

# L<sup>A</sup>T<sub>E</sub>X basics

## 1 Creating documents

Text!!!  $\epsilon \sqrt{x^2 + 1} \tau \int \sum_{n=1}^{\infty}$

$$\sum_{n=1}^{\infty}$$

This is  
wrong.

Use L<sup>A</sup>T<sub>E</sub>X by first opening and editing a plain text file. Save the file with the `.tex` extension. The `.tex` file can be compiled to produce a `.pdf` file using either `pdflatex` or `xelatex`. The choice of compiler is usually an option in a drop down menu in L<sup>A</sup>T<sub>E</sub>X software packages or, if using the command line, can be invoked by entering `pdflatex filename.tex` or `xelatex filename.tex` in a terminal. The `pdflatex` option is faster and more established, but the `xelatex` option is better at handling fonts.

L<sup>A</sup>T<sub>E</sub>X files can also be edited and compiled on a third party web site such as [www.overleaf.com](http://www.overleaf.com). This is a fine option to get up and running quickly, but most serious users install L<sup>A</sup>T<sub>E</sub>X on their personal computer. There are many free options for downloading and installing L<sup>A</sup>T<sub>E</sub>X on each operating system:

- Windows users can use MikTeX. See [miktex.org/](http://miktex.org/).
- Apple users can use MacTeX. See [www.tug.org/mactex/](http://www.tug.org/mactex/).
- Linux should be able to figure it out themselves.

## 2 Entering mathematics

Mathematics can be typeset using the packages `amssymb`, `amsmath` and `amsthm`. These packages are maintained by the American Mathematical Society.

To produce inline “textstyle” mathematics, place mathematics between the symbols `\(` and `\)` or between the symbols `$` and `$`. To produce “displaystyle” mathematics on its own centered line, similar to

$$\frac{d}{dx} \arcsin x = \frac{1}{\sqrt{1-x^2}},$$

place mathematics between `\[` and `\]` or between `\begin{equation*}` and `\end{equation*}`. This is known as “displaystyle”. Inline mathematics can appear as displaystyle using the `\displaystyle ..` command and displayed mathematics can appear as textstyle using `\textstyle ..`.

Mathematics symbols are typeset using commands such as `\(\Xi\)`, producing  $\Xi$ .  $\text{\LaTeX}$  will complain if such a mathematics symbol is not called in math mode. A list of mathematics symbols can be found on pages 75–82 of our text. The web site

<http://detexify.kirelabs.org/classify.html>

can also help in finding symbols. *Use standard AMS packages whenever possible!*

The most frequently encountered functions and operators in mathematics have pre-defined command names. For example:

$$\sin x, \cos x, \tan x, \arcsin x, \ln x$$

Use `\operatorname{..}` if a function or operator does not have a predefined command, like this:  $\operatorname{erf} x$ .

Binomial coefficients:  $1 + 2 + \cdots + n = \binom{n+1}{2}$ , and matrices:

$$\begin{bmatrix} a & \cdots & b \\ \vdots & \ddots & \\ -3 & \cdots & 4 \end{bmatrix}$$

$$\begin{bmatrix} a & b \\ c & d \end{bmatrix} \quad \begin{vmatrix} a & b \\ c & d \end{vmatrix} \quad \begin{pmatrix} a & b \\ c & d \end{pmatrix} \quad \begin{smallmatrix} a & b \\ c & d \end{smallmatrix} \quad \begin{matrix} a & b \\ c & d \end{matrix} \quad \begin{bmatrix} a & b \\ c & d \end{bmatrix} \quad \left\| \begin{smallmatrix} a & b \\ c & d \end{smallmatrix} \right\|$$

By convention, matrices are not written in boldface but vectors such as  $\mathbf{x}$  are. To typeset a transpose, use the `\intercal` symbol, such as  $\mathbf{x}^\intercal$ .

### 3 Spacing

Sometimes the spacing between mathematics symbols should be adjusted. The spacing commands to be used in math mode, in order of longest space to smallest space, are:

`\quad`    `\quad`    `\`    `\;`    `\:`    `\,`    `\!`

These produce spaces equal to the width of two eMs, one eM (one quad), the width of inter-word spacing,  $\frac{5}{18}$  quad,  $\frac{4}{18}$  quad,  $\frac{3}{18}$  quad, and  $-\frac{3}{18}$  quad. It is proper form to use `\,` before differentials in integrals, like this

$$\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} e^{-(x^2+y^2)} dx dy = \int_0^{2\pi} \int_0^{\infty} e^{-r^2} r dr d\theta.$$

Here is the incorrect typesetting, without the proper spacing:

$$\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} e^{-(x^2+y^2)} dx dy = \int_0^{2\pi} \int_0^{\infty} e^{-r^2} r dr d\theta.$$

In rare cases spacing can be adjusted using `\phantom{stuff}` which creates a space of the same length as the typeset length of `stuff`. Using `\phantom` frequently is a sign of poor typesetting.

Parentheses of the correct size are given by `\left( .. \right)`. The parentheses do not have to be the same type. To suppress a parentheses, replace the parenthesis with a period. For example,

$$\left\{ x \in \mathbb{R} : \int_0^x \sin t dt \leq 1 \right\}.$$

### 4 Multi-line mathematics

To display multi-line math example, use `\begin{align*}..\end{align*}`, where the `&` symbol controls where the alignment occurs and `\\` gives a new line. For instance, consider

$$\int_a^b x^n dx = \frac{x^{n+1}}{n+1} \Big|_a^b \tag{1}$$

$$\begin{aligned} &= \frac{b^{n+1}}{n+1} - \frac{a^{n+1}}{n+1} \\ &= \frac{1}{n+1} (b^{n+1} - a^{n+1}). \end{aligned} \tag{2}$$

For long expressions that don't fit on one line, use `\begin{multline*}`, with `\\` denoting a new line:

$$\begin{aligned} \alpha + \beta + \gamma + \delta + \varepsilon + \zeta + \eta + \theta \\ + \iota + \kappa + \lambda + \mu + \nu + \xi + \pi + \rho \\ + \sigma + \tau + \upsilon + \varphi + \chi + \psi + \omega. \end{aligned}$$

Fractions can be displayed a couple of ways:  $\frac{1}{2}$  versus  $\frac{1}{2}$ .