Mathematical expressions

The feature that makes LATEX the right edition tool for scientific documents is the ability to render complex mathematical expressions. Here, explains the basic commands to display equations.

Mathematical modes

LATEX allows two writing modes for mathematical expressions: the inline mode and the display mode. The first one is used to write formulas that are part of a text. The second one is used to write expressions that are not part of a text or paragraph, and are therefore put on separate lines.

Type	**Inline (within text) formulas**	**Displayed equations**	**Displayed and automatically numbered equations**
Environment	`math`	`displaymath`	`equation`
LaTeX shorthand	`\(...\)`	`\[...\]`	
TeX shorthand	`$...$`	`$$...$$`	
Comment			`equation*` (starred version) suppresses numbering, but requires amsmath

Inline mode expressions:

1. Math environment:

   \documentclass{article}

   \begin{document}

   My first math expression is

   \begin{math}

   x^3+y^3=(x+y)^3

   \end{math}

   end{document}

output:

My first math expression is $x^3 + y^3 = (x + y)^3$

(Or)

2. Latex shorthand: \(….\)

   \(x^2+y^2 =z^2\)

(Or)

3. Tex shorthand: $....$

   $x^3+y^2 =z^3$

Display mode expressions

1. Displaymath environment:

   \begin{document}
   Disply mode expression is
   \begin{displaymath}
   x^3+y^3=(x+y)^3
   \end{displaymath}

   Output :
   Display mode expression is

$$x^3 + y^3 = (x + y)^3$$

(Or)

2. Latex shorthand: \[….\]

   \[x^2+y^2 =z^2\]

(Or)

3. Tex shorthand: $$....$$

   $$x^3+y^2 =z^3$$

We can write math formulas using these modes. Now we learn different math formulas using latex code as follows here.

Symbols:

In latex writing symbols directly from the keyboard

```
+ - = ! / ( ) [ ] < > | ' :
```

Greek letters commands:

```
\alpha, \Alpha, \beta, \Beta, \gamma, \Gamma, \pi, \Pi, \phi, \varphi, \mu, \Phi
```

$$\alpha, \mathrm{A}, \beta, \mathrm{B}, \gamma, \Gamma, \pi, \Pi, \phi, \varphi, \mu, \Phi$$

Binary Operation/Relation Symbols

$\times$	\times	$\otimes$	\otimes
$\div$	\div	$\cap$	\cap
$\cup$	\cup	$\neq$	\neq
$\leq$	\leq	$\geq$	\geq
$\in$	\in	$\perp$	\perp
$\notin$	\notin	$\subset$	\subset
$\simeq$	\simeq	$\approx$	\approx
$\wedge$	\wedge	$\vee$	\vee
$\oplus$	\oplus	$\otimes$	\otimes
$\Box$	\Box	$\boxtimes$	\boxtimes
$\equiv$	\equiv	$\cong$	\cong

Trigonometric functions:

```
\cos (2\theta) = \cos^2 \theta - \sin^2 \theta
```

$$\cos(2\theta) = \cos^2\theta - \sin^2\theta$$

Exercises :

$$\sin(\alpha \pm \beta) = \sin\alpha\cos\beta \pm \cos\alpha\sin\beta$$

$$\cos(\alpha \pm \beta) = \cos\alpha\cos\beta \mp \sin\alpha\sin\beta$$

$$\tan(\alpha \pm \beta) = \frac{\tan\alpha \pm \tan\beta}{1 \mp \tan\alpha\tan\beta}$$

Powers and Indices:

Powers and indices are equivalent to superscripts and subscripts in normal text mode. Thecaret (^; also known as the circumflex accent11) character is used to raise something, and the underscore (_) is for lowering. If more than one expression is raised or lowered, they should be grouped using curly braces ({ and }).

```
k_{n+1} = n^2 + k_n^2 - k_{n-1}
```

$$k_{n+1} = n^2 + k_n^2 - k_{n-1}$$

Exercises:

$$a^m \times a^n = a^{m+n}$$

$$(a^m)^n = a^{mn}$$

$$a^m \div a^n = a^{m-n}$$

$$a^0 = 1$$

$$a^{-1} = \frac{1}{a} \text{ and } a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{1}{2}} = \sqrt{a} \text{ and } a^{\frac{1}{q}} = \sqrt[q]{a}$$

$$a^{\frac{p}{q}} = (a^p)^{\frac{1}{q}} = \sqrt[q]{a^p},$$

$$a^{\frac{p}{q}} = (a^{\frac{1}{q}})^p = (\sqrt[q]{a})^p$$

Square root:

```
\sqrt{\frac{a}{b}}
```

$$\sqrt{\frac{a}{b}}$$

```
\sqrt[n]{1+x+x^2+x^3+\ldots}
```

$$\sqrt[n]{1+x+x^2+x^3+\ldots}$$

Exercises:

$$\sqrt{x+y} \neq \sqrt{x} + \sqrt{y}$$

$$\sqrt{\frac{x}{y}} = \frac{\sqrt{x}}{\sqrt{y}}$$

Fractions:

Syntax: \frac{numerator}{denominator}

$$\frac{n!}{k!(n-k)!}$$

Continued fractions:

Continued fractions should be written using \cfrac command

```
\begin{equation}
  x = a_0 + \cfrac{1}{a_1
          + \cfrac{1}{a_2
          + \cfrac{1}{a_3 + \cfrac{1}{a_4} } } }
\end{equation}
```

$$x = a_0 + \cfrac{1}{a_1 + \cfrac{1}{a_2 + \cfrac{1}{a_3 + \cfrac{1}{a_4}}}}$$

Exercises:

$$\frac{3x+5}{2x^2-5x-3} = \frac{2}{x-3} - \frac{1}{2x+1}$$

$$\frac{5x}{(x^2+x+1)(x-2)} = \frac{-\frac{10}{7}x + \frac{5}{7}}{x^2+x+1} + \frac{\frac{10}{7}}{x-2}$$

$$\frac{5x}{(x^2+x+1)(x-2)} = \frac{Ax+B}{x^2+x+1} + \frac{C}{x-2}$$