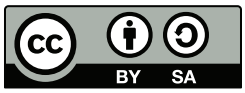
LaTeX quick reference

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This guide is available from http://web.eecs.utk.edu/~mgates3/
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Purpose. This document was initially made as a quick reference to all the commands that I typically use, organized so I can understand it, with examples and without clutter. It also includes many shortcuts that I have defined in my mgates.sty file. It is not intended to be exhaustive, nor overly descriptive. Most of the general LaTeXcommands can be found in the *Not So Short Introduction to LaTeX 2ε* [4]; most of the math in the *Short Math Guide to LaTeX* [2]; most of the bibliography information in the BibTeX tutorial [3] and the natbib documentation [1].

I also wrote a separate Latex fonts guide.

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1 Commands

1.1 Document structure

`\documentclass[`*options*`]{`*class*`}`

Common classes

article	articles without chapters
proc	proceedings, based on article
minimal	minimal formatting
report	reports with chapters
book	real books

Common options

10pt, 11pt, 12pt	main font size
a4paper, letterpaper, ...	paper size
fleqn	equations left-aligned instead of centered
leqno	equation numbers on left instead of right
titlepage, notitlepage	start new page after title
onecolumn, twocolumn	one or two columns
twoside, oneside	
landscape	paper orientation
openright, openany	chapters begin on right page, or any page

Preamble

`\usepackage[`*options*`]{`*package*`}`

`\includeonly{`*filenames*`}`
skip `\include` with listed files

Document

`\begin{document}`

`\include{`*filename*`}`
start new page with contents of file

`\input{`*filename*`}`
include contents of file, without starting a new page

`\end{document}`

1.2 Page format

`\pagestyle{ plain | headings | empty }`

plain	page number in footer
headings	page number and chapter in header
empty	no header or footer

`\thispagestyle{ plain | headings | empty }`
override `\pagestyle` on a single page

```
% set 1" margins on 8.5" x 11" paper
% top left is measured from 1", 1"
\topmargin       0in
\oddsidemargin   0in
\evensidemargin  0in
\headheight      0in
\headsep         0in
\topskip         0in
\textheight      9in
\textwidth       6.5in

% set these after the TOC
\setlength{\parindent}{0em}
\setlength{\parskip}{1em}

\setlength\arraycolsep{2pt}
```

1.3 Chapters and Sections

```
\title{...}
\author{John Doe \and Jane Doe}
\date{\today}
\maketitle
```

`\frontmatter` % (book only) starts roman numeral page numbering, unnumbered sections

```
\setcounter{tocdepth}{1}  % whether to display sub- or subsubsections in toc
\tableofcontents
```

`\mainmatter` % (book only) starts arabic page & section numbering

```
\part{...}
\chapter{...}              \chapter*{...}          % (book only)
\section{...}              \section*{...}
\subsection{...}           \subsection*{...}
\subsubsection{...}        \subsubsection*{...}
\paragraph{...}            \paragraph*{...}
\subparagraph{...}         \subparagraph*{...}
```

`\appendix` % (book only) starts alphabetic section numbering

`\backmatter`

* Starred versions are unnumbered and not in the table of contents.

Examples:

1 section

1.1 subsection

1.1.1 subsubsection

paragraph Run-in paragraph header. Lorem ipsum dolar blah blah blah blah blah blah blah blah blah blah blah blah blah blah blah blah

subparagraph Run-in paragraph header. Lorem ipsum dolar blah blah blah blah blah blah blah blah blah blah blah blah blah blah blah blah

1.4 Fonts

Font sizes

Point size		Latex cmd	User-defined *	Sample
5	6	`\tiny`	`\xxxsmall`	the quick brown fox
7	8	`\scriptsize`	`\xxsmall`	the quick brown fox
8	10	`\footnotesize`	`\xsmall`	the quick brown fox
9	11	`\small`	`\small`	the quick brown fox
10	**12**	`\normal`	`\normal`	the quick brown fox
12	14	`\large`	`\large`	the quick brown fox
14	17	`\Large`	`\xlarge`	the quick brown fox
17	20	`\LARGE`	`\xxlarge`	the quick brown fox
20	25	`\huge`	`\xxxlarge`	the quick brown fox
25	25	`\Huge`	`\xxxxlarge`	the quick brown fox

* see mgates.sty file

Fonts

Command	Sample
`\textrm`	roman
`\textsf`	sans serif
`\texttt`	`typewriter`
`\textup`	upright
`\textsl`	*slanted*
`\emph`	*emphasized*
`\underline`	underline
`\textit`	*italic*
`\textmd`	medium
`\textbf`	**bold font**
`\textsc`	Small Caps
`\textnormal`	normal

In math mode (e.g. inside $...$), use the math fonts listed in the math section.

1.5 Reserved characters

Char	Special meaning	Command
#	?	\#
$	math mode	\$
%	comment	\%
^	math superscript	\^{}
&	tab stop	\&
_	math subscript	_
{	start parameter	\{
}	end parameter	\
~	nonbreaking space	\~{}
\	start command	$\backslash$

These can also be typed in the verbatim environment or with `\verb`.

1.6 Special characters

Symbol	Command	Symbol	Command	Symbol	Command
“	``	”	'' or ''		
‘	`	’	'		
in-law	in-law	13–67 (en)	13--67	yes—no (em)	yes---no
yes . . . no	yes \ldots no	¿No?	?`No?	¡No!	!`No!
†	\dag	‡	\ddag		
§	\S	¶	\P		
©	\copyright	®	\textregistered		
£	\pounds	€	\texteuro *		

* in textcomp package

1.7 Accented characters

Char	Command	Char	Command	Char	Command	Char	Command
ò	`\‘o`	ó	`\’o`	ô	`\^o`	õ	`\~o`
ō	`\=o`	ȯ	`\.o`	ö	`\"o`	ç	`\c c`
ŏ	`\u o`	ǒ	`\v o`	ő	`\H o`		
o̩	`\d o`	o̲	`\b o`	o͡o	`\t oo`		
œ	`\oe`	Œ	`\OE`	æ	`\ae`	Æ	`\AE`
å	`\aa`	Å	`\AA`				
ø	`\o`	Ø	`\O`	ł	`\l`	Ł	`\L`

The first 4 lines can be applied to appropriate characters.
To put accent over i or j, use `\i` (ı) or `\j` (ȷ).

1.8 Special spaces

Command	Size	1 space	10 spaces
`\,`	3/8 quad	( )	[ ]
`\:`	4/8 quad	( )	[ ]
`\;`	5/8 quad	( )	[ ]
`\␣`	en? space	( )	[ ]
`\quad`	em space	( )	[ ]
`\qquad`	2 quad	( )	[ ]
`\!`	−3/8 quad	()]	[

In math mode, `phantom` reserves space for text without printing it, for example

$$\begin{aligned} x_1 &\phantom{{}+ x_2} + x_3 = 2, \\ x_1 &+ x_2 \phantom{{}+ x_3} = 5, \\ x_1 &+ x_2 + x_3 = 7. \end{aligned}$$

```
x_1 \phantom{+ x_2} + x_3 = 2,  \\
x_1 + x_2 \phantom{+ x_3} = 5,  \\
x_1 + x_2 + x_3 = 7.
```

1.9 Special phrases

Command	Sample
`\today`	October 4, 2026
`\TeX`	TEX
`\LaTeX`	LATEX
`\LaTeXe`	LATEX 2ε

1.10 Line and page breaks

`\\` or `\newline`
line break, without new paragraph. `\\*` also prohibts page break.

`\linebreak[`n`]`
`\nolinebreak[`n`]`
line break, keeping line justified. n ranges from 0 to 4 (most insistent).

For example, here is a paragraph with a newline in it, lorem ipsum dolar blah blah blah blah blah blah blah blah blah blah blah blah blah blah blah blah, `\newline`.
It also has a linebreak in it for comparison, lorem ipsum dolar blah blah blah blah blah blah blah blah blah blah blah blah blah blah blah blah, `\linebreak[4]`. Notice the difference in justification. Using `\linebreak` can cause "underfull hbox" warnings.

`\newpage`
page break

`\pagebreak[`n`]`
`\nopagebreak[`n`]`
page break, keeping line justified. n ranges from 0 to 4 (most insistent).

`\hyphenation{ fortran hy-phen-a-tion }`
list of words and where they may be hyphenated (in preamble).

`\-`
where a word may be hyphenated (in text). Example: `su\-per\-scal\-ar`

`\␣` space not to enlarge
`~` space not to enlarge or line break
"Mr. Smith" (`Mr.\ Smith`) or
"Mr. Smith" (`Mr.~Smith`) instead of
"Mr. Smith" (`Mr. Smith`)

`\@` between capital letter and punctuation that really does end a sentance
"...FORTRAN. But..." (`FORTRAN\@. But`) instead of
"...FORTRAN. But..." (`FORTRAN. But`)

1.11 References, citations, footnotes

`\label{`*name*`}` assigns a unique name to an equation, figure, table, or section. For figures and tables, label must be after the caption.

`\eqref{`*name*`}` inserts reference to the labeled equation; equivalent to `(\ref{`*name*`})`.

`\ref{`*name*`}` inserts reference to the label. You must add the descriptive text such as "figure."

`\pageref{`*name*`}` inserts page number of the label.

`\cite{`*name*`}` inserts reference to bibliography citation. Name is assigned by `bibitem`, not `label`.

`\footnote{`*text*`}` generates a footnote.

See also equation numbering on page 18.

1.12 Hyperlinks

```
\usepackage[options]{hyperref}
\usepackage[colorlinks, urlcolor=blue, linkcolor=black]{hyperref}
```

To color links, use the `colorlinks` option. To override default colors, specify

linkcolor	red	internal links (sections, pages, etc.)
citecolor	green	citation links (bibliography)
filecolor	magenta	file links
urlcolor	cyan	URL links (mail, web)

`\href{`*url*`}{`*text*`}`
`\href{http://www.ctan.org/}{CTAN}` CTAN

`\href{mailto:noone@example.com}{noone@example.com}` noone@example.com

2 Environments

2.1 Text alignment

this paragraph is
flush left.

```
\begin{flushleft}
this paragraph \\
is flush left.
\end{flushleft}
```

this paragraph is
flush right.

```
\begin{flushright}
this paragraph \\
is flush right.
\end{flushright}
```

this paragraph is
centered.

```
\begin{center}
this paragraph \\
is centered.
\end{center}
```

2.2 Boxes

Only minipage is an environment, but these are all related.

`\mbox{...}`
`\makebox[`*width*`][t|b|c]{...}`
groups items in a box. Everything must be on one line (?).

`\fbox{...}`
`\framebox[`*width*`][t|b|c]{...}`
framed box. Everything must be on one line (?).

`\parbox[t|b|c]{`*width*`}{...}`
paragraph box that wraps text.

`\begin{minipage}[t|b|c]{`*width*`} ... \end{minipage}`
minipage box, similar to parbox but can contain almost anything.

`\begin{boxedminipage}[t|b|c]{`*width*`} ... \end{boxedminipage}`
with `\usepackage{boxedminipage}`.

`\rule{`*width*`}{`*height*`}`

`\raisebox`

page and other parameters to tweak

2.3 Block quotes

Martin Luther King Jr. said,

> I have a dream that someday. . .

```
Martin Luther King Jr. said,
\begin{quote}
I have a dream that someday\ldots
\end{quote}
```

For multiple paragraph quotations, use `quotation` instead of `quote`, to indent the first line of each paragraph.

2.4 Verse

Reverse indents if line wraps.

Humpty Dumpty

Humpty Dumpty sat on a wall:
Humpty Dumpty had a great fall.
All the King's horses and all the King's men
Couldn't put Humpty together again.

```
\textbf{Humpty Dumpty}
\begin{verse}
Humpty Dumpty sat on a wall:\\
Humpty Dumpty had a great fall.\\
All the King's horses and all the
King's men\\
Couldn't put Humpty together again.
\end{verse}
```

2.5 Verbatim

`verbatim` reproduces text exactly as you type it, not interpretting any characters or commands. It was used here for all the LaTeX code listings.

```
\begin{verbatim}
text can include special characters # $ <
and \textbf{commands}.
\end{verbatim}
```

`\verb+text+`
where the delimiter '+' is any character except letters, *, and space.

Adding a star highlights spaces.
`\begin{verbatim*} ... \end{verbatim*}`
`\verb*+text with spaces+` `text␣with␣spaces`

2.6 Lists

1. One
3. Two (with special number)
2. Three

```
\begin{enumerate}
\item One
\item[3.] Two (with special number)
\item Three
\end{enumerate}
```

- One
- Two (with special bullet)

```
\begin{itemize}
\item One
\item[-] Two (with special bullet)
\end{itemize}
```

One Description of one

Two Description of two

```
\begin{description}
\item[One] Description of one
\item[Two] Description of two
\end{description}
```

2.7 Tables (tabular)

col1	col2	col3
col1	col2	col3
col1	col2	col3

```
\begin{tabular}{l|ll}
col1  &  col2  &  col3 \\
\hline
col1  &  col2  &  col3 \\
col1  &  col2  &  col3 \\
\end{tabular}
```

In general:

```
\begin{tabular}[t|b|c]{column spec}
col1  &  col2  &  ...  &  coln \\
col1  &  col2  &  ...  &  coln \\
\end{tabular}
```

In *column spec*, for each column use `l`, `r`, `c` for a left, right, or centered column, `p{`*width*`}` for a column of given width that wraps text. Use `|` (pipe) for a vertical line between columns. Use `@{...}` to specify the delimiter between columns. An empty `@{}` deletes the gutter or left indent.

Between lines, use `\hline` for a horizontal line.

Use `\multicolumn{`*n*`}{`*column spec*`}{`*text*`}` to have text span multiple columns.

2.8 Figures and Tables

A figure typically includes 1 or more graphics. Example:

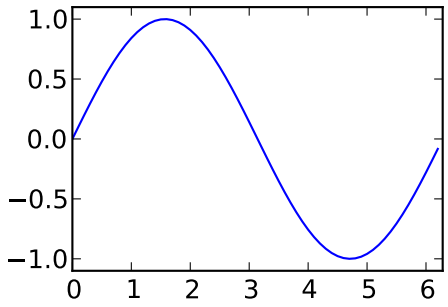


Figure 1: $\sin(x)$

```
\begin{figure}[h]
    \centering
    \includegraphics[scale=0.8]{sine}
    \caption{$\sin(x)$}
    \label{sine}
\end{figure}
```

A table typically includes a tabular environment; see previous section. Example:

	sales	growth
2000	10,000	15%
2001	12,000	20%

Table 1: Sales growth

```
\begin{table}[h]
    \centering
    \begin{tabular}{ccc}
          &  sales   &  growth  \\
    2000  &  10,000  &  15\%  \\
    2001  &  12,000  &  20\%  \\
    \end{tabular}
    \caption{Sales growth}
    \label{sales-growth}
\end{table}
```

`figure` and `table` take an optional placement specifier:

`h` *here* in the text
`t` *top* of a page
`b` *bottom* of a page
`p` on a special *page* of only floats
`!` be insistent

To use `includegraphics`, include `\usepackage[`*driver*`]{graphicx}` in the preamble. The *driver* should normally be omitted; if necesary, it is `dvips` for latex and `pdftex` for pdflatex. Files must be eps for dvips, while pdftex takes pdf, jpg, tif, or png. It's convenient to leave off the extension; latex/pdflatex will look for the appropriate file. (In this example, spring.pdf or spring.eps.) Since many journals want eps files instead of pdf files, I often generate eps files first, then convert them to pdf using epstopdf.

`includegraphics` options

`width=`*width*	scale to width, maintaining aspect ratio if no height
`height=`*height*	scale to height, maintaining aspect ratio if no width
`angle=`*degrees*	rotate counterclockwise
`scale=`*scale*	resize image by scalar value

3 Math

Surround inline equations with dollar signs, for example `$x=2$` produces $x = 2$. For equations in their own block, use one of the environments below. For unnumbered equations append a * star to the environment name. As a shortcut for unnumbered equations, `\[...\]` is the same as `\begin{equation*}...\end{equation*}`.

`equation` sets a single equation (1).

$$x = a + b. \tag{1}$$

```
\begin{equation} \label{x1}
 x = a + b.
\end{equation}
```

`gather` sets multiple equations (2,3), centered on each other.

$$x = a + b, \tag{2}$$
$$y = c + d + e + f. \tag{3}$$

```
\begin{gather}
 x = a + b,          \label{x2} \\
 y = c + d + e + f. \label{y2}
\end{gather}
```

`align` sets multiple equations (4,5), aligned typically on = sign.

$$x = a + b, \tag{4}$$
$$y = c + d + e + f, \tag{5}$$

```
\begin{align}
 x &= a + b,          \label{x3} \\
 y &= c + d + e + f, \label{y3}
\end{align}
```

`multline` splits a long equation (6) over multiple lines, distributing the space.

$$\begin{aligned} x = a + b + c + d + e + f \\ + g + h + i + j + k. \\ + l + m + n. \end{aligned} \tag{6}$$

```
\begin{multline} \label{x6}
 x = a + b + c + d + e + f \\
   + g + h + i + j + k. \\
   + l + m + n.
\end{multline}
```

`split` splits a long equation (7) over multiple lines, aligning it. Use inside equation, align, or gather.

$$\begin{aligned} x &= a + b \\ &= c + d + e. \end{aligned} \tag{7}$$

```
\begin{equation}
\begin{split} \label{x5}
 x &= a + b      \\
   &= c + d + e.
\end{split}
\end{equation}
```

`subequations` assigns all enclosed equations subordinate equation numbering, so (8a,8b) are parts of (8).

$$x = a + b, \tag{8a}$$
$$y = c + d + e + f. \tag{8b}$$

```
\begin{subequations} \label{group4}
\begin{align}
 x &= a + b,          \label{x4} \\
 y &= c + d + e + f. \label{y4}
\end{align}
\end{subequations}
```

`align` can also have several columns of equations or descriptions. The `intertext` command is useful to insert text while preserving alignment.

$$x = 1, \qquad y = 2, \qquad \text{initialize}$$
$$z = 3, \qquad w = 4,$$

some more text, and

$$a = 5, \qquad b = 5.$$

```
\begin{align*}
 x &= 1, & y &= 2, && \text{initialize}
 \\
 z &= 3, & w &= 4,
\intertext{some more text, and}
 a &= 5, & b &= 5.
\end{align*}
```

The non-AMS command for aligning equations is `eqnarray`, but it produces rather poor spacing and is *not recommended*.

$$x = a + b, \tag{9}$$
$$y = c + d + e + f. \tag{10}$$

```
\begin{eqnarray}
 x &=& a + b,          \label{x7} \\
 y &=& c + d + e + f. \label{y7}
\end{eqnarray}
```

3.1 Equation numbering

`\label{`*name*`}` assigns a unique name to an equation.

`\eqref{`*name*`}` generates reference to equation; equivalent to `(\ref{`*name*`})`

For `subequations`, both the whole group and individial equations can have labels.

To get equation numbers of form $m.n$ where m is the section number and n is the equation number within section, use `\numberwithin{equation}{section}` in preamble.

See also references on page 10.

3.2 Sub/superscripts

Subscripts are done with _ underbar, like `x_{1}` for x_1.
Superscripts are done with ^ caret, like `x^{1}` for x^1.
Use braces for double sub/superscripts, like `{B^a}^T` for B^{aT} or `\int_{x_1}` for $\int_{x_1}$.

3.3 Fractions and binomial coefficient

`\frac{`*numerator*`}{`*denominator*`}` makes fractions in either display or text style, depending on context.
`\dfrac` forces display (big) style.
`\tfrac` forces text (small) style.

Inline: frac $\frac{1}{2}$, dfrac $\dfrac{1}{2}$, tfrac $\tfrac{1}{2}$.
In equation:

$$\text{frac } \frac{1}{2}, \quad \text{dfrac } \dfrac{1}{2}, \quad \text{tfrac } \tfrac{1}{2}.$$

```
\frac{1}{2}
\dfrac{1}{2}
\tfrac{1}{2}
```

Similarly, `\binom, \dbinom, \tbinom` for binomial coefficient (i.e. n choose k)

$$\text{binom } \binom{n}{k}, \quad \text{dbinom } \dbinom{n}{k}, \quad \text{tbinom } \tbinom{n}{k}.$$

```
\binom{n}{k}
\dbinom{n}{k}
\tbinom{n}{k}
```

3.4 Math Fonts

Command	Name	Samples				Package
`\mathrm`	roman	ABCDE	abcde	12345	$\alpha\omega\Omega$	
`\mathsf`	sans serif	ABCDE	abcde	$\mathsf{12345}$	$\alpha\omega\Omega$	
`\mathtt`	typewriter	$\mathtt{ABCDE}$	$\mathtt{abcde}$	$\mathtt{12345}$	$\alpha\omega\Omega$	
`\mathit`	italic	ABCDE	abcde	$\mathit{12345}$	$\alpha\omega\Omega$	
`\mathbf`	bold font	$\mathbf{ABCDE}$	$\mathbf{abcde}$	$\mathbf{12345}$	$\alpha\omega\mathbf{\Omega}$	
`\bm`	bold symbol	$\bm{ABCDE}$	$\bm{abcde}$	$\mathbf{12345}$	$\bm{\alpha\omega\Omega}$	bm
`\mathbb`	blackboard	$\mathbb{ABCDE}$				
`\mathcal`	calligraphic	$\mathcal{ABCDE}$				
`\mathfrak`	frak	$\mathfrak{ABCDE}$	$\mathfrak{abcde}$	$\mathfrak{12345}$		amsfonts, amssymb
`\mathnormal`	normal	$\mathnormal{ABCDE}$	$\mathnormal{abcde}$	12345	$\alpha\omega\mathnormal{\Omega}$	amsfonts, amssymb

3.5 Functions

Functions to typeset in roman

`\sin`	`\cos`	`\tan`	`\sec`	`\csc`	`\cot`
`\sinh`	`\cosh`	`\tanh`			`\coth`
`\arcsin`	`\arccos`	`\arctan`			
`\exp`	`\lg`	`\ln`	`\log`		
`\min`	`\max`	`\arg`			
`\inf`	`\sup`				
`\liminf`	`\limsup`	`\lim`			
`\det`	`\ker`	`\dim`			
`\gcd`	`\deg`	`\hom`	`\Pr`		

User-defined (see mgates.sty file)

`\sech`	`\cond`	`\range`	`\rank`

Limits specified in subscript: `\lim_{n \to 0}` is $\lim_{n \to 0}$.

To add new functions, for example $\operatorname{rank}(A)$, use `\DeclareMathOperator{\rank}{rank}`. The starred version `\DeclareMathOperator*` makes functions with limits like lim.

Modular arithmetic has 4 variants. This expression means "5 is congruent to 1, modulo 2."

$$5 \equiv 1 \pmod 2$$
$$5 \equiv 1 \mod 2$$
$$5 \equiv 1 \pod 2$$

```
5 &\equiv 1 \pmod 2  \\
5 &\equiv 1 \mod 2   \\
5 &\equiv 1 \pod 2
```

Denote the modulo operation of finding the remainder with = equals and the binary `bmod`,

$$1 = 5 \bmod 2.$$

```
1 = 5 \bmod 2.
```

3.6 Accents and over/under commands

$\hat{x}$	`\hat{x}`	$\tilde{x}$	`\tilde{x}`	$\dot{x}$	`\dot{x}`	$\acute{x}$	`\acute{x}`	$\vec{x}$	`\vec{x}`
$\check{x}$	`\check{x}`	$\bar{x}$	`\bar{x}`	$\ddot{x}$	`\ddot{x}`	$\grave{x}$	`\grave{x}`	$\breve{x}$	`\breve{x}`

The wide and over/under commands span multiple elements. The over/underbrace also take super/subscripts for a description. Note the over/underset take two arguments, not a super/subscript, and are backwards of over/underbrace.

$\widehat{xyz}$	`\widehat{xyz}`	$\widetilde{xyz}$	`\widetilde{xyz}`
$\overline{xyz}$	`\overline{xyz}`	$\underline{xyz}$	`\underline{xyz}`
$\overleftarrow{xyz}$	`\overleftarrow{xyz}`	$\underleftarrow{xyz}$	`\underleftarrow{xyz}`
$\overrightarrow{xyz}$	`\overrightarrow{xyz}`	$\underrightarrow{xyz}$	`\underrightarrow{xyz}`
$\overleftrightarrow{xyz}$	`\overleftrightarrow{xyz}`	$\underleftrightarrow{xyz}$	`\underleftrightarrow{xyz}`
$\overbrace{xyz}^{a}$	`\overbrace{xyz}^{a}`	$\underbrace{xyz}_{a}$	`\underbrace{xyz}_{a}`
$\overset{a}{xyz}$	`\overset{a}{xyz}`	$\underset{a}{xyz}$	`\underset{a}{xyz}`

3.7 Greek

In English alphabetic order

α	`\alpha`	A	`A`		
β	`\beta`	B	`B`		
χ	`\chi`	C	`C`		
δ	`\delta`	Δ	`\Delta`		
ϵ	`\epsilon`	E	`E`	ε	`\varepsilon`
η	`\eta`	H	`H`		
γ	`\gamma`	Γ	`\Gamma`	$\digamma$	`\digamma`
ι	`\iota`	I	`I`		
κ	`\kappa`	K	`K`		
λ	`\lambda`	Λ	`\Lambda`		
μ	`\mu`	M	`M`		
ν	`\nu`	N	`N`		
ω	`\omega`	Ω	`\Omega`		
o	`o`	O	`O` (omicron)		
ϕ	`\phi`	Φ	`\Phi`	φ	`\varphi`
π	`\pi`	Π	`\Pi`	ϖ	`\varpi`
ψ	`\psi`	Ψ	`\Psi`		
ρ	`\rho`	P	`P`	ϱ	`\varrho`
σ	`\sigma`	Σ	`\Sigma`	ς	`\varsigma`
τ	`\tau`	T	`T`		
θ	`\theta`	Θ	`\Theta`	ϑ	`\vartheta`
υ	`\upsilon`	Υ	`\Upsilon`		
ξ	`\xi`	Ξ	`\Xi`		
ζ	`\zeta`	Z	`Z`		

Greek alphabetic order is

$\alpha\ \beta\ \gamma\ \delta\ \epsilon\ \zeta\ \eta\ \theta\ \iota\ \kappa\ \lambda\ \mu\ \nu\ \xi\ \pi\ o\ \rho\ \sigma\ \tau\ \upsilon\ \phi\ \chi\ \psi\ \omega$
$A\ B\ \Gamma\ \Delta\ E\ Z\ H\ \Theta\ I\ K\ \Lambda\ M\ N\ \Xi\ \Pi\ O\ P\ \Sigma\ T\ \Upsilon\ \Phi\ C\ \Psi\ \Omega.$

3.8 Hebrew

$\aleph$	`\aleph`
$\beth$	`\beth`
$\gimel$	`\gimel`
$\daleth$	`\daleth`

3.9 Symbols

(A selective list. See the AMS *Short Math Guide* and the *Not So Short Introduction* for more exhaustive lists.)

Relationships (negate using `\not`)

$<$	`<`	$>$	`>`	$=$	`=`
$\le$	`\le`	$\ge$	`\ge`	$\equiv$	`\equiv`
$\ll$	`\ll`	$\gg$	`\gg`	$\sim$	`\sim`
$\subset$	`\subset`	$\supset$	`\supset`	$\approx$	`\approx`
$\subseteq$	`\subseteq`	$\supseteq$	`\supseteq`		
$\in$	`\in`	$\ni$	`\ni`, `\owns`	$\propto$	`\propto`
$\notin$	`\notin`			$\neq$	`\ne`
$\parallel$	`\parallel`	$\perp$	`\perp`	$\cong$	`\cong`

Operators

$+$	$+$	$-$	`-`	$\cdot$	`\cdot`	$\times$	`\times`	$\div$	`\div`
$\pm$	`\pm`	$\mp$	`\mp`	$\star$	`\star`	$*$	`*`, `\ast`		
$\oplus$	`\oplus`	$\ominus$	`\ominus`	$\odot$	`\odot`	$\otimes$	`\otimes`	$\oslash$	`\oslash`
$\cup$	`\cup`	$\cap$	`\cap`	$\setminus$	`\setminus`				
$\bigcup$	`\bigcup`	$\bigcap$	`\bigcap`	$\biguplus$	`\biguplus`				
$\vee$	`\vee`	$\wedge$	`\wedge`	$\neg$	`\neg`				
$\vee$	`\lor`	$\wedge$	`\land`	$\neg$	`\lnot`				
$\sum$	`\sum`	$\prod$	`\prod`	$\coprod$	`\coprod`				
$\int$	`\int`	$\oint$	`\oint`	$\iint$	`\iint`	$\iiint$	`\iiint`	$\int\cdots\int$	`\idotsint`
∂	`\partial`	∇	`\nabla`						

User-defined (see mgates.sty)

$\int_\Omega$	`\intO`					$\int_{\Omega^e}$	`\intOe`		
$\int_\Gamma$	`\intG`	$\int_{\Gamma_g}$	`\intGg`	$\int_{\Gamma_h}$	`\intGh`	$\int_{\Gamma_h^e}$	`\intGhe`		
dx	`\dx`	dy	`\dy`	dz	`\dz`	dr	`\dr`	dt	`\dt`
$\mathrm{d}\Omega$	`\dO`	$\mathrm{d}\Gamma$	`\dG`	$d\theta$	`\dT`				
∂f	`\p f`	∇f	`\del f`	∇f	`\grad f`	$\nabla\cdot f$	`\divr f`	$\nabla\times f$	`\curl f`
$\cup$	`\union`	$\cap$	`\inter`	$f\circ g$	`\compose`				

Limits are specified as sub- and superscripts: `\sum_{i=0}^{n}` is $\sum_{i=0}^{n}$.

Roots use `\sqrt`, with optional radix

$\sqrt{2}$ `\sqrt{2}` $\sqrt[3]{2}$ `\sqrt[3]{2}`

Misc symbols

$\leftarrow$	\gets	$\to$	\to	$\mapsto$	\mapsto	$\iff$	\iff		
$\ldots$	\dots	$\cdots$	\cdots	$\vdots$	\vdots	$\ddots$	\ddots	$\cdot$	\cdot
$\Re$	\Re	$\Im$	\Im						
$\forall$	\forall	$\exists$	\exists	$\nexists$	\nexists	$\therefore$	\therefore	$\because$	\because
$\emptyset$	\emptyset	∞	\infty	$\hbar$	\hbar	$\wp$	\wp		
$\angle$	\angle	$\triangle$	\triangle	$\square$	\square	$\Diamond$	\Diamond		

User-defined (see mgates.sty file)

$\boldsymbol{x}$	\xx	$\boldsymbol{y}$	\yy	$\boldsymbol{f}$	\ff	$\mathbf{0}$	\0 (zero)		
$\boldsymbol{A}$	\A	$\boldsymbol{I}$	\I	$\boldsymbol{J}$	\J	$\boldsymbol{K}$	\K	$\boldsymbol{M}$	\M
$\mathbb{R}$	\Real	$\mathbb{C}$	\Complex	$\mathbb{I}$	\Imag	$\mathrm{Re}(x)$	\re{x}	$\mathrm{Im}(x)$	\im{x}
$\mathbb{N}$	\Natural	$\mathbb{Z}$	\Integer	$\mathbb{Q}$	\Rational	$\mathbb{P}$	\Poly		
Δt	\Dt	$\frac{1}{2}$	\half	$\Rightarrow$	\implies				

Arrows	L	R	LR	LL	LR	LLR	U	D	UD
*left*arrow	$\leftarrow$	$\rightarrow$	$\leftrightarrow$	$\longleftarrow$	$\longrightarrow$	$\longleftrightarrow$	$\uparrow$	$\downarrow$	$\updownarrow$
*Left*arrow	$\Leftarrow$	$\Rightarrow$	$\Leftrightarrow$	$\Longleftarrow$	$\Longrightarrow$	$\Longleftrightarrow$	$\Uparrow$	$\Downarrow$	$\Updownarrow$
\hook*left*arrow	$\hookleftarrow$	$\hookrightarrow$							
*left*harpoonup	$\leftharpoonup$	$\rightharpoonup$	$\leftrightharpoons$						
*left*harpoondown	$\leftharpoondown$	$\rightharpoondown$							

Substitute

left,	right,	leftright,
longleft,	longright,	longleftright,
up,	down,	updown

for *left* in the command to get the desired direction and length. Note `\leftrightharpoons` is plural. There are many more variants available; see the AMS *Short Math Guide*.

For putting super/subscripts on arrows, use

$$A \xleftarrow{a+b} B \xrightarrow[c-d]{a-b} C$$

```
A \xleftarrow{a+b} B \xrightarrow[c-d]{a-b} C
```

See also accents on page 21 for arrows above/below elements.

3.10 Brackets and delimiters

Left	Right	Common	User-defined pairing (see mgates.sty)
((	))		$\left(\frac{x}{y}\right)$ \parens{...}
[[	]]		$\left[\frac{x}{y}\right]$ \brackets{...}
{ \{	} \}		$\left\{\frac{x}{y}\right\}$ \braces{...}
$\langle$ \langle	$\rangle$ \rangle		$\left\langle\frac{x}{y}\right\rangle$ \angles{...}
$\lfloor$ \lfloor	$\rfloor$ \rfloor		$\left\lfloor\frac{x}{y}\right\rfloor$ \floor{...}
$\lceil$ \lceil	$\rceil$ \rceil		$\left\lceil\frac{x}{y}\right\rceil$ \ceil{...}
| \lvert	| \rvert	| |, \vert	$\left\lvert\frac{x}{y}\right\rvert$ \abs{...}
$\|$ \lVert	$\|$ \rVert	$\|$ \\|, \Vert	$\left\lVert\frac{x}{y}\right\rVert$ \norm{...}
/ /	\ \backslash		

Use paired \left*delimiter* and \right*delimiter* to resize delimiters to fit their contents. To use delimiter on only one side, use invisible \left. or \right. for other side. (Doesn't work across lines in multiline equations.)

AMS provides cases for piecewise function:

$$\delta_{ij} = \begin{cases} 0, & i = j, \\ 1, & \text{else.} \end{cases}$$

```
\delta_{ij} = \begin{cases}
 0,  &  i=j, \\
 1,  &  \text{else}.
\end{cases}
```

Non-AMS convention is to use an array:

$$\delta_{ij} = \left\{ \begin{array}{ll} 0, & i = j, \\ 1, & \text{else.} \end{array} \right.$$

```
\delta_{ij} = \left\{ \begin{array}{ll}
 0,  &  i=j, \\
 1,  &  \text{else}.
\end{array} \right.
```

3.11 Matrices

AMS provides 4 matrix environments differing in delimiters, and 1 for small inline matrices.

Example	AMS command	User-defined shortcut

$\begin{matrix} 1 & 2 \\ 3 & 4 \end{matrix}$	`\begin{matrix}`
	`1 & 2 \\`
	`3 & 4`
	`\end{matrix}`	

$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$	`\begin{bmatrix}`
	`1 & 2 \\`
	`3 & 4`
	`\end{bmatrix}`
		`\mat{`
		`1 & 2 \\`
		`3 & 4`
		`}`

$\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$	`\begin{pmatrix}`
	`1 & 2 \\`
	`3 & 4`
	`\end{pmatrix}`
		`\pmat{`
		`1 & 2 \\`
		`3 & 4`
		`}`

$\begin{Bmatrix} 1 & 2 \\ 3 & 4 \end{Bmatrix}$	`\begin{Bmatrix}`
	`1 & 2 \\`
	`3 & 4`
	`\end{Bmatrix}`
		`\qmat{`
		`1 & 2 \\`
		`3 & 4`
		`}`

Inline $\left[\begin{smallmatrix} 1 & 2 \\ 3 & 4 \end{smallmatrix}\right]$ matrix.	`\left[`
	`\begin{smallmatrix}`
	`1 & 2 \\`
	`3 & 4`
	`\end{smallmatrix}`
	`\right]`
		`\smat{`
		`1 & 2 \\`
		`3 & 4`
		`}`

Non-AMS convention is to use an array. This has the advantage of allowing vetical and horizontal lines to partition the matrix.

$$\left[\begin{array}{cc|cc} 1 & 2 & 3 & 4 \\ \hline 3 & 4 & 5 & 6 \end{array}\right]$$

```
\left[ \begin{array}{cc|cc}
1 & 2 \\
\hline
3 & 4
\end{array} \right]
```

`array` is similar to `tabular` but in the math environment.

4 Bibliography using BibTeX

There are 2 ways to make a bibliography: create a BibTeX database, or manually format it. BibTeX can automatically format various citation and bibliography styles, eliminating tedious manual re-formatting. Multiple tex files can use the same BibTeX database, eliminating redundant data entry. I'll give notes for BibTeX first, but include manual formatting at the end for completeness.

4.1 Enabling BibTeX

In your .tex file set the bibliography style (e.g. plain) and BibTeX database (e.g. references.bib). For plainnat, abbrvnat, unsrtnat, and custom-bib styles add `\usepackage{natbib}`. For apalike add `\usepackage{apalike}`.

```
\bibliographystyle{plain}
\bibliography{references.bib}
```

Style	Sort	Labels	Notes
plain	by author	numeric, like [1]	
plainnat	by author	numeric or author-year	`\usepackage{natbib}`
abbrv	by author	numeric	abbreviates authors and journals
abbrvnat	by author	numeric or author-year	`\usepackage{natbib}`
alpha	by author	alphanumeric, like [SJL05]	
unsrt	as cited	numeric	
unsrtnat	as cited	numeric or author-year	`\usepackage{natbib}`
apalike	by author	author-year, like [Smith 2005]	`\usepackage{apalike}`
custom-bib	asks questions to generate custom bibliography style		

To change the title of the bibliography section (e.g. to "References") use
`\renewcommand{\refname}{References}` (for articles)
`\renewcommand{\bibname}{References}` (for reports and books)

To compile the bibliography, run latex, then bibtex, then latex twice more! (What were they thinking when they designed this program?)

```
latex  file.tex
bibtex file.tex
latex  file.tex
latex  file.tex
```

4.2 Bibliography formats

These are common styles. Many more are available, or use `custom-bib` to build one to match your needs or a journal's demands.

References, for style plain

[1] Nicolas Markey. *Tame the BeaST*, 2005.

[2] Mark Smith, Adam Jones, and Wei Lee. Caffeine usage in Chicago. *Journal of Coffee Drinkers*, 6:121–142, 2005.

References, for style unsrt

[1] Mark Smith, Adam Jones, and Wei Lee. Caffeine usage in Chicago. *Journal of Coffee Drinkers*, 6:121–142, 2005.

[2] Nicolas Markey. *Tame the BeaST*, 2005.

References, for style abbrv

[1] N. Markey. *Tame the BeaST*, 2005.

[2] M. Smith, A. Jones, and W. Lee. Caffeine usage in Chicago. *Journal of Coffee Drinkers*, 6:121–142, 2005.

References, for style alpha

[Mar05] Nicolas Markey. *Tame the BeaST*, 2005.

[SJL05] Mark Smith, Adam Jones, and Wei Lee. Caffeine usage in Chicago. *Journal of Coffee Drinkers*, 6:121–142, 2005.

References, for style apalike

Markey, N. (2005). *Tame the BeaST*.

Smith, M., Jones, A., and Lee, W. (2005). Caffeine usage in Chicago. *Journal of Coffee Drinkers*, 6:121–142.

4.3 Citation formats and natbib

`\cite` makes a citation and includes its entry in the bibliography.
`\nocite{`*name*`}` includes an entry in the bibliography without citing it.
`\nocite{*}` includes *all* BibTeX entries in the bibliography.

The natbib package provides the `\citet`, `\citep`, and other variants. To use natbib, add it to the preamble, and choose a natbib-compatible style. It has extensive commands and options; see the natbib documentation.

```
\usepackage[options]{natbib}
\bibliographystyle{plainnat}
```

Some natbib package options:

Option	Description
round	round parenthesis ( )
square	square brackets [ ]
authoryear	author-year citations
numbers	numeric citations
super	superscript numeric citations

The original plain, unsrt, abbrv make the top 3 numeric citations. Depending on its options, natbib can generates author-year, numeric citations, or superscript citations (not shown).

Command	author-year citation	numeric citation
`\cite{Smith05}`	Smith et al. (2005)	[3]
`\cite{Smith05,Markey05}`	Smith et al. (2005); Markey (2005)	[3, 2]
`\cite[p. 135]{Smith05}`	(Smith et al., 2005, p. 135)	[3, p. 135]
`\citet{Smith05}`	Smith et al. (2005)	Smith et al. [3]
`\citet*{Smith05}`	Smith, Jones, and Lee (2005)	Smith, Jones, and Lee [3]
`\citep{Smith05}`	(Smith et al., 2005)	[3]
`\citep*{Smith05}`	(Smith, Jones, and Lee, 2005)	[3]
`\citeauthor{Smith05}`	Smith et al.	Smith et al.
`\citeyear{Smith05}`	2005	2005
`\citeyearpar{Smith05}`	(2005)	[2005]

Command	`apalike` citation	`alpha` citation
`\cite{Smith05}`	(Smith et al., 2005)	[SJL05]
`\cite{Smith05,Markey05}`	(Smith et al., 2005; Markey, 2005)	[SJL05, Mar05]
`\cite[p. 135]{Smith05}`	(Smith et al., 2005, p. 135)	[SJL05, p. 135]

4.4 BibTeX database

A .bib file contains the bibliography database. Each entry has a unique name that is referenced by `\cite`, and multiple field=value pairs terminated with commas. Values should be in `"..."` quotes. Acronyms and proper names that *must* be capitalized in titles, put in `{...}` braces. Abbreviations can be made using @STRING.

Author and editor names are either "First von Last" or "von Last, First", separated by "and". For *et al.* use "and others".

Various other peculiarities are dealt with in [3].

See table 2 for entry types and fields. Here is an example:

```
@STRING{ JCD = "Journal of Coffee Drinkers" }
@Article{ Smith05,
    author  = "Mark Smith and Adam Jones and Wei Lee",
    title   = "Caffeine usage in {Chicago}",
    journal =  JCD
    year    =  2005,
    volume  =  6,
    pages   = "121--142",
}
```

4.5 Manually formatted bibliographies

For manual formatting, instead of `\bibliographystyle` and `\bibliography`, use `thebibliography` environment. The argument is the widest label, here "SJL05", so it can be indented properly. `\bibitem` takes the label as an optional argument; otherwise the label is just numeric.

```
\begin{thebibliography}{SJL05}

\bibitem[SJL05]{Smith05}
M. Smith, A. Jones, and W. Lee.
\newblock{Caffeine usage in Chicago.}
\newblock \emph{Journal of Coffee Drinkers} 2005; \textbf{6}:121--142.

\end{thebibliography}
```

(BibTeX builds thebibliography in a .bbl file, based on the current style. Thus if a BibTeX style is not quite right, you can use BibTeX to build the bibliography until the final edits, then copy the .bbl file into the .tex file and make final tweaks manually.)

Field	@Article	@Book	@Booklet	@InBook	@InCollection	@InProceedings	@Manual	@Misc	@PhdThesis / @MastersThesis	@Proceedings	@TechReport	@Unpublished	Example
address		o	o	o	o	o	o		o	o	o		"New York, NY"
author	x	or	o	or	x	x	o	o	x		x	x	"Mark Smith"
booktitle					x	x							"Multigrid Methods"
chapter				or	o								"2.1"
edition		o		o	o								"Second"
editor		or		or	o	o				o			"Mark Smith"
institution											x		"Intel"
journal	x												"Acta Numerica"
month	o	o	o	o	o	o	o	o	o	o	o	o	5 (e.g. May)
note	o	o	o	o	o	o	o	o	o	o	o	x	"In press"
number	o	o		o	o	o				o			1
organization						o	o			o			"SIAM"
pages	o			or	o	o				o			"73--130"
publisher		x		x	x	o				o			"Wiley"
school									o				"Yale University"
series		o		o	o	o				o			"In a Nutshell"
title	x	x	x	x	x	x	x	o	x	x	x	x	"Algebraic Multigrid"
type				o	o				o		o		"Research note"
volume	o	o		o	o	o				o			3
year	x	x	o	x	x	x	o	o	x	x	x	o	1987
howpublished			o					o				o	
url													"http://example.com"

Table 2: BibTeX entry types and associated fields. x is required, or is choice between 2 required fields, o is optional. `url` is not recognized by the classical plain, alpha, unsrt styles, but is supported by some newer styles.

Todo

theorems, lemmas, proofs, etc.

References

[1] Patrick Daly. *Natural Sciences Citations and References*, 2006.

[2] Michael Downes. *Short Math Guide for LaTeX*. American Mathematical Society, 2002.

[3] Nicolas Markey. *Tame the BeaST: the B to X of BibTeX*, 2005.

[4] Tobiaus Oetiker, Hubert Partl, Irene Hyna, and Elisabeth Schlegl. *Not So Short Introduction to LaTeX2e*, 2008.