

Most Important Maths Formulas for JEE Main Updated Formulas, Download PDF



Coordinate Geometry

- **Straight line**

1. Slope formula

$$m : \frac{y_2 - y_1}{x_2 - x_1}$$

2. Slope-intercept formula:

$$y = mx + c$$

3. Point-slope formula:

$$y - y_1 = m(x - x_1)$$

4. General form of a line:

$$Ax + By + C = 0$$

5. Slope from the general form:

$$m = -\frac{A}{B}$$

6. Distance formula:

$$|\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}|$$

• Circles

1. General equations of a circle:

$$|x^2 + y^2 + 2gx + 2fy + c = 0|$$

2. Centre of a circle:

$$|(-g, -f)|$$

3. Radius of a circle:

$$|r = \sqrt{g^2 + f^2 - c}|$$

4. Standard circle equation:

$$|(x - a)^2 + (y - b)^2 = r^2|$$

5. Length of the tangent from the point:

$$|\sqrt{x_1^2 + y_1^2 + 2gx_1 + 2fy_1 + c}|$$

• Parabola

1. Standard parabola:

$$|y^2 = 4ax|$$

2. Focus of the parabola:

$$|(a, 0)|$$

3. Latus rectum length of parabola:

$$4a$$

• Ellipse

1. Standard ellipse:

$$|\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1|$$

2. Ellipse focal relation:

$$|c^2 = a^2 - b^2|$$

- **Hyperbola**

1. Standard hyperbola:

$$|\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1|$$

2. Hyperbola focal relocation:

$$|c^2 = a^2 + b^2|$$

3. Asymptotes of a hyperbola:

$$|y = \pm \frac{b}{a}x|$$

Differential Calculus – Limits, Continuity and Differentiability

(Expected 3-4 questions in JEE Main)

- **Standard trigonometric limits**

1. $\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$

2. $\lim_{x \rightarrow 0} \frac{\tan x}{x} = 1$

$$\lim_{x \rightarrow 0} \frac{1 - \cos x}{x^2} = \frac{1}{2}$$

- **Exponential/Log Limits**

1. $\lim_{x \rightarrow 0} (1 + x)^{1/x} = e$

2. $\lim_{x \rightarrow 0} \frac{e^x - 1}{x} = 1$

3. $\lim_{x \rightarrow 0} \frac{\ln(1 + x)}{x} = 1$

- **Algebraic Limits**

$$1. \quad \lim_{x \rightarrow a} \frac{x^n - a^n}{x - a} = na^{n-1}$$

$$2. \quad \lim_{x \rightarrow 0} \frac{\sqrt{1+x} - 1}{x} = \frac{1}{2}$$

• L hospital type rule

$$1. \quad \text{If } \lim_{x \rightarrow a} \frac{f(x)}{g(x)} \text{ is of the form } \frac{0}{0},$$

$$2. \quad \lim_{x \rightarrow a} \frac{f(x)}{g(x)} = \lim_{x \rightarrow a} \frac{f'(x)}{g'(x)}$$

• Continuity Rules

1. Continuity at a point: A function $f(x)$ is continuous at $x=a$ if:

$$\lim_{x \rightarrow a} f(x) = f(a)$$

2. Polynomial functions are always continuous for all real numbers.

3. Rational functions are continuous except where the denominator = 0.

4. $\sin x$, $\cos x$, and e^x are continuous in their domain.

5. For a piecewise-defined function to be continuous at

$$x = a : LHL = RHL = f(a)$$

• Left-Hand and Right-Hand Limits:

For $f(x)$ to be continuous at $x = a$:

Skip to main content

$$\lim_{x \rightarrow a^-} f(x) = \lim_{x \rightarrow a^+} f(x) = f(a).$$

• Algebra of Continuous Functions

If f and g are continuous at a , then these are also continuous:

$$1. f(x) + g(x)$$

$$2. f(x) - g(x)$$

$$3. f(x) \cdot g(x)$$

• Differentiability

Condition for differentiability:

$$f \text{ is differentiable at } a \iff \lim_{h \rightarrow 0} \frac{f(a+h) - f(a)}{h}$$

- **Derivatives**

- Power rule:**

$$\frac{d}{dx}(x^n) = nx^{n-1}$$

- **Trigonometry:**

$$1. \quad \frac{d}{dx}(\sin x) = \cos x$$

$$2. \quad \frac{d}{dx}(\cos x) = -\sin x$$

$$3. \quad \frac{d}{dx}(\tan x) = \sec^2 x$$

$$4. \quad \frac{d}{dx}(\cot x) = -\csc^2 x$$

$$5. \quad \frac{d}{dx}(\sec x) = \sec x \tan x$$

$$6. \quad \frac{d}{dx}(\csc x) = -\csc x \cot x$$

- **Inverse trigonometric derivatives**

$$1. \quad \frac{d}{dx}(\sin^{-1} x) = \frac{1}{\sqrt{1-x^2}}$$

$$2. \quad \frac{d}{dx}(\cos^{-1} x) = -\frac{1}{\sqrt{1-x^2}}$$

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$$\frac{d}{dx}(\tan^{-1} x) = \frac{1}{1+x^2}$$

- **Exponential log:**

$$1. \quad \frac{d}{dx}(e^x) = e^x$$

$$2. \quad \frac{d}{dx}(a^x) = a^x \ln a$$

$$3. \quad \frac{d}{dx}(\ln x) = \frac{1}{x}$$

- **Product rule:**

$$\frac{d}{dx}[u \cdot v] = u'v + uv'$$

- **Quotient rule:**

$$\frac{d}{dx}\left(\frac{u}{v}\right) = \frac{u'v - uv'}{v^2}$$

- **Chain rule:**

$$\frac{d}{dx}[f(g(x))] = f'(g(x)) \cdot g'(x)$$

- **Continuity of Standard Functions (All Continuous Everywhere):**

1. Polynomials
2. Rational functions (except where denominator = 0)
3. Trigonometric functions
4. Exponential functions
5. Logarithmic functions (continuous on $x > 0$)

Integral Calculus (Indefinite Integrals, Standard Integrals, Definite Integrals, Properties and Integration Methods)

(Expected 3-5 questions in JEE Main from Integral Calculus)

- **Basic integration rules**

1. Power rule:

$$\int x^n dx = \frac{x^{n+1}}{n+1} + C \quad (n \neq -1)$$

2. Integral of

$$1/x : \int \frac{1}{x} dx = \ln|x| + C$$

3. Constant rule:

$$\int k f(x) dx = k \int f(x) dx$$

4. Sum rule:

$$\int [f(x) + g(x)] dx = \int f(x) dx + \int g(x) dx$$

- **Standard integrals**

1. Exponential:

$$\int e^x dx = e^x + C$$

$$\int a^x dx = \frac{a^x}{\ln a} + C$$

2. Trigonometric:

$$\int \sin x dx = -\cos x + C$$

$$\int \cos x dx = \sin x + C$$

$$\int \sec^2 x dx = \tan x + C$$

$$\int \csc^2 x dx = -\cot x + C$$

$$\int \sec x \tan x dx = \sec x + C$$

$$\int \csc x \cot x dx = -\csc x + C$$

- **Inverse trigonometric:**

$$\int \frac{1}{\sqrt{1-x^2}} dx = \sin^{-1}(x) + C$$

$$\int \frac{-1}{\sqrt{1-x^2}} dx = \cos^{-1}(x) + C$$

$$\int \frac{1}{1+x^2} dx = \tan^{-1}(x) + C$$

- Hyperbolic integrals:

$$\int \sinh x dx = \cosh x + C$$

$$\int \cosh x dx = \sinh x + C$$

- Special standard integrals:

$$\int \frac{1}{a^2+x^2} dx = \frac{1}{a} \tan^{-1}\left(\frac{x}{a}\right) + C$$

$$\int \frac{1}{\sqrt{x^2-a^2}} dx = \ln|x + \sqrt{x^2-a^2}| + C$$

$$\int \frac{1}{a^2-x^2} dx = \frac{1}{2a} \ln\left|\frac{a+x}{a-x}\right| + C$$

$$\int \sqrt{a^2-x^2} dx = \frac{x}{2} \sqrt{a^2-x^2} + \frac{a^2}{2} \sin^{-1}\left(\frac{x}{a}\right) + C$$

$$\int \sqrt{x^2 - a^2} dx = \frac{x}{2} \sqrt{x^2 - a^2} - \frac{a^2}{2} \ln |x + \sqrt{x^2 - a^2}| + C$$

- Methods of integration:

Integration by substitution:

$$\text{If } u = g(x), \quad \int f(u) du = \int f(g(x)) g'(x) dx$$

Integration by parts:

$$\int u dv = uv - \int v du$$

ILATE Rule:

$$I \text{ (Inverse)} > L \text{ (Log)} > A \text{ (Algebraic)} > T \text{ (Trigonometric)} > E \text{ (Exponential)}$$

- Partial fractions:

Linear factors:

$$\text{If } \frac{P(x)}{(x-a)(x-b)}, \quad \frac{P(x)}{(x-a)(x-b)} = \frac{A}{x-a} + \frac{B}{x-b}$$

Repeated linear factors:

$$\frac{1}{(x-a)^2(x-b)} = \frac{A}{x-a} + \frac{B}{(x-a)^2} + \frac{C}{x-b}$$

Quadratic irreducible factors:

$$\frac{1}{(x^2 + a^2)(x-b)} = \frac{Ax + B}{x^2 + a^2} + \frac{C}{x-b}$$

- **Must know standard integrations from partial fractions:**

$$\int \frac{1}{x+a} dx = \ln |x+a| + C$$

$$\int \frac{1}{x^2 + a^2} dx = \frac{1}{a} \tan^{-1} \left(\frac{x}{a} \right) + C$$

$$\int \frac{x}{x^2 + a^2} dx = \frac{1}{2} \ln(x^2 + a^2) + C$$

- **Trigonometric integrations:**

1. Using identities –

- Powers of sine & cosine:

If power is odd, strip a sine/cosine.

If powers are both even, use half-angle formulas:

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

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

- Important standard integrals:

$$\int \tan x dx = -\ln |\cos x| + C$$

$$\int \cot x dx = \ln |\sin x| + C$$

$$\int \sec x dx = \ln |\sec x + \tan x| + C$$

$$\int \csc x dx = \ln |\csc x - \cot x| + C$$

$$\int \sec^2 x \, dx = \tan x + C$$

$$\int \csc^2 x \, dx = -\cot x + C$$

- Trigonometric standard integrals:

$$\int \tan x \, dx = -\ln |\cos x|$$

$$\int \sec x \, dx = \ln |\sec x + \tan x|$$

- Definite integrals:

- Fundamental theorem of calculus:

$$\int_a^b f'(x) \, dx = f(b) - f(a)$$

- Property: Change of limits:

$$\int_a^b f(x) \, dx = -\int_b^a f(x) \, dx$$

- Symmetry (even/odd functions):

$$\int_{-a}^a f(x) \, dx = 2 \int_0^a f(x) \, dx \quad (\text{even})$$

$$\int_{-a}^a f(x) \, dx = 0 \quad (\text{odd})$$

- Important property for JEE:

$$\int_0^a f(x) \, dx = \int_0^a f(a-x) \, dx$$

- Periodicity:

$$f(x + T) = f(x) \Rightarrow$$

$$\int_0^{nT} f(x) dx = n \int_0^T f(x) dx$$

- Area under the curve:

$$\text{Area} = \int_a^b [f(x) - g(x)] dx$$

Vectors & 3D Geometry

- **Basics of vectors**

1. Position vectors:

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$$

2. Vector operations:

$$\pm \vec{B} = (A_x \pm B_x)\hat{i} + (A_y \pm B_y)\hat{j} + (A_z \pm B_z)\hat{k}$$

3. Scalar multiplication:

$$k\vec{A} = (kA_x)\hat{i} + (kA_y)\hat{j} + (kA_z)\hat{k}$$

4. Magnitude of a vector:

$$\sqrt{A_x^2 + A_y^2 + A_z^2}$$

- **Dot product (scalar product)**

- 1.

$$\vec{A} \cdot \vec{B} = |\vec{A}| |\vec{B}| \cos \theta$$

- 2.

$$\vec{A} \cdot \vec{B} = A_x B_x + A_y B_y + A_z B_z$$

3. Angle between two vectors:

$$\cos \theta = \frac{\vec{A} \cdot \vec{B}}{|\vec{A}| |\vec{B}|}$$

4. Condition for perpendicularity:

$$\vec{A} \cdot \vec{B} = 0$$

- **Cross product (Vector product)**

$$\vec{A} \times \vec{B} =$$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

1. Magnitude:

$$|\vec{A} \times \vec{B}| = |\vec{A}| |\vec{B}| \sin \theta$$

2. Condition for parallel vectors:

$$\vec{A} \times \vec{B} = 0$$

3. Area of a parallelogram:

$$\text{Area} = |\vec{A} \times \vec{B}|$$

- **Triple product**

1. Scalar triple product:

$$\text{Scalar Triple Product: } \vec{A} \cdot (\vec{B} \times \vec{C}) =$$

$$\begin{vmatrix} A_x & A_y & A_z \\ B_x & B_y & B_z \\ C_x & C_y & C_z \end{vmatrix}$$

2. Volume of a parallelepiped:

$$V = |\vec{A} \cdot (\vec{B} \times \vec{C})|$$

3. Vector triple product:

$$\vec{A} \times (\vec{B} \times \vec{C}) = \vec{B}(\vec{A} \cdot \vec{C}) - \vec{C}(\vec{A} \cdot \vec{B})$$

• Equation of a line in 3D

1. Vector form:

$$\text{Vector form: } \vec{r} = \vec{a} + \lambda \vec{b}$$

2. Parametric form:

$$x = x_0 + \lambda l, y = y_0 + \lambda m, z = z_0 + \lambda n$$

3. Symmetric form:

$$\frac{x - x_0}{l} = \frac{y - y_0}{m} = \frac{z - z_0}{n}$$

• Equation of a plane

1. Vector form:

$$\text{Vector form: } \vec{n} \cdot (\vec{r} - \vec{r}_0) = 0$$

2. Cartesian form:

$$Ax + By + Cz + D = 0$$

3. Distance from a point

$$(x_1, y_1, z_1)$$

to a plane:

$$(x_1, y_1, z_1)$$

:

$$d = \frac{|Ax_1 + By_1 + Cz_1 + D|}{\sqrt{A^2 + B^2 + C^2}}$$

• Angle between two planes

$$\cos \theta = \frac{|A_1 A_2 + B_1 B_2 + C_1 C_2|}{\sqrt{A_1^2 + B_1^2 + C_1^2} \sqrt{A_2^2 + B_2^2 + C_2^2}}$$

Here, l, m, n are direction ratios of the line, and A, B, C are the plane coefficients.

- **Distance between two skew lines**

$$d = \frac{|(\vec{a_2} - \vec{a_1}) \cdot (\vec{b_1} \times \vec{b_2})|}{|\vec{b_1} \times \vec{b_2}|}$$

Matrices & Determinants

- Inverse of a matrix :

$$A^{-1} = \frac{1}{|A|} \text{adj}(A), \quad |A| \neq 0$$

- Adjoint Property:

$$A \cdot \text{adj}(A) = |A| I$$

- Determinant of an Adjoint:

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

- Determinant of a product:

$$|AB| = |A| |B|$$

- Row/column operations:
- Swap rows and determinant sign changes :

$$R_i \leftrightarrow R_j \Rightarrow |A| \rightarrow -|A|$$

- Multiply a row by k:

$$R_i \rightarrow kR_i \Rightarrow |A| \rightarrow k|A|$$

- Add multiple of one row to another:

$$R_i \rightarrow R_i + kR_j \Rightarrow |A| \text{ unchanged}$$

- Product determinant – Determinant = 0 condition,

$$\text{If two rows/columns are identical} \Rightarrow |A| = 0$$

- Matrix multiplication formula:

$$(AB)_{ij} = \sum_{k=1}^n a_{ik} b_{kj}$$

- Transpose of product:

$$(AB)^T = B^T A^T$$

- Orthogonal matrix formula:

$$A^{-1} = A^T$$

- **Symmetric and skew-symmetric:**

1. Symmetric

$$-A^T = A$$

2. Skew-symmetric

$$A^T = -A, \quad a_{ii} = 0$$

- **AX = B (unique/no/infinite solutions):**

1. Unique solution

$$|A| \neq 0 \Rightarrow X = A^{-1}B$$

2. No solution

$$|A| = 0, \quad \text{adj}(A)B \neq 0$$

3. Infinite solution

$$|A| = 0, \quad \text{adj}(A)B = 0$$

- **Determinant of 2×2 and 3×3**

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix}$$

$$= ad - bc$$

-

$$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix}$$

$$= a(ei - fh) - b(di - fg) + c(dh - eg)$$

Permutation & Combination

- Factorial basics:

$$n! = n \cdot (n - 1)!, \quad 0! = 1$$

- Permutations (n distinct objects):

$${}^n P_r = \frac{n!}{(n - r)!}$$

- Combinations (n distinct objects):

$${}^n C_r = \frac{n!}{r!(n - r)!}$$

- Relation:

$${}^n P_r = {}^n C_r \cdot r!$$

- Combinations symmetry:

$${}^n C_r = {}^n C_{n-r}$$

- Permutations with repetitions:

$${}^n P_r = n^r$$

- Permutations of repeated letters:

$$\frac{n!}{p! q! r! \dots}$$

- Circular permutations:
- Clockwise \equiv anticlockwise counted differently:

$$(n - 1)!$$

CW & ACW same (necklaces, garlands):

$$\frac{(n - 1)!}{2}$$

Selection + arrangement:

$${}^nC_r \times r!$$

- Number of subsets:

$$2^n$$

- Binomial theorem essentials:
- General terms:

$$T_{r+1} = {}^nC_r a^{n-r} b^r$$

- Middle term(s):
 - For odd number of objects (n is odd):
Only one middle term
Middle term: term number = (n/2)
Value: (n-1)!
 - For even number of objects (n is even):
There are two middle terms
Middle terms: term numbers = (n/2) and (n/2 + 1)
Value: both equal to (n-1)!

Probability

- Classical probability:

$$P(A) = \frac{n(A)}{n(S)}$$

- Addition theorem:

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

- Multiplication theorem:

$$P(A \cap B) = P(A) \cdot P(B|A)$$

Independent events:

$$P(A \cap B) = P(A)P(B)$$

- Conditional probability:

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

- Baye's Theorem:

$$P(A_i|B) = \frac{P(A_i) P(B|A_i)}{\sum_{j=1}^n P(A_j) P(B|A_j)}$$

- Complement rule:

$$P(A') = 1 - P(A)$$

- Total probability theorem:

$$P(B) = \sum_{i=1}^n P(A_i) P(B|A_i)$$

Matrix Topper Techniques To Memorise JEE Main Maths Formulas

Build your confidence by learning memorisation techniques given by JEE toppers and Matrix mentors. Toppers do not rely on rote learning the formulas. However, instead, they understand the concept behind the formulas and utilise effective memory techniques to recall them. Here are some memory techniques recommended by teachers and toppers-

- Before memorising the formula, toppers practice questions where the formula will be used. This helps the brain to recall the formula when needed.
- Toppers make a list of all the important formulas under different chapters to avoid confusion.
- Another great trick is to find the origin and logic behind the formula. Helps in memorising the formula effortlessly.
- Use flashcards and keep them handy. Revise the formulas using these flashcards every week.
- Try to recall the formulas using words connected to them. For example, the slope-form formula.

Conclusion

The Maths section can make or break your JEE score. It is a subject that is heavily dominated by formulas. To crack this section, JEE aspirants must focus on learning and understanding the important formulas. Aspirants can use this list of important formulas during their revision. Follow this with a smart study strategy and regular Maths practice to top the Maths section in JEE Main. This way, JEE aspirants can outperform in the Maths section.