A quick guide to LaTeX

What is LaTeX?

LaTeX (usually pronounced "LAY teck," sometimes "LAH teck," and never "LAY tex") is a *format*, or collection of macro commands, for TeX, the standard for most professional mathematics and scientific writing. TeX is a powerful typesetting engine created by Donald Knuth of Stanford University (his first version appeared in 1978). Leslie Lamport was responsible for creating LaTeX, a popular set of user commands for TeX. A team of LaTeX programmers created the current version, LaTeX 2ε.

Mathematics

Math vs. text vs. functions

In properly typeset mathematics, the variables appear in italics (for example, $f(x) = x^2+2x-3$). The exception to this rule is predefined functions (for example, $\sin(x)$). Thus it is important to *always* treat text, variables, and functions correctly. See the difference between x and x, -1 and -1, and $sin(x)$ and $\sin(x)$.

There are two ways to present a mathematical expression – *inline* or as a *display*.

Inline mathematical expressions

Inline math expressions occur as part of the normal flow of text. To produce an inline expression, place the math expression between dollar signs (`$`). For example, typing `$90^{\circ}$ is the same as $\frac{\pi}{2}$ radians` yields 90° is the same as $\frac{\pi}{2}$ radians.

Displayed mathematical expressions

Displays are mathematical expressions that are given their own line and are centered on the page. These are usually used for important equations that deserve to be showcased on their own line or for large equations that cannot fit inline. To produce displayed mathematics, place the mathematical expression between the symbols `\[` and `\]`. Typing `\[x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}\]` yields

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

Display style

To get full-size inline math, use `\displaystyle`. Use this sparingly. Typing `this $\displaystyle \sum_{n=1}^{\infty}\frac{1}{n}$, and not this $\sum_{n=1}^{\infty}\frac{1}{n}$` yields this $\displaystyle \sum_{n=1}^{\infty} \frac{1}{n}$, and not this $\sum_{n=1}^{\infty} \frac{1}{n}$.

Images

You can put images (pdf, png, jpg, or gif) in your document. They need to be in the same location as your .tex file when you compile the document. Omit `[width=.5in]` if you want the image to be full-sized.

```
\begin{figure}[tbp]
\includegraphics[width=.5in]{imagename.jpg}
\caption{The (optional) caption goes here.}
\end{figure}
```

Text decorations

Your text can be *italic* (`\textit{italic}`), **bold** (`\textbf{bold}`), or <u>underlined</u> (`\underline{underlined}`).

Your math can contain bold, $\mathbf{R}$ (`\mathbf{R}`), or blackboard bold, $\mathbb{R}$ (`\mathbb{R}`). You may want to used these to express the sets of real numbers ($\mathbb{R}$ or $\mathbf{R}$), integers ($\mathbb{Z}$ or $\mathbf{Z}$), rational numbers ($\mathbb{Q}$ or $\mathbf{Q}$), and natural numbers ($\mathbb{N}$ or $\mathbf{N}$).

For text appearing inside a math expression, use `\text`.
`(0,1]=\{x\in\mathbb{R}:x>0\text{ and }x\le 1\}` yields
$(0,1] = \{x \in \mathbb{R} : x > 0 \text{ and } x \le 1\}$.

(Without the `\text` command it treats "and" as three variables: $(0,1] = \{x \in \mathbb{R} : x > 0 and x \le 1\}$.)

Spaces and new lines

LaTeX ignores extra spaces and new lines. For example,

```
This    sentence will       look
fine after      it is     compiled.
```

This sentence will look fine after it is compiled.

Leave one full empty line between two paragraphs. Place `\\` at the end of a line to create a new line (but not create a new paragraph).

```
This
compiles

like\\
this.
```

This compiles
like
this.

Use `\noindent` to prevent a paragraph from indenting.

Comments

Use `%` to create a comment. Nothing on the line after the `%` will be typeset. `$f(x)=\sin(x)$ %this is the sine function` yields $f(x) = \sin(x)$.

Delimiters

description	*command*	*output*
parentheses	`(x)`	(x)
square brackets	`[x]`	[x]
curly braces	`\{x\}`	{x}

To automatically make delimiters large enough to fit the content, use them together with `\right` and `\left`. For example, `\left\{ \sin \left( \frac{1}{n} \right) \right\} _{n}^{\infty}` produces

$$\left\{ \sin \left(\frac{1}{n} \right) \right\}_{n}^{\infty}.$$

Curly braces are non-printing characters that are used to gather text that has more than one character. Observe the differences between the four expressions `x^2`, `x^{2}`, `x^2t`, `x^{2t}` when typeset: x^2, x^{2}, x^2t, x^{2t}.

Lists

You can produce ordered and unordered lists.

description	*command*	*output*

unordered list	`\begin{itemize}`
	`  \item Thing 1`
	`  \item Thing 2`
	`\end{itemize}`
		• Thing 1
		• Thing 2

ordered list	`\begin{enumerate}`
	`  \item Thing 1`
	`  \item Thing 2`
	`\end{enumerate}`
		1. Thing 1
		2. Thing 2

Symbols (in *math* mode)

The basics

description	*command*	*output*
addition	`+`	$+$
subtraction	`-`	$-$
plus or minus	`\pm`	$\pm$
multiplication (times)	`\times`	$\times$
multiplication (dot)	`\cdot`	$\cdot$
division symbol	`\div`	$\div$
division (slash)	`/`	/
circle plus	`\oplus`	$\oplus$
circle times	`\otimes`	$\otimes$
equal	`=`	$=$
not equal	`\ne`	$\ne$
less than	`<`	$<$
greater than	`>`	$>$
less than or equal to	`\le`	$\le$
greater than or equal to	`\ge`	$\ge$
approximately equal to	`\approx`	$\approx$
infinity	`\infty`	∞
dots	`1,2,3,\ldots`	$1, 2, 3, \ldots$
dots	`1+2+3+\cdots`	$1 + 2 + 3 + \cdots$
fraction	`\frac{a}{b}`	$\frac{a}{b}$
square root	`\sqrt{x}`	$\sqrt{x}$
nth root	`\sqrt[n]{x}`	$\sqrt[n]{x}$
exponentiation	`a^b`	a^b
subscript	`a_b`	a_b
absolute value	`|x|`	$\|x\|$
natural log	`\ln(x)`	$\ln(x)$
logarithms	`\log_{a}b`	$\log_a b$
exponential function	`e^x=\exp(x)`	$e^x = \exp(x)$
degree	`\deg(f)`	$\deg(f)$

Functions

description	*command*	*output*
maps to	`\to`	$\to$
composition	`\circ`	$\circ$

piecewise function	`|x|=\begin{cases}`
	`x & x\ge 0\\`
	`-x & x<0`
	`\end{cases}`
		$\|x\| = \begin{cases} x & x \ge 0 \\ -x & x < 0 \end{cases}$

Greek and Hebrew letters

command	*output*	*command*	*output*
`\alpha`	α	`\tau`	τ
`\beta`	β	`\theta`	θ
`\chi`	χ	`\upsilon`	υ
`\delta`	δ	`\xi`	ξ
`\epsilon`	ϵ	`\zeta`	ζ
`\varepsilon`	ε	`\Delta`	Δ
`\eta`	η	`\Gamma`	Γ
`\gamma`	γ	`\Lambda`	Λ
`\iota`	ι	`\Omega`	Ω
`\kappa`	κ	`\Phi`	Φ
`\lambda`	λ	`\Pi`	Π
`\mu`	μ	`\Psi`	Ψ
`\nu`	ν	`\Sigma`	Σ
`\omega`	ω	`\Theta`	Θ
`\phi`	ϕ	`\Upsilon`	Υ
`\varphi`	φ	`\Xi`	Ξ
`\pi`	π	`\aleph`	$\aleph$
`\psi`	ψ	`\beth`	$\beth$
`\rho`	ρ	`\daleth`	$\daleth$
`\sigma`	σ	`\gimel`	$\gimel$

Set theory

description	*command*	*output*
set brackets	`\{1,2,3\}`	$\{1,2,3\}$
element of	`\in`	$\in$
not an element of	`\not\in`	$\notin$
subset of	`\subset`	$\subset$
subset of	`\subseteq`	$\subseteq$
not a subset of	`\not\subset`	$\not\subset$
contains	`\supset`	$\supset$
contains	`\supseteq`	$\supseteq$
union	`\cup`	$\cup$
intersection	`\cap`	$\cap$
big union	`\bigcup_{n=1}^{10}A_n`	$\bigcup_{n=1}^{10} A_n$
big intersection	`\bigcap_{n=1}^{10}A_n`	$\bigcap_{n=1}^{10} A_n$
empty set	`\emptyset`	$\emptyset$
power set	`\mathcal{P}`	$\mathcal{P}$
minimum	`\min`	$\min$
maximum	`\max`	$\max$
supremum	`\sup`	$\sup$
infimum	`\inf`	$\inf$
limit superior	`\limsup`	$\limsup$
limit inferior	`\liminf`	$\liminf$
closure	`\overline{A}`	$\overline{A}$

Calculus

description	*command*	*output*
derivative	`\frac{df}{dx}`	$\frac{df}{dx}$
derivative	`f'`	f'
partial derivative	`\frac{\partial f}{\partial x}`	$\frac{\partial f}{\partial x}$
integral	`\int`	$\int$
double integral	`\iint`	$\iint$
triple integral	`\iiint`	$\iiint$
limits	`\lim_{x\to \infty}`	$\lim_{x \to \infty}$
summation	`\sum_{n=1}^{\infty}a_n`	$\sum_{n=1}^{\infty} a_n$
product	`\prod_{n=1}^{\infty}a_n`	$\prod_{n=1}^{\infty} a_n$

Logic

description	*command*	*output*
not	`\sim`	$\sim$
and	`\land`	$\land$
or	`\lor`	$\lor$
if...then	`\to`	$\to$
if and only if	`\leftrightarrow`	$\leftrightarrow$
logical equivalence	`\equiv`	$\equiv$
therefore	`\therefore`	$\therefore$
there exists	`\exists`	$\exists$
for all	`\forall`	$\forall$
implies	`\Rightarrow`	$\Rightarrow$
equivalent	`\Leftrightarrow`	$\Leftrightarrow$

Linear algebra

description	*command*	*output*
vector	`\vec{v}`	$\vec{v}$
vector	`\mathbf{v}`	$\mathbf{v}$
norm	`||\vec{v}||`	$\|\|\vec{v}\|\|$

matrix	`\left[`
	`\begin{array}{ccc}`
	`1 & 2 & 3 \\`
	`4 & 5 & 6\\`
	`7 & 8 & 0`
	`\end{array}`
	`\right]`
		$\left[\begin{array}{ccc} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 0 \end{array}\right]$

determinant	`\left|`
	`\begin{array}{ccc}`
	`1 & 2 & 3 \\`
	`4 & 5 & 6 \\`
	`7 & 8 & 0`
	`\end{array}`
	`\right|`
		$\left\|\begin{array}{ccc} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 0 \end{array}\right\|$

determinant	`\det(A)`	$\det(A)$
trace	`\operatorname{tr}(A)`	$\operatorname{tr}(A)$
dimension	`\dim(V)`	$\dim(V)$

Number theory

description	*command*	*output*
divides	`\mid`	$\mid$
does not divide	`\not \mid`	$\nmid$
div	`\operatorname{div}`	div
mod	`\mod`	$\mod$
greatest common divisor	`\gcd`	$\gcd$
ceiling	`\lceil x \rceil`	$\lceil x \rceil$
floor	`\lfloor x \rfloor`	$\lfloor x \rfloor$

Geometry and trigonometry

description	*command*	*output*
angle	`\angle ABC`	$\angle ABC$
degree	`90^{\circ}`	90°
triangle	`\triangle ABC`	$\triangle ABC$
segment	`\overline{AB}`	$\overline{AB}$
sine	`\sin`	$\sin$
cosine	`\cos`	$\cos$
tangent	`\tan`	$\tan$
cotangent	`\cot`	$\cot$
secant	`\sec`	$\sec$
cosecant	`\csc`	$\csc$
inverse sine	`\arcsin`	$\arcsin$
inverse cosine	`\arccos`	$\arccos$
inverse tangent	`\arctan`	$\arctan$

Symbols (in *text* mode)

These symbols do *not* have to be surrounded by dollar signs.

description	*command*	*output*
dollar sign	`\$`	$
percent	`\%`	%
ampersand	`\&`	&
pound	`\#`	#
backslash	`\textbackslash`	\
left quote marks	` `` `	“
right quote marks	`''`	”
single left quote	`` ` ``	‘
single right quote	`'`	’
hyphen	`X-ray`	X-ray
en-dash	`pp. 5--15`	pp. 5–15
em-dash	`Yes---or no?`	Yes—or no?

Getting started with Overleaf and LaTeX

LaTeX collaborative authoring online: https://overleaf.com
Overleaf LaTeX documentation: https://overleaf.com/learn
Learn LaTeX in 30 minutes:
https://overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes

Comprehensive TeX Archive Network: http://www.ctan.org/
TeX Users Group: http://www.tug.org/

Want to work offline? Local install options for Linux or Windows: TeX Live; MacOS: MacTeX; Windows: MiKTeX