tier 2: The “Precision” Units (Focus: 25-30% Weightage) **Units 9, 11, and 12** (Coordinate Geometry, 3D, and Stats). These are formula-heavy but predictable. Scoring here depends on your speed and accuracy with standard results.

Tier 3: The “Rank Boosters” (Focus: 20-25% Weightage) **Units 1, 2, 4, and 5**. While these can be tricky, they often provide the “Numerical Type” questions in Section B.

Ritesh Sir Advice: *Dedicate the last 15 days to solving PYQs (2023-2025) in a timed environment. In Mathematics, “knowing” the method isn’t enough, reaching the final answer without calculation errors is what gets you the percentile.*

OFFICIAL SYLLABUS RELEASE

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