Comprehensive List of Mathematical Symbols
Comprehensive List of Mathematical Symbols

For the corresponding web guides, see Mathematical Symbols.

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### 1 Constant

#### 1.1 Key Mathematical Numbers
### Comprehensive List of Mathematical Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (Zero, additive identity)</td>
<td>$0$</td>
<td>$3 + 0 = 3$</td>
</tr>
<tr>
<td>1 (One, multiplicative identity)</td>
<td>$1$</td>
<td>$5 \times 1 = 5$</td>
</tr>
<tr>
<td>$\sqrt{2}$ (Square root of 2)</td>
<td>$\sqrt{2}$</td>
<td>$(\sqrt{2} + 1)^2 = 3 + 2\sqrt{2}$</td>
</tr>
<tr>
<td>$e$ (Euler’s constant)</td>
<td>$e$</td>
<td>$\ln(e^2) = 2$</td>
</tr>
<tr>
<td>$\pi$ (Pi, Archimedes’ constant)</td>
<td>$\pi$</td>
<td>$\frac{\pi^2}{6} = \frac{1}{1^2} + \frac{1}{2^2} + \cdots$</td>
</tr>
<tr>
<td>$\varphi$ (Phi, golden ratio)</td>
<td>$\varphi$</td>
<td>$\varphi = \frac{1 + \sqrt{5}}{2}$</td>
</tr>
<tr>
<td>$i$ (Imaginary unit)</td>
<td>$i$</td>
<td>$(1 + i)^2 = 2i$</td>
</tr>
</tbody>
</table>

#### 1.2 Key Mathematical Sets

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\emptyset$ (Empty set)</td>
<td>$\varnothing$</td>
<td>$</td>
</tr>
<tr>
<td>$\mathbb{N}$ (Set of natural numbers)</td>
<td>$\mathbb{N}$</td>
<td>$\forall x, y \in \mathbb{N}, x + y \in \mathbb{N}$</td>
</tr>
<tr>
<td>$\mathbb{Z}$ (Set of integers)</td>
<td>$\mathbb{Z}$</td>
<td>$\mathbb{N} \subseteq \mathbb{Z}$</td>
</tr>
</tbody>
</table>
### Comprehensive List of Mathematical Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
</table>
| \( \mathbb{Z}_+ \)  
(Set of positive integers) | $\mathbb{Z}_+$ | $3 \in \mathbb{Z}_+$ |
| \( \mathbb{Q} \)  
(Set of rational numbers) | $\mathbb{Q}$ | $\sqrt{2} \notin \mathbb{Q}$ |
| \( \mathbb{R} \)  
(Set of real numbers) | $\mathbb{R}$ | $\forall x \in \mathbb{R} \ (x^2 \geq 0)$ |
| \( \mathbb{R}_+ \)  
(Set of positive real numbers) | $\mathbb{R}_+$ | $\forall x, y \in \mathbb{R}_+ \ (xy \in \mathbb{R}_+)$ |
| \( \mathbb{C} \)  
(Set of complex numbers) | $\mathbb{C}$ | $\exists z \in \mathbb{C} \ (z^2 + 1 = 0)$ |
| \( \mathbb{Z}_n \)  
(Set of integer modulo \( n \)) | $\mathbb{Z}_n$ | In the world of \( \mathbb{Z}_2 \), \( 1 + 1 = 0 \). |
| \( \mathbb{R}^3 \)  
(Three-dimensional Euclidean space) | $\mathbb{R}^3$ | \( (5, 1, 2) \in \mathbb{R}^3 \) |

### 1.3 Key Mathematical Infinities

| Symbols  
(Explanation) | LaTeX Code | Example |
|--------------|------------|---------|
| \( \aleph_0 \)  
(Cardinality of natural numbers) | $\aleph_0$ | \( \aleph_0 + 5 = \aleph_0 \) |
| \( \mathfrak{c} \)  
(Cardinality of real numbers) | $\mathfrak{c}$ | \( \mathfrak{c} = 2^{\aleph_0} \) |
| \( \omega \)  
(Smallest infinite ordinal number) | $\omega$ | $\forall n \in \mathbb{N} \ (n < \omega)$ |
## 1.4 Other Key Mathematical Objects

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0$ (Zero vector)</td>
<td>$\mathbf{0}$</td>
<td>$\forall v \in V, v + 0 = v$</td>
</tr>
<tr>
<td>$e$ (Identity element of a group)</td>
<td>$e$</td>
<td>$e \circ e = e$</td>
</tr>
<tr>
<td>$I$ (Identity matrix)</td>
<td>$I$</td>
<td>$AI = IA = A$</td>
</tr>
<tr>
<td>$C$ (Constant of integration)</td>
<td>$C$</td>
<td>$\int 1 , dx = x + C$</td>
</tr>
<tr>
<td>$\top$ (Tautology)</td>
<td>$\top$</td>
<td>For each proposition $P$, $P \land \top \equiv P$.</td>
</tr>
<tr>
<td>$\bot$ (Contradiction)</td>
<td>$\bot$</td>
<td>For each proposition $P$, $P \land \neg P \equiv \bot$.</td>
</tr>
<tr>
<td>$Z$ (Standard normal distribution)</td>
<td>$Z$</td>
<td>$Z \sim N(0, 1)$</td>
</tr>
</tbody>
</table>

## 2 Variables

### 2.1 Variables for Numbers

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m, n, p, q$ (Integers and natural numbers)</td>
<td>$m$, $n$, $p$, $q$</td>
<td>$m + n - q = 1$</td>
</tr>
</tbody>
</table>
Comprehensive List of Mathematical Symbols

\(a, b, c\)  
(Coefficients for functions and equations)

\(ax + by = 0\)

\(x, y, z\)  
(UnKnowns in functions and equations)

If \(2x + 5 = 3\), then \(x = -1\).

\(\Delta\)  
(Discriminant)

\(\Delta = b^2 - 4ac\) for quadratic polynomials

\(i, j, k\)  
(Index variables)

\(\sum_{i=1}^{10} i = 55\)

\(t\)  
(Time variable)

At \(t = 5\), the velocity is \(v(5) = 32\).

\(z\)  
(Complex numbers)

\(z\bar{z} = |z|^2\)

## 2.2 Variables in Geometry

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>(P, Q, R, S) (Vertices)</td>
<td>(P$, $Q$, $R$, $S$</td>
<td>(PQ \perp QR)</td>
</tr>
<tr>
<td>(\ell) (Lines)</td>
<td>(\ell$</td>
<td>(\ell_1 \parallel \ell_2)</td>
</tr>
<tr>
<td>(\alpha, \beta, \gamma, \theta) (Angles)</td>
<td>(\alpha$, $\beta$, $\gamma$, $\theta$</td>
<td>(\alpha + \beta + \theta = 180^\circ)</td>
</tr>
</tbody>
</table>

## 2.3 Variables in Calculus

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
</table>

2.3 Variables in Calculus
### Comprehensive List of Mathematical Symbols

<table>
<thead>
<tr>
<th>Symbols</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x), g(x,y), h(z)$ (Functions)</td>
<td>$f(x)$, $g(x,y)$, $h(z)$</td>
<td>$f(2) = g(3,1) + 5$</td>
</tr>
<tr>
<td>$a_n, b_n, c_n$ (Sequences)</td>
<td>$a_n$, $b_n$, $c_n$</td>
<td>$a_n = \frac{3}{n+2}$</td>
</tr>
<tr>
<td>$h, \Delta x$ (Limiting variables in derivatives)</td>
<td>$h$, $\Delta x$</td>
<td>$\lim_{h \to 0} \frac{e^h - e^0}{h} = 1$</td>
</tr>
<tr>
<td>$\delta, \varepsilon$ (Small quantities in proofs involving limits)</td>
<td>$\delta$, $\varepsilon$</td>
<td>For all $\varepsilon &gt; 0$, there is a $\delta &gt; 0$ such that $</td>
</tr>
<tr>
<td>$F(x), G(x)$ (Antiderivatives)</td>
<td>$F(x)$, $G(x)$</td>
<td>$F'(x) = f(x)$</td>
</tr>
</tbody>
</table>

### 2.4 Variables in Linear Algebra

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>u, v, w (Vectors)</td>
<td>$\mathbf{u}$, $\mathbf{v}$, $\mathbf{w}$</td>
<td>$3\mathbf{u} + 4\mathbf{v} = \mathbf{w}$</td>
</tr>
<tr>
<td>A, B, C (Matrices)</td>
<td>$A$, $B$, $C$</td>
<td>$AX = B$</td>
</tr>
<tr>
<td>$\lambda$ (Eigenvalues)</td>
<td>$\lambda$</td>
<td>$A\mathbf{v} = \lambda \mathbf{v}$</td>
</tr>
</tbody>
</table>

### 2.5 Variables in Set Theory and Logic

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, B, C (Sets)</td>
<td>$A$, $B$, $C$</td>
<td>$A \subseteq B \cup C$</td>
</tr>
</tbody>
</table>
### 2.6 Variables in Probability and Statistics

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>X, Y, Z (Random variables)</td>
<td>$X$, $Y$, $Z$</td>
<td>$E(X + Y) = E(X) + E(Y)$</td>
</tr>
<tr>
<td>μ (Population means)</td>
<td>$\mu$</td>
<td>$H_0: \mu = 5$</td>
</tr>
<tr>
<td>σ (Population standard deviations)</td>
<td>$\sigma$</td>
<td>$\sigma_1 = \sigma_2$</td>
</tr>
<tr>
<td>s (Sample standard deviations)</td>
<td>$s$</td>
<td>$s \neq \sigma$</td>
</tr>
<tr>
<td>n (Sample sizes)</td>
<td>$n$</td>
<td>For $n \geq 30$, use the normal distribution.</td>
</tr>
<tr>
<td>ρ (Population correlations)</td>
<td>$\rho$</td>
<td>$H_a: \rho &lt; 0$</td>
</tr>
<tr>
<td>r (Sample correlations)</td>
<td>$r$</td>
<td>If $r = 0.75$, then $r^2 = 0.5625$.</td>
</tr>
<tr>
<td>π (Population proportions)</td>
<td>$\pi$</td>
<td>$\pi = 0.5$</td>
</tr>
<tr>
<td>p (Sample proportions)</td>
<td>$p$</td>
<td>$p = \frac{X}{n}$</td>
</tr>
</tbody>
</table>
3 Delimiters

3.1 Common Delimiters

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>. (Decimal separator)</td>
<td>$.$</td>
<td>25.9703</td>
</tr>
<tr>
<td>: (Ratio indicator)</td>
<td>$::$</td>
<td>$1 : 4 : 9 = 3 : 12 : 27$</td>
</tr>
<tr>
<td>, (Object separator)</td>
<td>$.$</td>
<td>(3, 5, 12)</td>
</tr>
<tr>
<td>( ), [ ], { } (Order-of-operation indicators)</td>
<td>$()$, $[]$, ${}$</td>
<td>$(a + b) \times c$</td>
</tr>
<tr>
<td>( ), [ ] (Interval indicators)</td>
<td>$()$, $[]$</td>
<td>$3 \notin (3, 4], 4 \in (3, 4]$</td>
</tr>
</tbody>
</table>

3.2 Other Delimiters

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ), [ ], (x, y), $\begin{pmatrix} a \ b \end{pmatrix}$ (Vector/matrix indicators)</td>
<td>$()$, $[]$, $\begin{pmatrix} a \ b \end{pmatrix}$</td>
<td>$\begin{pmatrix} 1 &amp; 4 \ 3 &amp; 6 \end{pmatrix}$</td>
</tr>
<tr>
<td>{ } (Set builder)</td>
<td>${}$</td>
<td>${\pi, e, i}$</td>
</tr>
<tr>
<td></td>
<td>( “Such that” markers)</td>
<td>$\mid, :$</td>
</tr>
</tbody>
</table>
Comprehensive List of Mathematical Symbols

\[ \| \|, \| \| \] (Metric-related operators)
\[ \| (3, 4) \| = 5 \]

\[ \begin{cases} f(x) & x \ge a \\ g(x) & x < a \end{cases} \]
(Piecewise-function marker)

\[ \langle \rangle \] (Inner product operator)
\[ \langle ka, b \rangle = k \langle a, b \rangle \]

\[ \lceil \rceil \] (Ceiling operator)
\[ \lceil 2.476 \rceil = 3 \]

\[ \lfloor \rfloor \] (Floor operator)
\[ \lfloor \pi \rfloor = 3 \]

4 Operators

4.1 Common Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x + y ) (Sum)</td>
<td>$x + y$</td>
<td>( 2a + 3a = 5a )</td>
</tr>
<tr>
<td>( x - y ) (Difference)</td>
<td>$x - y$</td>
<td>( 11 - 5 = 6 )</td>
</tr>
<tr>
<td>(-x) (Additive inverse)</td>
<td>$-x$</td>
<td>( -3 + 3 = 0 )</td>
</tr>
<tr>
<td>( x \times y, x \cdot y, xy ) (Product)</td>
<td>$x \times y$, $x \cdot y$, $xy$</td>
<td>( (m + 1)n = mn + n )</td>
</tr>
<tr>
<td>( x \div y, x/y ) (Quotient)</td>
<td>$x \div y$, $x/y$</td>
<td>( 152 \div 3 = 50.6 )</td>
</tr>
</tbody>
</table>
### Comprehensive List of Mathematical Symbols

\[
\frac{x}{y} \quad \text{(Fraction)}
\]

\[
x^y \quad \text{(Power)}
\]

\[
x \pm y \quad \text{(Plus and minus)}
\]

\[
\sqrt{x} \quad \text{(Positive square root)}
\]

\[
|x| \quad \text{(Absolute value)}
\]

\[
x\% \quad \text{(Percent)}
\]

### Function-related Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \operatorname{dom}f ) (Domain)</td>
<td>$\operatorname{dom}f$</td>
<td>If ( g(x) = \ln x ), then ( \operatorname{dom}(g) = \mathbb{R} ).</td>
</tr>
<tr>
<td>( \operatorname{ran}f ) (Range)</td>
<td>$\operatorname{ran}f$</td>
<td>If ( h(y) = \sin y ), then ( \operatorname{ran}(h) = [-1, 1] ).</td>
</tr>
<tr>
<td>( f(x) ) (Image of an element)</td>
<td>$f(x)$</td>
<td>( g(5) = g(4) + 3 )</td>
</tr>
<tr>
<td>( f(X) ) (Image of a set)</td>
<td>$f(X)$</td>
<td>( f(A \cap B) \subseteq f(A) \cap f(B) )</td>
</tr>
<tr>
<td>( f \circ g ) (Composite function)</td>
<td>$f \circ g$</td>
<td>If ( g(3) = 5 ) and ( f(5) = 8 ), then ( (f \circ g)(3) = 8 ).</td>
</tr>
</tbody>
</table>

### 4.3 Elementary Functions
### Comprehensive List of Mathematical Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$k_n x^n + \cdots + k_0 x^0$ (Polynomial)</td>
<td>$k_n x^n \cdots k_0 x^0$</td>
<td>The polynomial $x^3 + 2x^2 + 3$ has a root in $(-3, -2)$.</td>
</tr>
<tr>
<td>$e^x$, $\exp x$ (Natural exponential function)</td>
<td>$e^x$, $\exp x$</td>
<td>$e^{x+y} = e^x \cdot e^y$</td>
</tr>
<tr>
<td>$b^x$ (General exponential function)</td>
<td>$b^x$</td>
<td>$2^x &gt; x^2$ for large $x$.</td>
</tr>
<tr>
<td>$\ln x$ (Natural logarithmic function)</td>
<td>$\ln x$</td>
<td>$\ln(x^2) = 2 \ln x$</td>
</tr>
<tr>
<td>$\log x$ (Common logarithmic function)</td>
<td>$\log x$</td>
<td>$\log 10000 = 4$</td>
</tr>
<tr>
<td>$\log_b x$ (General logarithmic function)</td>
<td>$\log_b x$</td>
<td>$\log_2 x = \frac{\ln x}{\ln 2}$</td>
</tr>
<tr>
<td>$\sin x$ (Sine function)</td>
<td>$\sin x$</td>
<td>$\sin \pi = 0$</td>
</tr>
<tr>
<td>$\cos x$ (Cosine function)</td>
<td>$\cos x$</td>
<td>$\cos \frac{\pi}{4} = \frac{\sqrt{2}}{2}$</td>
</tr>
<tr>
<td>$\tan x$ (Tangent function)</td>
<td>$\tan x$</td>
<td>$\tan x = \frac{\sin x}{\cos x}$</td>
</tr>
</tbody>
</table>

### 4.4 Algebra-related Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gcd(x, y)$ (Greatest common factor)</td>
<td>$\gcd(x, y)$</td>
<td>$\gcd(35, 14) = 7$</td>
</tr>
</tbody>
</table>
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$\lfloor x \rfloor$ (Floor operator) \hspace{0.5cm} $\lceil x \rceil$ (Ceiling operator)

$\min (A)$ (Minimum) \hspace{0.5cm} $\max (A)$ (Maximum)

$x \mod y$ (Modulo operator)

$\sum_{i=m}^{n} a_i$ (Summation) \hspace{0.5cm} $\prod_{i=m}^{n} a_i$ (Pi Product)

$[a]$ (Equivalence class)

$\deg f$ (Degree of polynomial)

$\bar{z}$ (Complex conjugate)

$|z|$ (Absolute value of complex number)

$\arg z$ (Arguments of complex number)

4.5 Geometry-related Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\min (A)$</td>
<td>$\min (A)$</td>
<td>If $\min (A) = 3$, then $\min(A + 5) = 8$.</td>
</tr>
<tr>
<td>$\max (A)$</td>
<td>$\max (A)$</td>
<td>$\max(A \cup B) \geq \max(A)$</td>
</tr>
<tr>
<td>$x \mod y$</td>
<td>$x \bmod y$</td>
<td>$36 \mod 5 = 1$</td>
</tr>
<tr>
<td>$\sum_{i=m}^{n} a_i$</td>
<td>$\sum_{i=m}^{n} a_i$</td>
<td>$\sum_{i=1}^{5} i^2 = 55$</td>
</tr>
<tr>
<td>$\prod_{i=m}^{n} a_i$</td>
<td>$\prod_{i=1}^{n} a_i$</td>
<td>$\prod_{i=1}^{n} = n!$</td>
</tr>
<tr>
<td>$[a]$</td>
<td>$[a]$</td>
<td>$[a] \equiv {x \mid xRa}$</td>
</tr>
<tr>
<td>$\deg f$</td>
<td>$\deg f$</td>
<td>$\deg(2x^2 + 3x + 5) = 2$</td>
</tr>
<tr>
<td>$\bar{z}$</td>
<td>$\bar{z}$</td>
<td>$5 - 8i = 5 + 8i$</td>
</tr>
<tr>
<td>$</td>
<td>z</td>
<td>$</td>
</tr>
<tr>
<td>$\arg z$</td>
<td>$\arg z$</td>
<td>$\arg(1 + i) = \frac{\pi}{4} + 2\pi n$</td>
</tr>
</tbody>
</table>
### Comprehensive List of Mathematical Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\angle ABC$</td>
<td>$\angle ABC$</td>
<td>$\angle ABC = \angle CBA$</td>
</tr>
<tr>
<td>$\angle ABC, m\angle ABC$</td>
<td>$\angle ABC, m\angle ABC$</td>
<td>$\angle ABC = \angle A'B'C'$</td>
</tr>
<tr>
<td>$\overrightarrow{AB}$</td>
<td>$\overrightarrow{AB}$</td>
<td>$\overrightarrow{AB} = \overrightarrow{BA}$</td>
</tr>
<tr>
<td>$</td>
<td>AB</td>
<td>$</td>
</tr>
</tbody>
</table>

#### 4.6 Logic-related Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negation $\neg P$</td>
<td>$\neg P$</td>
<td>$\neg (1 = 2)$</td>
</tr>
<tr>
<td>Conjunction $P \land Q$</td>
<td>$P \land Q$</td>
<td>$P \land Q \equiv Q \land P$</td>
</tr>
<tr>
<td>Disjunction $P \lor Q$</td>
<td>$P \lor Q$</td>
<td>$\pi^c \in Q \lor \pi^c \notin Q$</td>
</tr>
<tr>
<td>Conditional $P \to Q$</td>
<td>$P \to Q$</td>
<td>$P \to Q \equiv (\neg P \lor Q)$</td>
</tr>
<tr>
<td>Biconditional $P \leftrightarrow Q$</td>
<td>$P \leftrightarrow Q$</td>
<td>$P \leftrightarrow Q \implies P \to Q$</td>
</tr>
</tbody>
</table>
### 4.7 Set-related Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\forall x P(x)$ (Universal statement)</td>
<td>$\forall x P(x)$</td>
<td>$\forall y \in \mathbb{N} (y + 1 \in \mathbb{N})$</td>
</tr>
<tr>
<td>$\exists x P(x)$ (Existential statement)</td>
<td>$\exists x P(x)$</td>
<td>$\exists z (z^2 = -\pi)$</td>
</tr>
</tbody>
</table>

#### 4.8 Vector-related Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$|v|$ (Norm of vector)</td>
<td>$|v|$</td>
<td>$|(3, 4)| = 5$</td>
</tr>
</tbody>
</table>
### 4.9 Matrix-related Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A + B$ (Matrix sum)</td>
<td>$A+B$</td>
<td>$A + X = B$</td>
</tr>
<tr>
<td>$A - B$ (Matrix difference)</td>
<td>$A-B$</td>
<td>In general, $A - B \neq B - A$.</td>
</tr>
<tr>
<td>$-A$ (Additive inverse)</td>
<td>$-A$</td>
<td>$B + (-B) = 0$</td>
</tr>
<tr>
<td>$kA$ (Scalar product)</td>
<td>$kA$</td>
<td>$(-1)A = -A$</td>
</tr>
<tr>
<td>$AB$ (Matrix product)</td>
<td>$AB$</td>
<td>$AI = IA = A$</td>
</tr>
<tr>
<td>$A^T$ (Matrix transpose)</td>
<td>$A^T$</td>
<td>$I^T = I$</td>
</tr>
<tr>
<td>$A^{-1}$ (Matrix inverse)</td>
<td>$A^{-1}$</td>
<td>$(AB)^{-1} = B^{-1}A^{-1}$</td>
</tr>
<tr>
<td>$\text{tr}(A)$ (Trace of matrix)</td>
<td>$\text{tr}(A)$</td>
<td>$\text{tr}(A^T) = \text{tr}(A)$</td>
</tr>
</tbody>
</table>
Comprehensive List of Mathematical Symbols

\[
\text{det}(A), |A|, \begin{vmatrix} x & y \\ w & z \end{vmatrix} \quad \begin{vmatrix} 1 & 4 \\ 3 & 2 \end{vmatrix} = 2 - 12 = -10
\]

(Determinant)

4.10 Probability-related Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>( n! ) (Factorial)</td>
<td>( n! )</td>
<td>( 4! = 4 \cdot 3 \cdot 2 \cdot 1 )</td>
</tr>
<tr>
<td>( nPr ) (Permutation)</td>
<td>( nPr )</td>
<td>( 5P3 = 5 \cdot 4 \cdot 3 )</td>
</tr>
<tr>
<td>( nCr ) (Combination)</td>
<td>( \binom{n}{r} )</td>
<td>( \binom{5}{2} = \binom{5}{3} )</td>
</tr>
<tr>
<td>( P(E) ) (Probability of event)</td>
<td>( P(E) )</td>
<td>( P(A \cup B \cup C) = 0.3 )</td>
</tr>
<tr>
<td>( P(A</td>
<td>B) ) (Conditional probability)</td>
<td>( P(A</td>
</tr>
<tr>
<td>( E(X) ) (Expected value of random variable)</td>
<td>( E(X) )</td>
<td>( E(X + Y) = E(X) + E(Y) )</td>
</tr>
<tr>
<td>( V(X) ) (Variance of random variable)</td>
<td>( V(X) )</td>
<td>( V(5X) = 25V(X) )</td>
</tr>
</tbody>
</table>

4.11 Statistics-related Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
</table>
### 4.12 Key Probability Functions and Distributions

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bin((n, p)) (Binomial distribution)</td>
<td>$\operatorname{Bin}(n, p)$</td>
<td>$X \sim \text{Bin}(10, 0.5)$. If $X$ stands for the number of heads in 10 coin tosses, then $X \sim \text{Bin}(10, 0.5)$.</td>
</tr>
<tr>
<td>Geo((p)) (Geometric distribution)</td>
<td>$\operatorname{Geo}(p)$</td>
<td>$Y \sim \text{Geo}(1/5)$, then $E(Y) = 5$.</td>
</tr>
<tr>
<td>$U(a, b)$ (Continuous uniform distribution)</td>
<td>$U(a, b)$</td>
<td>$X \sim U(3, 7)$, then $V(X) = \frac{(7 - 3)^2}{12}$.</td>
</tr>
<tr>
<td>$N(\mu, \sigma^2)$ (Normal distribution)</td>
<td>$N(\mu, \sigma^2)$</td>
<td>$X \sim N(3, 5^2)$, then $\frac{X - 3}{5} \sim Z$.</td>
</tr>
<tr>
<td>$z_{\alpha}$ (Critical z-score)</td>
<td>$z_{\alpha}$</td>
<td>$z_{0.05} \approx 1.645$.</td>
</tr>
<tr>
<td>$t_{\alpha, \nu}$ (Critical t-score)</td>
<td>$t_{\alpha, \nu}$</td>
<td>$t_{0.05, 1000} \approx z_{0.05}$.</td>
</tr>
<tr>
<td>$\chi^2_{\alpha, \nu}$ (Critical Chi-squared-score)</td>
<td>$\chi^2_{\alpha, \nu}$</td>
<td>$\chi^2_{0.05, 30} \approx 43.77$.</td>
</tr>
</tbody>
</table>

---

\( \overline{X} \) (Sample mean) \quad \overline{X} = \frac{\sum X}{n}

\( s^2 \) (Sample variance) \quad s^2 = \frac{\sum (X - \overline{X})^2}{n - 1}

\( \sigma^2 \) (Population variance) \quad \sigma^2 = \frac{\sum (X - \mu)^2}{n}
### 4.13 Calculus-related Operators

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \lim_{n \to \infty} a_n ) (Limit of sequence)</td>
<td>( \displaystyle \lim_{n \to \infty} a_n )</td>
<td>( \lim_{n \to \infty} \frac{n + 3}{2n} = \frac{1}{2} )</td>
</tr>
<tr>
<td>( \lim_{x \to c} f(x) ) (Limit of function)</td>
<td>( \displaystyle \lim_{x \to c} f(x) )</td>
<td>( \frac{\pi \sin x}{2} = \frac{\pi}{2} \lim_{x \to 3} \sin x )</td>
</tr>
<tr>
<td>( \sup(A) ) (Supremum)</td>
<td>( \sup(A) )</td>
<td>( \sup([-3, 5]) = 5 )</td>
</tr>
<tr>
<td>( \inf(A) ) (Infimum)</td>
<td>( \inf(A) )</td>
<td>If ( B = {1, \frac{1}{2}, \ldots} ), then ( \inf(B) = 0 ).</td>
</tr>
<tr>
<td>( f', f'', f''' ) ( f^{(n)} ) (Derivative)</td>
<td>( f', f'', f''', f^{(n)} )</td>
<td>( (\sin x)''' = -\cos x )</td>
</tr>
<tr>
<td>( \int_a^b f(x) , dx ) (Definite integral)</td>
<td>( \displaystyle \int_a^b f(x) , dx )</td>
<td>( \int_0^1 \frac{1}{1 + x^2} = \frac{\pi}{4} )</td>
</tr>
<tr>
<td>( \int f(x) , dx ) (Indefinite integral)</td>
<td>( \displaystyle \int f(x) , dx )</td>
<td>( \int \ln x , dx = x \ln x - x )</td>
</tr>
<tr>
<td>( f_x ) (Partial derivative)</td>
<td>( f_x )</td>
<td>If ( f(x, y) = x^2 y^3 ), then ( f_x(x, y) = 2xy^3 ).</td>
</tr>
</tbody>
</table>
5 Relational Symbols

5.1 Equality-based Relational Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x = y ) (Equal)</td>
<td>( x = y )</td>
<td>( 3x - x = 2x )</td>
</tr>
<tr>
<td>( x \ne y ) (Non-equal)</td>
<td>( x \ne y )</td>
<td>( 2 \ne 3 )</td>
</tr>
<tr>
<td>( x \approx y ) (Approximately equal)</td>
<td>( x \approx y )</td>
<td>( \pi \approx 3.1416 )</td>
</tr>
<tr>
<td>( x \sim y, xRy ) (Related to)</td>
<td>( x \sim y, xRy )</td>
<td>( xRy ) if and only if (</td>
</tr>
<tr>
<td>( x \equiv y ) (Equivalent to)</td>
<td>( x \equiv y )</td>
<td>( 2 \equiv 101 ) in ( \text{mod } 33 )</td>
</tr>
<tr>
<td>( f(x) \propto g(x) ) (Proportional to)</td>
<td>( f(x) \propto g(x) )</td>
<td>( V \propto r^3 )</td>
</tr>
</tbody>
</table>

5.2 Comparison-based Relational Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x &lt; y ) (Less than)</td>
<td>( x &lt; y )</td>
<td>( \sin x &lt; 3 )</td>
</tr>
<tr>
<td>( x &gt; y ) (Greater than)</td>
<td>( x &gt; y )</td>
<td>( \pi &gt; e )</td>
</tr>
<tr>
<td>( x \le y ) (Less than or equal to)</td>
<td>( x \le y )</td>
<td>( n! \le n^n )</td>
</tr>
</tbody>
</table>
### 5.3 Number-related Relational Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$m \mid n$ (Divisibility)</td>
<td>$m \mid n$</td>
<td>$101 \mid 1111$</td>
</tr>
<tr>
<td>$m \perp n$ (Coprime integers)</td>
<td>$m \perp n$</td>
<td>$31 \perp 97$</td>
</tr>
</tbody>
</table>

### 5.4 Geometry-related Relational Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ell_1 \parallel \ell_2$ (Parallel)</td>
<td>$\ell_1 \parallel \ell_2$</td>
<td>$PQ \parallel RS$</td>
</tr>
<tr>
<td>$\ell_1 \perp \ell_2$ (Perpendicular)</td>
<td>$\ell_1 \perp \ell_2$</td>
<td>$\overrightarrow{AB} \perp \overrightarrow{BC}$</td>
</tr>
<tr>
<td>$F \sim F'$ (Similar figures)</td>
<td>$F \sim F'$</td>
<td>$\triangle ABC \sim \triangle DEF$</td>
</tr>
<tr>
<td>$F \cong F'$ (Congruent figures)</td>
<td>$F \cong F'$</td>
<td>$\square ABCD \cong \square PQRS$</td>
</tr>
</tbody>
</table>

### 5.5 Set-related Relational Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
</table>
5.6 Logic-related Relational Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P \implies Q ) (Implies)</td>
<td>$P \implies Q$</td>
<td>( x ) is even ( \implies ) ( 2 ) divides ( x )</td>
</tr>
<tr>
<td>( P \iff Q ) (If and only if)</td>
<td>$P \iff Q$, $P \equiv Q$</td>
<td>( x \neq y \iff (x - y)^2 &gt; 0 )</td>
</tr>
<tr>
<td>( P \because Q ) (Because)</td>
<td>$P \because Q$</td>
<td>( x = \frac{\pi}{2} \because \sin x = 1 ) and ( \cos x = 0 )</td>
</tr>
</tbody>
</table>

5.7 Probability-related Relational Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
</table>
| \( A \perp B \) (Independent events) | $A \perp B$ | If \( A \perp B \), then \[
P(A \cap B) = P(A) \cap P(B).
\]
$X \sim F$

(X follows distribution $F$)

\[ Y \sim \text{Bin}(30, 0.4) \]

## 5.8 Calculus-related Relational Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f(x) \sim g(x)$ (Asymptotically equal)</td>
<td>$f(x) \sim g(x)$</td>
<td>$\pi(x) \sim \frac{x}{\ln x}$</td>
</tr>
<tr>
<td>$f(x) \in O(g(x))$ (In the big-O of)</td>
<td>$f(x) \in O(g(x))$</td>
<td>$2x^2 + 3x + 3 \in O(x^2)$</td>
</tr>
</tbody>
</table>

## 6 Notational Symbols

### 6.1 Common Notational Symbols

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ldots, \cdots$ (Horizontal ellipsis)</td>
<td>$\ldots$, $\cdots$</td>
<td>$1^2 + 2^2 + \cdots + n^2$</td>
</tr>
</tbody>
</table>
| $\vdots, \ddots$ (Vertical ellipsis) | $\vdots$, $\ddots$ | \[
\begin{pmatrix}
  a_{11} & \cdots & a_{1n} \\
  \vdots & \ddots & \vdots \\
  a_{m1} & \cdots & a_{mn}
\end{pmatrix}
\]
| $f : A \rightarrow B$, $A \xrightarrow{f} B$ (Function’s domain/codomain specifier) | $f : A \rightarrow B$, $A \xrightarrow{\{f\}} B$ | A function $g : \mathbb{N} \rightarrow \mathbb{R}$ can be thought of as a sequence. |
6.2 Notational Symbols in Geometry and Trigonometry

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>° (Degree)</td>
<td>$^\circ$</td>
<td>$\cos(90\degree) = 0$</td>
</tr>
<tr>
<td>′ (Arcminute)</td>
<td>′</td>
<td>$35' = \left(\frac{35}{60}\right)\degree$</td>
</tr>
<tr>
<td>″ (Arcsecond)</td>
<td>″</td>
<td>$20'' = \left(\frac{20}{60}\right)'$</td>
</tr>
<tr>
<td>rad (Radian)</td>
<td>$\text{rad}$</td>
<td>$\pi \text{ rad} = 180\degree$</td>
</tr>
<tr>
<td>grad (Gradian)</td>
<td>$\text{grad}$</td>
<td>$100 \text{ grad} = 90\degree$</td>
</tr>
</tbody>
</table>

6.3 Notational Symbols in Calculus

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>$+\infty$ (Positive infinity)</td>
<td>$+\text{infty}$</td>
<td>$\frac{n^2 + 1}{n} \to +\infty$</td>
</tr>
</tbody>
</table>
6.4 Notational Symbols in Probability and Statistics

<table>
<thead>
<tr>
<th>Symbols (Explanation)</th>
<th>LaTeX Code</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.i.d. (Independent and identically distributed)</td>
<td>i.i.d.</td>
<td>Given $n$ i.i.d. random variables $X_1, \ldots, X_n$, $V(X_1 + \cdots + X_n) = V(X_1) + \cdots + V(X_n)$.</td>
</tr>
<tr>
<td>$H_0$ (Null hypothesis)</td>
<td>$H_0$</td>
<td>$H_0 : \mu = 23$</td>
</tr>
<tr>
<td>$H_a$ (Alternative hypothesis)</td>
<td>$H_a$</td>
<td>$H_a : \sigma_1^2 \neq \sigma_2^2$</td>
</tr>
</tbody>
</table>

7 Additional Resources

- **Ultimate LaTeX Reference Guide**: A definitive reference guide on the LaTeX language, with the commands, environments and
packages most LaTeX users will ever need

- **Definitive Guide to Learning Higher Mathematics**: A standalone 10-principle framework for tackling higher mathematical learning, thinking and problem solving

- **10 Commandments of Higher Mathematical Learning**: An illustrated web guide on 10 scalable rules for learning higher mathematics

- **Definitive Glossary of Higher Mathematical Jargon**: A tour around higher mathematics in 100 terms