A Quick Guide to LaTeX

What is LaTeX?

LaTeX (usually pronounced "LAY teck," sometimes "LAH teck," and never "LAY tex") is a mathematics typesetting program that is the standard for most professional mathematics writing. It is based on the typesetting program TeX created by Donald Knuth (his first version appeared in 1978). Leslie Lamport created LaTeX, a more user-friendly version of TeX. A team of LaTeX programmers created the current version, LaTeX 2_ε.

Text vs. Math vs. Functions

In properly typeset mathematics, variables appear in italics (e.g., $f(x) = x^2 + 2x - 3$). The exception to this rule is predefined functions (like $\sin(x)$). 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 $\sin(x)$.

Text Decorations

Your text can be *italics* (`\textit{italics}`), **boldface** (`\textbf{boldface}`), or underlined (`\underline{underlined}`). Your math can contain boldface, $\mathbf{R}$ (`\mathbf{R}`), or blackboard bold, $\mathbb{R}$ (`\mathbb{R}`). You may want to use 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 $\mathbf{N}$).

To have text appear in 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: $(0,1] = \{x \in \mathbb{R} : x > 0 and x \le 1\}$.)

Inline Mathematical Expressions

Place a math expression between `$...$` or `\(...\)` to produce an inline expression. For example, typing `$90^{\circ}$ is the same as \(\frac{\pi}{2}\) radians` yields "90° is the same as $\frac{\pi}{2}$ radians."

Display Equations

Display equations are mathematical expressions given their own line and centered on the page. They are usually important equations that deserve to be showcased on their own line, or for tall or long equations that don't fit inline. To produce a display equation, surround the mathematical expression with `\[` and `\]`. Typing `\[x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}\]` yields

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

Displaystyle

To get full-sized inline mathematical expressions, use `\displaystyle`. Use this sparingly. Typing `I want this $\displaystyle \sum_{n=1}^{\infty} \frac{1}{n}$, not this $\sum_{n=1}^{\infty} \frac{1}{n}$.` yields

I want this $\displaystyle \sum_{n=1}^{\infty} \frac{1}{n}$, not this $\sum_{n=1}^{\infty} \frac{1}{n}$.

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 empty line between two paragraphs. Place `\\` at the end of a line to create a new line (but not a new paragraph). Use `\noindent` to prevent a paragraph from indenting.

```
This
compiles


like\\
this.
```

This compiles
like
this.

Comments

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

Images

You can put images (pdf, png, jpg, or gif) in your document. To do so, you need `\usepackage{graphicx}` at the start of your document, and the images need to be in the same directory as your .tex file. Omit `[width=5in]` if you want the image to be full-sized.

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

Delimiters

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

To make your 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 used to gather text with 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

Aligned Equations

description	*command*	*output*

aligned equations	`\begin{align*}`
	`f(0) &= 10\cos(0)\\`
	`&= 10`
	`\end{align*}`
		$f(0) = 10\cos(0)$
		$= 10$

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`	$\neq$
less than	`<`	$<$
greater than	`>`	$>$
less than or equal to	`\le`	$\leq$
greater than or equal to	`\ge`	$\geq$
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)`	$\deg(f)$

Created by Dave Richeson, Dickinson College, divisbyzero.com

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}`	$\|x\| = \begin{cases} x & x \geq 0 \\ -x & x < 0 \end{cases}$

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	`\gimel`	$\gimel$
`\sigma`	σ	`\daleth`	$\daleth$

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`	$\prod_{n=1}^{\infty} a_n$

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`	$\arctan$

Linear Algebra

description	*command*	*output*
vector	`\vec{v}`	$\vec{v}$
vector	`\mathbf{v}`	$\mathbf{v}$
norm	`|\vec{v}|`	$\|\vec{v}\|$
matrix	`\begin{bmatrix}` `1 & 2 & 3 \\` `4 & 5 & 6\\` `7 & 8 & 0` `\end{bmatrix}`	$\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 0 \end{bmatrix}$
determinant	`\begin{vmatrix}` `1 & 2 & 3 \\` `4 & 5 & 6 \\` `7 & 8 & 0` `\end{vmatrix}`	$\begin{vmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 0 \end{vmatrix}$
determinant	`\det(A)`	$\det(A)$
trace	`\operatorname{tr}(A)`	$\operatorname{tr}(A)$
dimension	`\dim(V)`	$\dim(V)$

Number Theory

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

Logic

description	*command*	*output*
not	`\sim`, `\lnot`	$\sim$, $\neg$
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`	$\Rightarrow$, $\implies$
equivalent	`\Leftrightarrow`, `\iff`	$\Leftrightarrow$, $\iff$

Symbols in Text Mode

The following 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?

Resources

TEX Users Group: tug.org
CTAN: ctan.org
Detexify: detexify.kirelabs.org
Mathpix: mathpix.com
The Not So Short Introduction to LATEX 2ε:
ctan.org/pkg/lshort
Mac: MacTeX tug.org/mactex,
LaTeXiT www.chachatelier.fr/latexit
Windows: TeXnicCenter www.texniccenter.org,
MiKTeX (miktex.org)
Online: Overleaf www.overleaf.com,
SageMath www.sagemath.org
TeX-SX tex.stackexchange.com