LaTeX quick reference 2.0

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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 LaTeX commands can be found in the *Not So Short Introduction to LaTeX 2ε* [14]; most of the math in the *Short Math Guide to LaTeX* [12]; most of the bibliography information in the BibTeX tutorial [13] and the natbib documentation [11].

I also wrote a separate Latex fonts guide.

LaTeX is highly customizable. Throughout the document, we pinpoint possibilities by proposing packages or extra commands, but without allways illustrating them. We scrath the surface and we keep to the standard settings and parameters.

Help. Online help is easy to find (whether to install an editors or a distribution, find packages, extensions, polices, etc):
– `http://tug.org/interest.html`,
– `http://tug.org/begin.html`,
– `http://www.ctan.org/help/catalogue`.
Consult `https://alternativeto.net/` for alternative editors and distributions, for any OS.

Units of measurement. Commands
(`begin{`*environment*`}{`*options*`}`, `\setlength..`, `\settowidth..`, `\addtodepth..`)
can take different units: 1pt (351.46μm), 1mm, 1cm, 1in, 1em (width of 'm'), 1ex (height of 'x').

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1 Commands

1.1 Document structure

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

Common *classes*

`article`	article template without chapters
`proc`	based on article, for proceeding
`minimal`	minimal formatting template
`report`	scientific report template with a cover page and chapter
`book`	template with a cover page and separate files for chapters
`memoir`	based on the book class, more customizable
`beamer`	presentation template with several themes
`seminar`	presentation template with several themes
`letter`	letter template
`moderncv`	resume template (more templates on CTAN)

Other *classes*:

– `Scrartcl` (KOMA-Script article), `Scrbook` (KOMA-script book), `Scrlttr2` (KOMA-script letter), and `Scrreprt` (KOMA-script report).
– `extarticle, extreport, extbook, extletter, extproc` (for sizes 8pt, 9pt, 10pt ,11pt, 12pt, 14pt, 17pt, 20pt),
– and many more on CTAN.[2]

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[3]
`onecolumn, twocolumn`	one or two unevenly-distributed column
`twoside, oneside`	paper printout
`landscape`	paper orientation
`openright, openany`	chapters begin on right page, or any page
`draft`	problems are easily identifiable, no images

`\documentclass[12pt, letterpaper, twocolumn, landscape]{`*class*`}`
adds options all at once, as in this example.

[2] Package crossword for creating of crosswords and sudokus, package musixtex for writing musical tablatures, package chessboard for generating chessboards, packages alterqcm, exam, mathexam, mcexam, moodle (and many others) for writing exams, package latex2html, hevea or tex4ht for creating webpages, package pandoc for creating ePub, etc.

[3] Forces an title page in an article class or remove a title page from a book class.

Preamble

`\documentclass[`*options*`]{`*class*`}`
`\usepackage[`*options*`]{`*package*`}` ...

Document

`\begin{document}`

`\begin{abstract}`
Abstract.
`\end{abstract}`

`\includeonly{`*filename1, filename2, filename3...*`}`
before the table of contents, skips `\include` with listed files (supersedes `\include`, see below)

`\setcounter{tocdepth}{2}` and
`\tableofcontents`
for example, build a 2-level table of contents (the first level is `section`, the second level is `subsection`). Find more on document dividers in section 1.3 on page 7.

`\include{`*filename*`}`
starts a new page with the content of a file (can be superseded by `\includeonly`, see above).
`\input{`*filename*`}`
without starting a new page, includes the content of a file.

`\end{document}`

Multiple languages in the document

`\documentclass[greek, french]{article}` (for example) with `\usepackage{babel}`
enable switching between languages with commands
`\selectlanguage{`*language*`}` and `\foreiglanguage{`*language*`}{`*text...*`}` or environment
`\begin{otherlanguage}{`*language*`}`
`\usepackage{LGR, T1}{fontenc}`
makes it possible to encode the Greek alphabet with the keyboard (typing 'a' becomes α).

Convert documents

– pdflatex converts to a PDF,
– latex2rtf converts to a RTF,
– HEVEA, latex2html, LaTeXML, bibtex2html convert to HTML,
– `usepackage{latex2html}` and `usepackage{tex4ht}` convert to HTML,[4]
– detex converts to TXT; run the command in the terminal.

[4] https://www.ctan.org/tex-archive/support/latex2html/ and
https://www.tug.org/applications/tex4ht/mn.html;
HTML can in turn be converted to ePUB, Markdown, reStructuredText or the likes.

1.2 Page format

`\pagestyle{ plain | headings | empty }`[5]
`plain` page number in footer only
`headings` defined by `\documentclass[`*options*`]{`*class*`}`
`empty` no header nor footer

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

`\usepackage[left=1in, right=1in, top=1in, bottom=1in]{geometry}`
sets the document margins.[6]
Alternatively, to set 1" margins on 8.5" x 11" paper, remove 1" to each side:

```
\topmargin        0in       \headheight   0in       \headsep    0in
\oddsidemargin    0in       \textheight   9in       \topskip    0in
\evensidemargin   0in       \textwidth    6.5in
```

`\setlength{\parindent}{0em}`
`\setlength{\parskip}{1em}`
set indentation and inter-paragraph spacing after the TOC.
`\noindent` vs. `\indent`
removes vs. forces the indentation.

`\setlength\arraycolsep{2pt}` sets the spacing on both sides of "=" in an array environment.

`\usepackage{setspace}` and
`\doublespacing`, `\onehalfspacing` or `\singlespacing`
in the preamble, set line spacing for the entire document.
`begin{onehalfspacing or doublespacing}...`
creates an environment to change line spacing for local usage.

`\usepackage{multicol}` and environment `\begin{multicols}{`*number*`}`
enables multiple evenly-distributed columns on one page in sections of the document.
`\begin{multicols*}{`*number*`}`
enables multiple unevenly-distributed columns.
`\setlength{\columnsep}{7mm}` and `\setlength{\columnseprule}{0.5pt}`
before the environment, sets space between columns and the separating line width (set 0pt for no line).
`\columnbreak`
skips to the next column.
For a multicolumn block example, see section 1.11 on page 16.

[5] Package fancyhdr and command \pagestyle{fancy} offer more customization (headers (left/center/right) & footers (left/center/right), on odd & even pages).
[6] Parameters: \paperheight, \paperwidth, \textheight, \textwidth, \heightrounded for text height.

1.3 Chapters and Sections

Preamble
`\documentclass[`*options*`]{`*class*`}`
`\usepackage{titlepages}`
customizations and options for the cover page as well as templates (consult the doc.).

Document prolegomena
`\titlepage` (article, book, report, seminar classes only)
`\notitlepage`
`\title{`*title*`}` or
`\title{`*title*`} \thanks{...}` (applied to the title; book & report classes only)

`\author{John Doe \and Jane Doe}` or
`\author{John Doe} \thanks{...}` (applied to the author; ; book & report classes only)
`\date{\today}` or `\date{`*date*`}` or `\today`

`\maketitle`
out the prologomena or the cover page.

`\frontmatter` (book class only)
sets roman numeral page numbering from 1; document divisions are unnumbered.

Preface, foreword, notification, etc.

```
\setcounter{tocdepth}{2}
\tableofcontents
\setcounter{lofdepth}{2}
\listoffigures
\listoftables
\listoftheorems
```

Document body
`\mainmatter` (book class only)
sets arabic numeral page numbering starting from 1; document divisions are numbered.
`\include{file}` include the first chapter, the first section,
`\include{file}` include the second chapter...

`\part[`*short*`]{`*title*`}`		(level -1)
`\chapter[`*short*`]{`*title*`}`	`\chapter*[`*short*`]{`*title*`}`[7]	(level 0; book & report classes)
`\section[`*short*`]{`*title*`}`	`\section*[`*short*`]{`*title*`}`	(level 1)
`\subsection[`*short*`]{`*title*`}`	`\subsection*[`*short*`]{`*title*`}`	(level 2)
`\subsubsection[`*short*`]{`*title*`}`	`\subsubsection*[`*short*`]{`*title*`}`	(level 3)
`\paragraph[`*short*`]{`*title*`}`	`\paragraph*[`*short*`]{`*title*`}`	(level 4)
`\subparagraph[`*short*`]{`*title*`}`	`\subparagraph*[`*short*`]{`*title*`}`	(level 5)

[7] Starred versions are unnumbered and excluded from the table of contents.

`\setcounter{section}{3}`
before `\section[`*short*`]{`*title*`}`, resets the counter; the section is then numbered 3.[8]
`\thesection`
prints the current section number.
`\renewcommand{\thesection}{\Roman{section}}`
sets roman numeral. Choose between `Roman`, `roman`, `Alph`, `alph` or, by default, `arabic`.[8]

`\pagebreak`
following a paragraph, forces a newpage or
`\newpage`
preceeding a paragraph, forces a newpage.

Document end
`\appendix` (book and report classes only)
`\chapter` into 'Appendix' and keeps the arabic numeral page numbering and document dividers become alphabetically numbered.

`\backmatter` (book class only)
transforms `\chapter` into 'Appendix' and keeps the arabic numeral page numbering, but document dividers become unnumbered ('Conclusion' for example). In the book class (only), `\appendix` and `\backmatter` can be employed together, the order does not matter.

Postface, afterword, credits, etc.

`\bibliographystyle{plain}` (to set the style)
`\bibliography{latex}` (to print the bibliography)
`\printindex` (to print one or multiple indexes).

Examples:

1 section

1.1 subsection

1.1.1 subsubsection

subsubsection (unnumbered)

paragraph Run-in paragraph header. Lorem ipsum dolar 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

short shows up in the table of contents, *title* shows up in the document.

[8] Replace 'section' and the same commands go for 'part', 'chapter', 'subsection', 'subsubsection', 'paragraph', 'subparagraph', 'page', 'equation', 'figure', 'table', 'footnote', 'enumi' (from enumerate lists first level and sub-levels: enumii, enumiii, enumiv, etc.). Dividers are even more customizable with package titlesec (font, style, etc.).

1.4 Embed PDF

`\usepackage{pdfpages}`
external PDF files embedding.
`\includepdf[pages={-3,5-7,{}, 9, 11-}]{file.pdf}`
pages 1 to 3, 5 to 7, a blank page ({}), 9, 11 and up from file.pdf into the document.
`[..., nup=1x2, landscape]`
imports 2 pages per page. There are other options; one for writting over the pdf for example (consult the documentation).
`\includepdfmerge{f1.pdf, 2, 5-9, f2.pdf, 3-4, f3.pdf, 7-}`
pages from several documents or files (f1.pdf, f2.pdf, and f3.pdf).

1.5 XeLaTeX, LuaLaTeX

LaTeX is not perfect; it is difficult to change the font and use other alphabets. XeLaTeX (pronounced 'zelatek') is an improvement (there might be some package incompatibilities, problems with maths [9]). The main font is still Computer Modern or CMR and we compile in XeLaTeX.

`\usepackage{fontspec}`
adds new fonts. Indicate the default fonts in the preamble. Here is an example (can be tried out in another document):

```
\documentclass{article}
\usepackage{fontspec, xltxtra}
\defaultfontfeatures{Scale=MatchLowercase, Mapping=tex-text}
\begin{document}
This text is in CMR, \LaTeX standard font. \\
\fontspec[Color=FF0000]{Times New Roman} A classic Times, in red. \\
\fontspec[Number=OldStyle]{Stempel Garamond LT Std} An Elzevirian variant \\
for numbers: 0123456789. \fontspec[BoldFont={Arial Black}]{Comic Sans MS} \\
We can change the font in \textbf{bold}. \\
\fontsize{8pt}{12pt}\selectfont \fontspec[Zapfino Forte LT Pro}]{Comic Sans MS}
\texttt{fontsize:} we can change font size and spacing.
\end{document}
```

Indicates the default fonts for the whole document by including the following in the preamble:[10]

```
\defaultfontfeatures{Ligatures=Tex, Scale=MatchLowercase}
\defaultfontfeatures{Scale=MatchLowercase, Mapping=tex-text}
\setmainfont{Times New Roman} % main (default proportional) font
\setmainfont{Comic Sans MS}   % sans serif (proportional) font
\setmainfont{Arial},          % typewritter (a monospaced or fixed-pitch) font
```

[9] Avoid packages inputenc and fontenc. Another alternative is LuaLaTeX.
[10] Monospaced fonts vs. proportional fonts. 'i' takes as much space as 'm' in monospace.

1.6 Fonts

Font sizes (the `\size{...}` mode and not the `{\size ...}` mode)[11]

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

`\scalebox{`*width*`}[`*height*`]{`*text*`}`
changes the size.
`\resizebox{`*width*`}{`*height*`}{`*text*`}`
changes the size. '!' maintains proportion automatically while the other parameter resize the text. Also, `\linewidth` is another available option for the width.
`\resizebox{!}{0.5cm}{example}`: example. Include font styles inside the boxes.

Fonts styles (the `\style{...}` mode and not the `{\style ...}` mode)

Command	Sample	Command	Sample
`\textrm{`*text*`}`	roman	`\textbf{`*text*`}`	**bold font**
`\textsf{`*text*`}`	sans serif	`\textit{`*text*`}`	*italic*
`\texttt{`*text*`}`	typewriter	`\textsc{`*text*`}`	SMALL CAPS
`\textup{`*text*`}`	upright	`\textnormal{`*text*`}`	normal
`\textsl{`*text*`}`	*slanted*	`\textmd{`*text*`}`	medium
`\emph{`*text*`}`	*emphasized*	`\textsuperscript{`*text*`}`	superscript
`\underline{`*text*`}`	underline	`\textsubscript{`*text*`}`	sunscript

`\usepackage[normalem]{ulem}` and commands `\uline{}`, `\uuline{}`, `\uwave{}`, `\dashuline{}`, `\dotuline{}`, `\sout{}`, `\xout{}`
for simple, double, wavy, dashed, dotted underlining, striked-out and crossed-out text.
`\usepackage{soul}`
extends the styles: hyphenatable spacing out (letterspacing), underlining, striking out, colored underline, etc.).

In math mode (within $...$ for example.), use the math fonts listed below.

[11] We switch to another size with \tiny, add text, and switch back to normal size with \normalsize. We can also use an environment such as {\tiny ...}. extarticle, extreport, extbook, extletter, extproc document classes allow more sizes. See section 1.1 on page 4.
[12] See mgates.sty file.

Math-savvy fonts
Some fonts are better suited for writing math (see section 3.4 on page 39).

The default font for an entire document is Computer Modern or CMR. We can set a difference font for the entire document (consult the package documentation, there are often more than one font per package) or set the font for local usage.

Package	Sample
`\usepackage{lmodern}`	LModern
`\usepackage{mathptmx}`	Times
`\usepackage{txfonts}`	Times
`\usepackage{pxfonts}`	Palatino
`\usepackage{mathpazo}`	Palatino
`\usepackage{fourier}`	Utopia
`\usepackage{mathdesign}`	Garamond
`\usepackage{kpfonts}`	Kp-Fonts

Additional fonts for local usage (not all math-savvy)[13]

Command	Sample
`\fontfamily{cmr}\selectfont{`*text*`}`	Computer Modern (when not by default)
`\fontfamily{phv}\selectfont{`*text*`}`	Helvetica
`\fontfamily{pcr}\selectfont{`*text*`}`	Courier
`\fontfamily{pnc}\selectfont{`*text*`}`	New Century Schoolbook
`\fontfamily{pbk}\selectfont{`*text*`}`	Bookman
`\fontfamily{ptm}\selectfont{`*text*`}`	Times
`\fontfamily{ppl}\selectfont{`*text*`}`	Palatino
`\fontfamily{put}\selectfont{`*text*`}`	Utopia
`\fontfamily{urw}\selectfont{`*text*`}`	Garamond
...	...

Load the package to use them (consult http://www.tug.dk/FontCatalogue/).

Lettrines

`\usepackage{lettrine}`
enables the use of lettrines. Lettrines can be customized in many ways:

BEGINNING a sentence with `\lettrine{B}{eginning}`.

PRECEED the command with `\renewcommand{\LettrineFontHook}{\itshape}` for italic lettrines.

PRECEED the command with `\renewcommand{\LettrineFontHook}{\sffamily}` for sansserif lettrines.

[13] Make sure the font is installed (consult the documentation for additional symbols and ornaments).

Font per language

`\usepackage{polyglossia}`
makes it possible to set a font for each language (an alternative to `\usepackage{babel}`). Here is an example:

```
\setromanfont{Times New Roman}  % the default font for French and Arabic
\usepackage{polyglossia}
\setmainlanguage{french}  % main
\setotherlanguage{arabic}  % second
\setotherlanguage{hebrew}  % second
\newfontfamily{\hebrewfont}[Scale=0.8, Script=Hebrew]{Ezra SIL}
  % the default font for Hebrew


\newfontfamily{\arabicfont}[Scale=0.8, Script=Arabic]{Ezra SIL}
```

changes the font for Arabic.

In the text, call the language-font with `\textarabic` or `\texthebrew` then `\textfrench` to switch (go back) between languages as with font sizes and styles.
`begin{arabic}` or `begin{hebrew}` environments for example
are useful for longer passages. LaTeX manages right-to-left alphabets.

Numbering lines

`\usepackage{lineno}` [14] and command `\linenumbers[2]`
start line numbering at '2'.

2 sentence 2
3 sentence 3
4 sentence 4

`\nolinenumbers` stops the numbering (as with this sentence).

`\modulolinenumbers[2]` (2 for 1 out of 2; 3 for 1 out of 3...) preceeding command `\linenumbers[6]`.

sentence 7
8 sentence 8
sentence 9

`\begin{linenumbers}[10]` environment enables more options for numbering:

11 in the right margin, in the inner/outer margin (left for even, right for odd pages),
12 In addition, we can restart numbering on every page, print only multiples of five for example,
13 adapt to math environments, etc.

[14] The package enables pagewise line number, line number reference through \ref and \pageref cross reference mechanism, and there are functionalities for math equation numbering.

Coloring

`usepackage[`*option*`]{xcolor}`[15]
enables text and background coloring. Base colors: black (default), blue, brown, cyan, darkgray, gray, green, lightgray, magenta, olive, orange, pink, purple, red, violet, white, yellow.

Command	Sample	Command	Sample
`{\color{blue}` *text*`}`	text	`\color{brown}` *text* `\color{black}`	text
`{\textcolor{cyan}{`*text*`}`	text	`{\textcolor{blue!70}{`*text*`}`	text
`{\fcolorbox{magenta}{olive}` *text*`}`	text	`{\colorbox{green}{`*text*`}`	text

```
\setlength{\fboxsep}{2mm}
\setlength{\fboxrule}{1mm}
\fcolorbox{magenta}{olive}{text},
```
for example, modify the parameters text

`\definecolor{turquoise}{rgb}{0, 0.4, 0.75}`
creates new colors to be used with 3-tone `rgb` or 4-tone `cmyk`; each tone goes from 0 to 1.
`\definecolor{gray-gray}{gray}{0.3}`
is another way to create new colors (text, background, lines).

TEX logos

LaTeX with `\LaTeX`, LaTeX2ε with `\LaTeXe`, TeX with `\TeX`
are standard logos.

AMS-TeX with `\AmSTeX`, BibTeX with `\BibTeX`, SliTeX with `\SliTeX`, Plain TeX with `\PlainTeX`
require `\usepackage{doc}`.

XeTeX with `\XeTeX`, XeLaTeX with `\XeLaTeX`, LuaTeX with `\LuaTeX`, LuaLaTeX with `\LuaLaTeX`
require `\usepackage{metalogo}`.

The are more logos with `\usepackage{hologo}` and `\usepackage{mflogo}`.

[15] *options* dvipznames, svgnames, x11names for different devices.

1.7 Reserved characters

Some characters are reserved to functionalities. We can bypass the functionality with '\'.

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

1.8 Special characters

Command	Symbol	Command	Symbol	Command	Symbol
``` `` ```	“	`" or '' `	"		
``` ` ```	‘	`'`	’		
`in-law` (1 '-')	in-law	`13--67` (2 '-')	13–67 (en)	`yes---no` (3 '-')	yes—no (em)
`yes \ldots no`	yes…no	``?`No?``	¿No?	``!`No!``	¡No!
`\dag`	†	`\ddag`	‡		
`\S`	§	`\P`	¶		
`\copyright`	©	`\textregistered`	®		
`\pounds`	£				

`\usepackage{textcomp}`

Command	Symbol
`\texteuro`	€

`\usepackage{eurosym}`

Command	Symbol
`1000\euro`	1000€
`\pounds10`	£1000

`\usepackage{pifont}`

Command	Symbol
`\ding{79}`	✯
`\ding{45}`	✍
...	...

`\usepackage{marvosym, dingbat, bbding, wasysym}`
offer more symbols. Consult
http://ctan.math.ca/tex-archive/info/symbols/comprehensive/symbols-a4.pdf

Draw a symbol and find it with
http://detexify.kirelabs.org/classify.html

1.9 Accented characters

Char	Command	Char	Command	Char	Command	Char	Command[16]
ò	\‘o	ó	\’o	ô	\^o	õ	\~o
ō	\=o	ȯ	\.o	ö	\"o	ç	\c c
ǒ	\u o	ǒ	\v o	ő	\H o	ı	\i
o̩	\d o	o̲	\b o	o͡o	\t oo	ȷ	\j
œ	\oe	Œ	\OE	æ	\ae	Æ	\AE
å	\aa	Å	\AA			ß	\ss{}
ø	\o	Ø	\O	ł	\l	Ł	\L

ß is an eszett or a scharfes S.

1.10 Special spaces

Horizontal spacing[17]

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

```
text1 + 20pt \hspace{20pt} + text2
```

text1 + 20pt + text2

Horizontal elastic spacing

1A \hfill 1B

2A \dotfill 2B

Sprinkling three ..... \dotfill within a line ..... does ..... this

3A \hrulefill 3B

4A \leftarrowfill ← 4B

5A \rightarrowfill → 5B

6A \dingfill{47} ✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏✏ 6B

\hspace{\stretch{1}} Both ends \hspace{\stretch{1}}

\hspace{\stretch{1}} Both ends \hspace{\stretch{3}}

[16] The first 4 lines can be applied to appropriate characters.

[17] The commands are applicable in math mode ($...$ for example).

`\phantom{...}`
reserves spaces for text without printing it. Useful in math mode:

$$x_1 + x_3 = 2,$$
$$x_1 + x_2 = 5,$$
$$x_1 + x_2 + x_3 = 7.$$

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

Vertical spacing (skipping)

text1 + 15pt

text2 + 1/4 line
text3 + 1/2 line
text4 + 1 line

text5 +

text6 +
text7

```
text1 + 15pt \vspace*{15pt}
text2 + 1/4 line \smallskip
text3 + 1/2 line \medskip
text4 + 1 line \bigskip
text5 + \vspace*{1 \baselineskip}
text6 + \vspace*{-0.25 \baselineskip}
text7
```

1.11 Special phrases

Command	Sample
`\today`	September 23, 2019
`\TeX`	TEX
`\LaTeX`	LATEX
`\LaTeXe`	LATEX 2_ε

Multicolumn example (related to section 1.2 on page 6)

In `\documentclass`, with *option* `twocolumn` or with `\begin{multicols*}{2}`, we create two unevenly-distributed columns.

With `\begin{multicols}{2}`, we create two evenly-distributed columns. This is the current case.

With `\columnbreak`, we skip to the next column.

1.12 Line and page breaks

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

`\linebreak[`*n*`]` (or `\nolinebreak[`*n*`]`)
line break (or not), keeping line justified; *n* ranges from 0 (less insistent) 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, `\newline` or `\\`.
- It also has a linebreak `n=4` in it for comparison, lorem ipsum dolar blah blah blah blah blah blah blah blah blah blah blah blah blah blah blah, `\linebreak[4]`.
- It also has a linebreak `n=2` in it for comparison, lorem ipsum dolar blah blah blah blah blah blah blah blah blah blah blah blah blah blah blah, `\linebreak[2]`.
- Notice the difference. Using `\linebreak` can cause "underfull hbox" warnings.

`\par`
paragraph break. A new indented paragraph always begins after a blank line or `\par`.

`\noindent` vs. `\indent`
removes the indentation (after `\par` for example) vs. forces an indentation (after `\\` for example) (see section 1.2 on page 6).

`\newpage` or `\pagebreak`
forces the content on a new page.
`\pagebreak[`*n*`]` (`\nopagebreak[`*n*`]`)
page break (or not), keeping line justified. *n* ranges from 0 to 4 (most insistent). `\cleardoublepage` forces a new odd page in `\documentclass[]{book}`.

`\hyphenation{ fortran hy-phen-a-tion para-graph convulation }`
in the preamble, implements a list of words and where they may (not) be hyphenated.
`\-`
in the document, sets where a word may be hyphenated; for example `su\-per\-scal\-ar`).

`\hbox{`*text*`}` prevents a line break or hyphenation.....However, the text may spill over the margin.

`\␣` or `~`
keep chain of characters together.
"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 sentence.
"...FORTRAN. But..." (`FORTRAN\@. But`) instead of
"...FORTRAN. But..." (`FORTRAN. But`)

1.13 References, citations, footnotes

`\label{`*name*`}`
assigns a unique name to an equation, a figure, a table, or a divider. For figures and tables, the label must follow the caption: `\caption{legend}\label{ref}`. See `\ref{`*name*`}` below.

`\eqref{`*name*`}`
inserts reference to the labeled equation. See equation numbering in section 3.1 on page 38.

`\ref{`*name*`}`
inserts the label sub-section number, for example: 1.12.
`\pageref{`*name*`}`
inserts the label page number, for example: 17.[18]

`\footnote{`*text*`}`
generates a footnote.[19]
`\addtocounter{footnote}{-1}\footnotemark{}`
recalls the previous note number; can be any number to refer to any note number.

`\marginpar{`*text*`}`
'example' generates a margin note.[20]

`\footnotemark{}`
set one mark inside a table (only one mark possible),
`\footnotetext{text}`
holds the footnote texy outside the table. No note is possible inside the minipage environment!

`\usepackage[`*options*`]{footmisc}`
customizes the footnotes. Among the the *options*: `para` allows the writing of several footnotes in one paragraph, without changing line. `perpage` resets the footnote numbering at every page. `side` converts all footnotes to margin notes.

`\usepackage{manyfoot}`
deals with multilevel notes such as 1, 2, 3; i, ii, iii; a, b, c (consult the documentation).
`\usepackage{ftnright}`
sends the notes at the end of the right column in a multicolumn page.
`\usepackage{endnote}` and command `\endnote{text}`
hold the note texts,[19], then `\theendnotes` writes them all down, for example, at the end of the document.
`\protect\footnote{note}`
enables a note in a text divider (a part, a chapter, a section, etc.).

[18] In both cases, we need two compilations to compute a new label-reference link..
[19] Customizable: line style, length, and width (the rule), font size, style, color, characters, separator, numeral system (arabic by default, roman, Roman, alph, Alph)
[20] \marginparwidth=45pt sets the note width, \marginparsep=2pt sets the margin-note separation width.

`\usepackage[french]{varioref}`
enables alternative references (change the option to the language of your choice).
`\label{name}`
inserts, for example, a reference here (linkA).
`\vref{name}` calls it with an absolute value: see section: **??** on page ??.
`\vpageref{name}` inserts a reference here (linkA).
`\vref{linkA}` calls it with a relative value in natural language: see section: on page ??.
`\vrefrange{name1}{name2}` refers to a range: see sections 1.12 to 1.13 on pages 17–19.
`\vpagerefrange{name1}{name2}` refers to a range: see: on pages 17–19.

`\footnoterule`
adds a horizontal footnote line anywhere in the document.

1.14 Hyperlinks

`\usepackage[colorlinks, `*options*`]{hyperref}`
colors links. For example:

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

options	Default	Effect
linkcolor=*color*	red	internal links (sections, pages, etc.)
citecolor=*color*	green	citation links (bibliography)
filecolor=*color*	magenta	file links
urlcolor=*color*	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

`\usepackage{url}` and `\url{`*url*`}`
`\url{http://www.ctan.org/}` http://www.ctan.org/
`\url{noone@example.com}` noone@example.com

1.15 Lines

Command	Line
`\rule[`*offset*`]{`*length*`}{`*width*`}`	
`\rule[10pt]{2cm}{0.1cm}`	
`\rule[0pt]{1in}{0.5cm}`	
`\rule{`*width*`}{`*height*`}`	
`\rule{0.5mm}{0.5in}`	
`\rule{1in}{0.3cm}`	

`\rule{\linewidth}{1mm}`
where `\linewidth` sets the width:

---

with `0.2\linewidth`, we have 0.2 or 20 % of a linewidth:

1.16 Index

`\usepackage{makeidx}` followed by command `\makeindex`
in the preamble. The next examples are printed in an index, at the end of this document.

`word\index{word}`
in the document, adds the word to the index.

Twelve ångström.
The story of Linux

Half-life

```
Twelve {aa{ngstr}\"o{m}}\index{anstrom@{\aa{ngstr}\"o{m}}} \\
The story of Linux\index{Linux}
  \index{linux@Linux!story of Linux} \\

Half-life\index{half-life}
```

LeCarre
LeCarre
theory of LeCarre
LeCarre
LeCarre
LeCarre

```
LeCarre\index{lecarre@LeCarre}
LeCarre\index{lecarre@LeCarre!theory of} \\
theory of LeCarre\index{Theory!of LeCarre|see{LeCarre}} \\
LeCarre\index{lecarre@LeCarre|textbf} \\
LeCarre\index{lecarre@LeCarre|(} \\
LeCarre\index{lecarre@LeCarre|)}
```

`@` (*classify the previous, but display the following*)
with the above example, `angstrom` acts as the alphabetic classifier in the index while `\aa{ngstr}\"o{m}` (*ångström*) shows up in the index.

`!` (*enter the following as a sub-entry of the previous*)
with the above example, `theory of` is a classified under entry `LeCarre`.
`of LeCarre` is a sub-entry classified under entry `Theory`. `@` has priority over `!`.
`|see` (*see*)
with the above example, `Theory!of LeCarre|see{LeCarre}`, under `Theory` and following `of LeCarre}`, *see* (or refer to) entry `LeCarre`.
Include characters `@ ! |see "` in the index by adding `"@ "! "|see ""`.

`textbf` and/or `textit`
generates a bold and/or italic page number.

```
LeCarre\index{lecarre@LeCarre|(}
LeCarre\index{lecarre@LeCarre|)}
```
generates several pages for one single word. LeCarre: 2 citations, 2 page numbers.
`Lecarre\index{lecarre@LeCarre|textbf}` overrides `LeCarre\index{lecarre@LeCarre}`.

`~`
within expressions keep it together. `neutral Ph` is not similar to `neutral~Ph`. It generates two entries. The same goes for `neutral~ph@neutralPh` and `neutral ph@neutralPh`.

`\printindex`
print out the index (see the end of this document).[20] Follow the procedure:

1– Compile the document (three compilations are needed). Some editors have a function for compiling the index; compile the index. Alternatively, compile the index with the CLI. Enter.

```
latex rapport.tex
makeindex rapport
latex rapport.tex
```

2– If there is an error message, the index is rejected. Find the errors, correct, and try again. When the compilation rejected entries, consult these generated (text) files: rapport.ilg & rapport.ind
3– Otherwise, recompile the document.
4– The index should appear on a new page, following `\printindex`.

`\usepackage{multind}` followed by `\makeindex{names}\makeindex{general}\...`[21]
in the preamble, following the standard index package and setup, enable multiple indexes such as one for names and a general index (as well as indices for words, authors, topics, etc.).
`\index{names}{LeCarre@LeCarre, Henry}` and `\index{general}{Chaos!Theorem of}`
adds words to the index of your choice.
`\printindex{names}{Index of Names}` and `\printindex{general}{General Index}`
print out the indexes (at the end of the document).[22]

[20] Index standards can change among languages, fields. Parameters are also customizable.
[21] ...an index for words, another for authors, another for topics, etc.
[22] The procedure generating the indexes is the same although it generates additional files. First, names.idx and

2 Environments

2.1 Text alignment [23]

this paragraph is
flush left.

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

with {\raggedright *text* \par} , the text is even on the left, ragged on the right.

\leftline{*text*} for *left-aligned text*

this paragraph is
flush right.

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

with {\raggedleft *text* \par} , the test is even on the right, ragged on the left.

\rightline{*right-aligned text*} ..... for *right-aligned text*

this paragraph is
centered.

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

with {\centering *text* \par} , the text is centered.

\centerline{*text*} for

centered text

\begin{sideways}
flips the content 90 degrees counterclockwise.

\begin{turn}{*angle*}
rotates the content *by any* angles).

\rotatebox[origin= lt lc lB lb ct c cB cb rt rc rB rb]{*angle*}{*text*}
turns text (and floats!) around 'hinges'. For example, -15 degrees around cB (centerBottom).

\usepackage{lscape}
extends the landscape mode to the document class and complement the geometry package.

general.idx files. Then, names.ist et general.ist files. Finally .ilg and .ind files

[23] Applies to text, figures, table, etc.

2.2 Boxes

`\begin{minipage}` and `\begin{boxedminipage}` are some of the available environments, but there are other way to embed text. Section 2.9 on page 35 addresses minipages in greater detail.

`\mbox{`*text*`}`
`\makebox[`*width*`][ l | c | r ]{`*text*`}`
are commands to group items in a horizontal box with no frame (10cm, to the right).
`\fbox{`*text*`}`
`\framebox[`*width*`][ l | c | r ]{`*text*`}`
are commands to group items in a horizontal box with a frame (10cm, to the right).

Modify an framed text with parameters (or reset the parameters).
`\setlength{\fboxsep}{2mm}` changes the text-frame separation.
`\addtolength{\fboxsep}{2mm}` adds 2mm to the text-frame separation.
Let's reset the separation to 1mm.

`\setlength{\fboxrule}{2pt}` changes the frame thickness.
`\addtolength{\fboxrule}{2pt}` adds 2pt to the frame thickness.
Let's reset the thickness to 1pt.

Modify an oval boxed text with one additional parameters.
`\cornersize{0.1}` changes the oval box corner rounding.
Set the rounding to 1: corner rounding.

`\raisebox{`*height*`}{`*text*`}`
raises a text box by 2mm above the current line.

`\usepackage{fancybox}` and commands
`\shadowbox{text}` adds a shadow box,
`\Ovalbox{text}` or `\ovalbox{text}` adds an oval frame or oval frame,
`\doublebox{text}` adds a double frame.

When you set a parameter at one point,
it is set for the rest of the document.
Never forget to reset the parameter!

```
\shadowbox{
\begin{minipage}{3in}
When you set a parameter at one point, \\
it is set for the rest of the document. \\
Never forget to reset the parameter!
\end{minipage}
}
```

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}
```

`\begin{quotation}` instead of `\begin{quote}`,
indents the first line of each paragraph in multiple paragraph quotations.

2.4 Verse

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}
```

Reverse indents if the line wraps.

2.5 Verbatim (for source codes, programming languages, and technical notes)

`\begin{verbatim}` or `\verb+`*text*`+`[24]
reproduce the text exactly as typed.

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

Indent with a 2-space tabs (although many coding language require 4-space tabs):

```
if (i < 0):
  print("Hello")
else:
  print("Bye")
```

[24] Inline verbatim, \verb+...+, where the delimiter '+' can also be any character except a letter, a '*' or a 'space'.

`\usepackage{moreverb}` and environment `begin{verbatimtab}{n}`
translate tabs into `n` space(s) (n=8 spaces by default).

`\begin{verbatim*}` or `\verb*+`*text*`+`...
adding stars highlight spaces: `text␣with␣spaces`

`\usepackage{verbatim}` and environment `\begin{comment}`
enable comments without adding % before comments. Comments are never displayed on a compiled document; practical for long blocks of comments.

`\usepackage{listings}` and environment `\begin{lstlisting}`
transcribe common programming languages (Bash, C, HTML, Java, PHP, Python, TeX, etc.) with their proper syntax and typography. Here is a simple Python 3 script. Command `\lstset{language=Python}` preceeds the environment:

```
# loop
def greeting(parameter):
  if (parameter == 0):
        print("Hi")
  else:
        print("Bye")

# launch the function
greeting(0)
```

`\usepackage{fancyvrb}`
bonifies environment `\begin{verbatim}` with fonts styles, numbered code lines, and colors. This a great complement to `\usepackage{moreverb}` and env. `begin{verbatimtab}{n}` (see above) to perfectly transcribe a code.

`\usepackage{algorithmic}` (`\usepackage{algorithm2e}`) and env. `\begin{algorithmic}`
enable the writting of algorithms.

Maths and theorems writing are covered in section 3 on page 37.

`\usepackage{chemfig}` along with `\usepackage{tikz}`
enable chemical graphics. Chemical equations are also covered in section 3 on page 37.

Many packages focus on linguistics: enumerated examples, syntactic trees, OT tableaux, feature matrices, IPA fonts, and many other applications.[25]

[25] gb3e, Covington, tipa, OTtablx, qtree + tree-dvips, xyling, xy, tikz-qtree, Tikz-dependency, avm, expec, etc.

2.6 Lists

1. One
3. Two (with special number)
- Three (default bullet)

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

- One
* Two (custom bullet)

```
\begin{itemize}
  \item One
  \item[*] Two (custom 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}
```

`\AtBeginDocument{\renewcommand{\labelitemi}{\textbullet}}`
in the preamble, sets the bullet type for the document. `\usepackage{pifont}` followed by `\AtBeginDocument{\renewcommand{\labelitemi}{\ding{47}}}` in the preamble, enables custom symbols in lists (`\ding{47}` is an example).

✏ One

`\renewcommand{\labelitemi}{\ding{47}}`
does the same, but outside a list (more on symbols in section 1.8 on page 14).

`\renewcommand{\theenumi}{\Roman{enumi}}`
enumerates with roman digits.
`\renewcommand{\theenumi}{\Alph{enumi}}`
enumerates with the alphabet . . . . . (arabic, Roman, roman, Alph, alph).
`\renewcommand{\labelenumi}{\theenumi-}`
enumerates with digits and symbols (currently, '-').
`\renewcommand{\labelenumi}{\theenumi~--}`
enumerates with symbol '--' . . . . . (labelenumi and theenumi, ...enumiii, ..enumiv, ...).[26]

I. One
(A) Two

I- One
A – Two

1- One
a – Two

```
\begin{itemize or enumerate}
  \item One
  \begin{itemize or enumerate}
    \item Two
  \end{itemize or enumerate}
\end{itemize or enumerate}
```

[26] Package paralist provides more list type (compacts, indented, etc.). Package enumitem enables more list customization.

2.7 Tables (tabular)

Save time and effort by building the table with online table generators; convert spreadsheet or csv files into LaTeXand and customize the code with commands.[27]

`\begin{tabular}[ t | c | b ]{`*spec*`}` environment
`t` top of the page
`c` center
`b` bottom

spec

Command	Effect	Command	Effect
`&`	column separator (skip)	`p{`*width*`}`	set col width; line text on top line[28]
`|`	vertical line	`m{`*width*`}`	set col width; line text on center line
`!{`*delimiter*`}`	delimiter + spaces	`b{`*width*`}`	set col width; line text on bottom line
`@{`*delimiter*`}`	delimiter only	`>{}`	insert command (begin)
`r`	right-aligned	`<{}`	insert command (end)
`c`	center-aligned	`*{}{}`	repeat on several columns
`l`	left-aligned		

– delimiter can be any character, symbol, chain of character-symbol, punctuation, horizontal spaces (`\quad` for example), math symbols, etc.
– commands can be anything from math (see below) to font types, styles, etc.
– `\hline` for a horizontal line (`\hline\hline` adds double horizontal lines).
– `\vline` for a vertical line.
– `\cline{`*col.a-col.b*`}` for a column line.
– `\setlength{\extrarowheight}{`*height*`}` adds space above each row.
– `[`*height*`]` before `\\` adds space following a row.

columns / rows	col2	col3 : col4...col5	*col*6	col7	col8
row2	column2	column3 : col4...col5	$\sqrt{9}$	column7	column8
row3	col2	col3 : col4...col5	β_0	col7	col8 + 7pt space
row4	col2	col3 : col4...col5	$\frac{1}{2}$	col7	col8 + 5pt space

[27] Package excel2latex has a macro that can convert Excel tables to LaTeX.
[28] This a vertical alignment. See section 2.9 on page 35 for examples of text alignment with a comparable texts.

```
\setlength{\extrarowheight}{7pt}
\begin{tabular}{|l||lr!{:}l@{...}r|>{$}c<{$}|c|l|}
\hline
\diagbox{rows}{columns} &
        col2    & col3    & col4 & col5 & col6         & col7    & col8 \\
\hline\hline
row2 &  column2 & column3 & col4 & col5 & \sqrt{9}     & column7 & column8 \\
row3 &  col2    & col3    & col4 & col5 & \beta_0      & col7    & col8 + 7pt..\\[7pt]
row4 &  col2    & col3    & col4 & col5 & \tfrac{1}{2} & col7    & col8 + 5pt..\\[5pt]
\hlinelar}
```

`\usepackage{diagbox}` and command `\diagbox[`*options*`]{`*row*`}{`*column*`}`
draw diagonal lines across a cell (in a contingency table for example).
options are: `height, width` for specifying height, width direction (`dir=NW` for North-West origin and `dir=SW` South-West origin) and `trim=` for offsetting the diagonal separator to the left, right, left-right or right-left (`l,r,lr,rl`). For example:

Product / Value for *x* \ Value for *y*	0	1
0	0	0
1	0	1

```
\begin{tabular}{|l|r|r|}
\hline
\diagbox[dir=NW, width=10cm]{Value\\for $x$}{Value\\ for $y$} &0 &1\\
\hline 0 & 0 & 0 \\
\hline 1 & 0 & 1 \\ \hline
\end{tabular}
```

`\begin{tabular*}{`*width*`}[ t | c | b ]{@{\extracolsep{\fill}}`*spec*`}`
enables tables to spread all across the page (what `\linewidth` does in essense).

`\usepackage{longtable}` and environment `\begin{longtable}[ t | c | b ]{`*spec*`}`
go further by generating tables that can span on multiple pages.

`\usepackage{array}` and environment `\begin{array}[ t | c | b ]{`*spec*`}`
are mostly used for creating matrices. See section 3.11 on page 46.

`\usepackage{tabularx}` and environment `begin{tablularx}{`*width*`}{`*position*`}{`*column*`}`
manage inter-column space and column distribution.

`\usepackage{multicol}` and command `\multicolumn{`*n*`}{`*column spec*`}{`*text*`}`
enable the spanning of the text over multiple columns; like in a spreadsheet, 'cells' are 'merged'. One row with one entry can top off rows with several columns for example.
`\usepackage{multirow}` and command `\multirow{`*n*`}{`*width*`}{`*text*`}`
do the same, but vertically. Substituting {*width*} with '*' let the width adjust automatically.

`\usepackage{multirow}` and `\usepackage{graphicx}`
with command `rotatebox` (see Section 2.1 on page 22).

text	a	b
	c	d
	e	f

```
\begin{tabular}{|r|c|l|}
\multirow{3}*{\rotatebox[origin=c]{90}{text}}
& a & b \\ \cline{2-3}
& c & d \\ \cline{2-3}
& e & f \\
\end{tabular}
```

Check out section 2.8 on page 30 to wrap text around a table, add captions, and build a list of tables.

Check out section 2.8 on page 30 to rotate figures and tables. There are different options that work for both figures and tables.

`usepackage[table]{xcolor}`
enables table coloring. See section 1.6 on page 13 for plain text examples.

The principal commands are:
`\columncolor[`*mode*`]{`*color*`}[`*left*`][`*right*`]`, `\rowcolor[`*mode*`]{`*color*`}`,
`\cellcolor[`*mode*`]{`*color*`}`,
`\arrayrulecolor[`*mode*`]{`*color*`}` for horizontal lines,
`\color{`*color*`}\vline\color{`*color*`}` for vertical lines,
`\doublerulesepcolor{`*color*`}`,
`\rowcolors[`*command*`]{`*initial row*`}{`*odd color*`}{`*even color*`}`,
`\rowcolors*[`*command*`]{`*initial row*`}{`*odd color*`}{`*even color*`}`,
`\showrowcolors`, `\hiderowcolors`.

`\usepackage{excel2latex}`
enables an macro in Excel to create a 'Convert table to LaTeX' tab in the Add-Ins menu. Select a zone in any sheet, click on the new tab, open a window with LaTeX code; copy-paste in any TeX editor to generate a table.

`\usepackage{spreadtab}` and environment `\begin{spreadtab}`
emulate a speadsheet inside a document. It works with other environments:
`{tabular}`, `{longtable}`, `{tabularx}`, `{array}`, `{matrix}`, etc.
Cells work like in a spreadsheet (a1, b2, c5, etc). Relative references too ([-2,3]). Text cell (@text), text-number cell (text:=numbertext). Functions can be implemented.

2.8 Figures and Tables

Let's begin with two examples.

`{figure}`

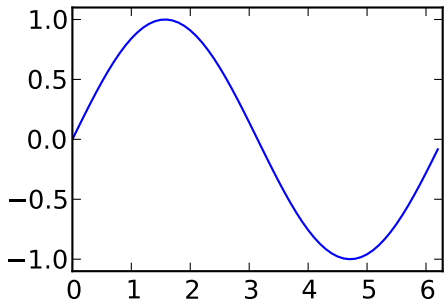


Figure 1: $\sin(x)$

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

`{table}`

	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}
```

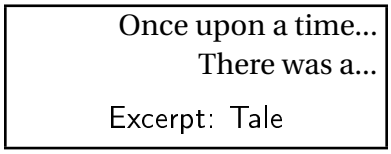
Float: figure, table

`\usepackage{float}`
enables `\begin{figure}` or `\begin{table}` floats, but also texts (citations, examples, poems, etc). A `\begin{{figure}}[`*option*`]` environment includes one or more graphics (more details on graphics follows) and a `\begin{{table}}[`*option*`]` environment includes one or more tables (see section 2.7 on page 27).

`\begin{figure}` and `\begin{table}` *options*:

`h, !h`	suggested, insisting! *here* in the text
`H`	precisely *Here* in the text
`t, !t`	suggested, insisting! *top* of a page
`b, !b`	suggested, insisting! *bottom* of a page
`p`	on a special *page* of floats only

The best practice is to align captions with the float; add an `\begin{flushright}` environment (or `\begin{flushleft}` or `\begin{center}`) following `\begin{figure}` before `\begin{minipage}` or `\begin{boxedminipage}`.




```
\begin{figure}[h]
  \begin{flushright}
    \begin{boxedminipage}{2in}
      \raggedleft % inversion because of flushright
      Once upon a time... \\
      There was a...
      \caption*{Excerpt: Tale}
    \end{boxedminipage}
  \end{flushright}
\end{figure}
```

Here are some rules of thumb about floats and edition:

– No more than 2 floats per page.
– Avoid too much customization (i.e. `!h, H, !t, !b, p`); let the algorithm manage the floats.[29]
– `\floatplacement{figure}[t]` or `\floatplacement{table}[b]` sets the default parameters for all floats in the entire document.
– `\clearpage` (almost similar to `\newpage`) make sure floats will show before the command itself to avoid being called in one section or chapter and appear in the next section or chapter.[30]
– `\usepackage[section]{placeins}` and command `{\afterpage{\clearpage}` constrains the placement to the section where the float is created. Replace `section` by `below/above` and the float shows up on the section last page, after/before the next section title. `\FloatBarrier` forces all floats preceeding the command to be executed.

graphics

`\usepackage[`*driver*`]{graphicx}` and command `\includegraphics[`*options*`]{`*file*`}`
call the image file. There are two ways to embed a file in the float:

– `\includegraphics[scale=0.05]{Static/hat.jpg}`, the long way: 
– `\includegraphics[scale=0.05]{Chap/hat}`, the short way: 
provided `DeclareGraphicsExtensions{.pdf,.png,.jpg}` specifies all the file extensions.

[29] Package pdfpages allows the inclusion of pages from a pdf file.
[30] Packages afterpage and flafter provide commands for better control for extensive use of floats.

`\includegraphics` *options*:

`width=`*width*	scale to width, maintaining aspect ratio if no height
`width=`*n*`\linewidth`	set width to *n* % of the total text width n=(0.20 for example)
`height=`*height*	scale to height, maintaining aspect ratio if no width in specified
`angle=`*degrees*	rotating counterclockwise
`scale=`*scalar*	resize the image by a scalar value
`page=`*page*	for a pdf, include the page number (1 by default)

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. ImageMagick can convert file formats. It's convenient to leave off the extension; latex/pdflatex will look for the appropriate file. Since many journals want eps files instead of pdf files, it's well-advised to generate eps files first, then to convert them to pdf using epstopdf. Keep the assets[31] in a subdirectory called Static, Assets or Img (provide a short name to minimize the length of path/file.extension.[32]

caption

`\usepackage{caption}` and command `\caption[`*short*`]{`*legend*`}`
add a numbered legend. *short* shows up in the list, *legend* shows up in the caption.
`\listoffigures` and `\listoftables`
print the lists anywhere in the document (allow 2 or 3 compilations).
`\caption*[`*short*`]{`*legend*`}`
removes the numbering from the legend and the caption is not accounted for in the lists.
`\captionof{`*type*`}[`*short*`]{`*legend*`}` & `\captionof*{`*type*`}[`*short*`]{`*legend*`}`
offer more customization: *type* assign the object as a `figure` or a `table` or a custom list.

label

Refer to the first label by typing `Figure \ref{sine}`: Figure 1;
on page `\pageref{sine}`: 30.
Refer to the second label by typing `Table \ref{sales-growth}`: Table 1;
on page: `\pageref{sales-growth}` 30.
See section 1.13 on page 18 for more details.

wrapfigure, wraptable

`\usepackage{wrapfig}` and
environment `\begin{wrapfigure}[`*nolines*`]{`*placement*`}[`*overhang*`]{`*width*`}`
can be substituted to `\begin{figure}` and `\begin{wraptable}` to `\begin{table}` to wrap text around float and provide more options to line up the float.

[31] Assets can come from other software as long as they are exported with the proper image extensions. Assets can also be schemas, vectorial drawing, and other graphics. we can find plenty of software that integrate well to LaTeX. LaTeX has its own drawing capabilities, but the main drawing package though is TikZ (as well as its dependencies and extensions). See an example in section 3.13 on page 48.

[32] Package grffile manages complicated path/file.extension.

`\begin{wrapfigure}` *options*
`[`*nolines*`]` height in 'number of lines'; if left empty, it self-adjusts
`{`*placement*`}`
l, i left of the page, inside where the binding is if printing on two sides
r, o right, outside
`[`*overhang*`]` margin spillover; set it to 0pt by default
`{`*width*`}` distance between the margin and the text; must be at least as large as the figure

The left figure spans on 5 lines, is set to the left without a margin overhang, and spans across 4cm from the margin to the text.

```
\begin{wrapfigure}[5]{l}[0pt]{4cm}
\includegraphics[scale=0.20]{Static/hat}
\end{wrapfigure}
```

Three commands enable more wrapping control:

– `\setlength{\columnsep}{`*size*`}` sets the horizontal spacing between the environment and the text (the figure hereby adds a 2cm),
– `\setlength{\wrapoverhang}{`*size*`}` set the horizontal spacing between the environment and the margin, and
– `\setlength{\intextsep}{`*size*`}` sets the vertical spacing, one command for the top, another for the bottom.

The package has some shortcomings, but there are alternativesthat offer customization:

– It cannot show floats in a list and there are problems around lists. Alternatively, `\usepackage{picins}` offers a command that work in and around lists with command
`parpic(`*width, height*`)(`*x-offset; it allows the placement of graphics in the center of paragraphs. y-offset*`)[`*position*`][`*placement*`]{`*inclusion*`}`.
– It requires to manually set the vertical placement. Alternatively, `\usepackage{picinpar}` and environment `\begin{window}[`*options*`]` automates it.
– `\usepackage{floatflt}` offers even serious customization (more complex as well).

sideway or landscape

`\usepackage[`*option*`]{rotating}` and environments `{sidewaysfigure}` & `{sidewaystable}` flip floats and caption sideways to fit on one page a long table or large figure in landscape mode; *option* can `figuresright` or `figuresleft`. Useful for large figures or tables we want to spread across an entire page. Here is a snippet without the result followed by an alternative method:

```
\begin{sidewaysfigure}[figuresright] % flip clockwise
  \centering
  \caption*{Mage}
     \includegraphics[width=6in]{Static/mage}
\end{sidewaysfigure}
```

`\begin{sideways}` inside `\begin{wrapfigure}` (or `\begin{wraptable}` or `\begin{figure}` or `\begin{table}`) and wrapped around `\includegraphics` flip the figure, but not the caption (hereby).
`\rotcaption{}` or `\rotcaption*{}`
if needed, flip the caption.

Sub-floats

`\usepackage{subfig}` and
command `subfloat[`*short*`][`*legend*`]{`*sub-float*`}`
enables two graphics in one float with either a single caption or two distinct captions for each sub-float.
`\setcounter{lofdepth}{2}` before `\caption` add two distinct captions. We can add a global caption. For example:

(a) White **(b)** Blue

Sorcerers

```
\centering
\subfloat[Mage][White]{\includegraphics[scale=0.10]{Static/mage}}\label{white}
\subfloat[Wizard][Blue]{\includegraphics[scale=0.75]{Static/wizard}}\label{blue}
\setcounter{lofdepth}{2}
\caption*{Sorcerers}
```

`\renewcommand{\thesubfigure}{\thefigure.\arabic{subfigure}}`
just before the first `\subfloat` replaces the `(a) (b)` caption with arabic sub-numbers in-synch with the section in both the caption and the lists. More customization is also possible.

(2.3) White **(2.4)** Blue

Sorcerers

More customization

`\usepackage{rotfloat}` with both environments `\begin{ex}` and `\begin{sidewaysex}`, as well as commands, allow the creation of custom floats.

Lists

`\listoffigures` and `\listoftables`
print the list of figuresand the list of tables (we need two compilations) following the TOC. See section 1.3 on page 7. For example:

List of Figures

1 sin(*x*) 30

2.9 Minipages

`\begin{minipage}[ t | b | c ]{`*width*`}`
is a container that can embed almost anything.

`\usepackage{boxedminipage}` and environment `\begin{boxedminipage}[ t | b | c ]{`*width*`}`
surround the minipage with a box. Examples:

`\begin{center}` wrapping `\begin{minipage}{10cm}`...

...isolates a text in a 10cm wide centered minipage.

`\begin{flushright}` wrapping `\begin{minipage}{5cm}` wrapping `\begin{center}`...

...isolates a centered text to the right in a 5cm wide minipage.

`\begin{flushleft}` wrapping `\begin{boxedminipage}{2in}` wrapping `\begin{flushright}`...

...isolates a right-justified text to the left in a 2in wide minipage.

`\begin{center}` wrapping `\begin{boxedminipage}{8cm}`...

...isolates a text in a 8cm wide centered boxed minipage.

However, we have much more flexibility with:

```
\setlength{\fboxsep}{3mm}\setlength{\fboxrule}{1.2pt},
\begin{flushright},
  \fbox{
  \begin{minipage}{10cm} ... }...
```

...isolates a text to the right in a 10cm wide minipage embedded in a custom fbox.

```
\cornersize{0.9}
\begin{flushleft}
  \Ovalbox{
  \begin{minipage}{10cm} ... }...
```

...isolates a text to the left in a 10cm wide minipage embedded in a custom Ovalbox.

```
\setlength{\fboxsep}{2mm}\setlength{\fboxrule}{0.5pt}
\fbox{
\begin{minipage}[t]{9cm} ... }...
```

Comparable text.

...isolates a text inside a box (2mm separator, 0.5pt thick) in a 9cm-wide minipage; a comparable text is lined up with the top of the box.

```
\setlength{\fboxsep}{5mm}\setlength{\fboxrule}{1pt}
\fbox{
\begin{minipage}[c]{12cm} ... }...
```

Comparable text.

...isolates a text inside a box (5mm separator, 1pt thick) in a 12cm-wide minipagea; a comparable text is lined up with the center of the box. .

```
\setlength{\fboxsep}{7mm}\setlength{\fboxrule}{2pt},
\fbox{
\begin{minipage}[b]{6cm} ... }...
```

...isolates a text inside a box (7mm separator, 2pt thick) in a 6cm-wide minipage; a comparable text is lined up with the bottom of the box.

Comparable text.

3 Math

`\usepackage{amsmath}`

is the main package for writing math and chemical equations, theorems, lemmas, proofs, etc. 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*}`.

`\begin{equation}` sets one equation (1).

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

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

`\begin{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}
```

`\begin{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}
```

`\begin{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}
```

`\begin{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}
```

`\begin{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}
```

`\begin{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 `\begin{eqnarray}`, but it produces rather poor spacing and is *not recommended.*[a]

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

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

[a] Other possible environments: split, gathered, and aligned.

3.1 Equation numbering

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

`\eqref{`*name*`}`
generates reference to equation such as: (9) (`\ref{`*name*`}` gives no parentheses).

`\usepackage{amsmath}` and command `\numberwithin{footnote}{chapter}`
for equations numbering by chapter (or by `{section}`...).

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

`\boxed{`*text*`}`
inside any math environment, can frame an (a part of the) equation: $\boxed{i^2 = -1}$

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

`\intertext{`*text*`}`
inserts a distinct row within `\begin{align}` for example (any multirow environments).

3.2 Sub/superscripts

Subscripts are done with _ the underbar, like `x_{1}` for x_1.
Superscripts are done with ^ the 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 the within-text style.

Inline: frac $\frac{1}{2}$, dfrac $\dfrac{1}{2}$, tfrac $\tfrac{1}{2}$.
In an 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{`*text*`}`	roman	ABCDE	abcde	12345	$\alpha\omega\Omega$	
`\mathsf{`*text*`}`	sans serif	ABCDE	abcde	12345	$\alpha\omega\Omega$	
`\mathtt{`*text*`}`	typewriter	ABCDE	abcde	12345	$\alpha\omega\Omega$	
`\bm{`*text*`}`	bold symbol	$\boldsymbol{ABCDE}$	$\boldsymbol{abcde}$	$\mathbf{12345}$	$\boldsymbol{\alpha\omega\Omega}$	bm
`\mathbb{`*text*`}`	blackboard	$\mathbb{ABCDE}$			$\alpha\omega\Omega$	
`\mathscr{`*text*`}`	euler	$\mathscr{ABCDE}$				mathrsfs
`\mathnormal{`*text*`}`	normal	$ABCDE$	$abcde$	12345	$\alpha\omega\Omega$	amsfonts, amssymb

In addition, `\mathit{`*text*`}` for an italic font,
`\mathbf{`*text*`}` for a bold font,
`\mathcal{`*text*`}` for a calligraphic, and, using
`\usepackage{amsfonts}` or `\usepackage{amssymb}`, `\mathfrak{`*text*`}` for a fraktur font.

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

`\DeclareMathOperator{\rank}{rank}`
adds new functions; for example rank(A).
`\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.
```

Formatting

`\usepackage[autolanguage]{numprint}`
format numbers and `\numprint{number}` generates 12,345.678,9 vs. `$ $` that generates $12345,6789$.

Rounding

`\nprounddigits{0}\numprint{number}`
rounds up number and 149999.99 becomes 150,000 while `\nprounddigits{2}\numprint{number}` turns 149.97567 into 149.98.

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}`
$\sqrt{xyz}$	`\sqrt{xyz}`	$\sqrt[n]{xyz}$	`\sqrt[n]{xyz}`
$\overset{\frown}{xyz}$	`\widearc{xyz}`	$\overrightarrow{xyz}$	`\wideOarc{xyz}`[33]

Chemical notations

Chemical notations use lots of arrows, accents, over/under, above/below elements and sub/superscript. Chemistry makes full use of all commands we can find in section 3.
For example (`\to` can replace `\xrightarrow{}`):

$$\mathrm{Zn_{(s)}} \xrightarrow{energy} \mathrm{Zn^{2+}_{(aq)}} + 2\mathrm{e^-} \tag{11.a}$$

$$\mathrm{Cu^{2+}_{(aq)}} + 2\mathrm{e^-} \longrightarrow \mathrm{Cu_{(s)}} \tag{11.b}$$

$$\mathrm{Zn_{(s)}} + \mathrm{Cu^{2+}_{(aq)}} \longrightarrow \mathrm{Cu_{(s)}} + \mathrm{Zn^{2+}_{(aq)}} \tag{11}$$

```
\begin{align}
  \mathrm{Zn_{(s)}} & \xrightarrow{\textit{energy}}
  \mathrm{Zn^{2+}_{(aq)}} + 2\mathrm{e^-} \tag{ox-red.a} \\
  \mathrm{Cu^{2+}_{(aq)}} + 2\mathrm{e^-} & \xrightarrow{\quad\quad }
  \mathrm{Cu_{(s)}} \tag{ox-red.b} \\[1.5mm]
  \hline
  \rule{0pt}{5mm}
  \mathrm{Zn_{(s)}} + \mathrm{Cu^{2+}_{(aq)}} & \xrightarrow{\quad\quad }
  \mathrm{Cu_{(s)}} + \mathrm{Zn^{2+}_{(aq)}} \label{ox-red}
\end{align}
```

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		

In Greek alphabetic order:

α	β	γ	δ	ϵ	ζ	η	θ	ι	κ	λ	μ	ν	ξ	π	o	ρ	σ	τ	υ	ϕ	χ	ψ	ω
A	B	Γ	Δ	E	Z	H	Θ	I	K	Λ	M	N	Ξ	Π	O	P	Σ	T	Υ	Φ	C	Ψ	Ω.

3.8 Hebrew

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

[33] widearc and wideOarc with package fourier.

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`			$\circ$	`\circ`
$\bigcup$	`\bigcup`	$\bigcap$	`\bigcap`	$\biguplus$	`\biguplus`			$\bullet$	`\bullet`
$\vee$	`\vee`	$\wedge$	`\wedge`	$\neg$	`\neg`			$\bigcirc$	`\bigcirc`
$\vee$	`\lor`	$\wedge$	`\land`	$\neg$	`\lnot`			$\diamond$	`\diamond`
$\sum$	`\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 $\sum_{i=0}^{n}$
– `\lim_{n \to 0}` is $\lim_{n\to 0}$

Dots vs. low dots vs. common dots: `$ x_0 \dots x_1 \ldots x_2 \cdots x_3 $` is $x_0 \dots x_1 \ldots x_2 \cdots x_3$

Roots use `\sqrt`, with optional radix.

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

Miscellaneous symbols

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

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	Re(x)	\re{x}	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 an example with a chemical equation in section 3.6 on page 41. Chemistry use lots of arrows, accents, over/under, above/below elements and sub/superscript.

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	⟩ \rangle		$\left\langle\frac{x}{y}\right\rangle$ \angles{...}
⌊ \lfloor	⌋ \rfloor		$\left\lfloor\frac{x}{y}\right\rfloor$ \floor{...}
⌈ \lceil	⌉ \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 and to fit their contents. To use delimiter on one side, use invisible \left. or \right. for other side. It 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 vertical 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[ t | c | b ]{`*spec*`}`
is similar to `tabular` (section 2.7 on page 27), but in the math environment (section 3 on page 37).

3.12 Theorems

'Theorem' is a generic term for a series of thematic paragraphs: *theorem, definition, lemma, remark, corollary, specification, proposition, example, exercise, postulate, problem, tip,* etc.

`\usepackage{amsthm}` and `\newtheorem{`*name*`}{`*printed*`}`
in the preamble; *name* generates a new environment and *printed* appears in the text.
`\newtheorem*{`*name*`}{`*printed*`}`
is unnumbered and unlisted.

`\newtheorem{ex}{Exercise}`
goes in the preamble under the package for creating a new series named 'Exercise'.
`\begin{ex}[`*case*`]`
becomes a new environment. For each 'theorem', the counter increases like any other counters. Each numbered *case* becomes a distinct paragraph such as:

Exercise 1 (Creating a matrix)**.** *AMS provides 4 matrix environments... blah blah blah...*

`\setcounter{thm}{0}`
forces the counter to restart for all 'theorems'; set any number.

`\newtheorem{`*name*`}[`*numberby*`]{`*printed*`}`
in the preamble; all theorems share a common counter.
`\newtheorem{`*name*`}{`*printed*`}[`*numberby*`]`
in the preamble; *numberby* can be `section` or `subsection`. For example:

`\newtheorem{pr}{Problem}[section]`
goes in the preamble for creating a new series named 'Problem'. `\begin{pr}[`*case*`]` becomes a new environment. For each 'theorem', the counter restarts at each new section. We can add `label{}` following the `begin{}` statement. Each section numbered *case* becomes a distinct paragraph such as:

Problem 3.1 (Creating an equation)**.** *There are several environments for writing equations...*

`\usepackage{thmtools}` and `\listoftheorems`
print the list of 'theorems' (we need two compilations) following the TOC and the other lists. See section 1.3 on page 7.

List of Theorems

1 Exercise (Creating a matrix) 47

3.1 Problem (Creating an equation) 47

`\usepackage[thmmarks, amsmath, framed]{ntheorem}` and `\usepackage{framed}` enable more customization. `\theoremstyle{ plain | definition | remark }` preceeding the 'theorem' environment, changes the style:

– `plain`: Theorem, Lemma, Corollary, Proposition, Conjecture, Criterion, Assertion.
– `definition`: Definition, Condition, Problem, Example, Exercise, Algorithm, Question, Axiom, Property, Assumption, Hypothesis.
– `remark`: Remark, Note, Notation, Claim, Summary, Acknowledgment, Case, Conclusion.

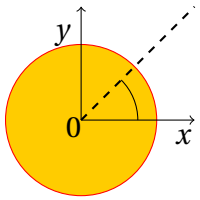
A lot more can be done with the font. We can add symbols to preceed/close/follow each 'theorem' and a separator between the number and the body. We can change the number style, add colors, and add a frame. These commands go in the preample before `\newtheorem`.[34]

`\begin{proof}`
is a theorem-like environment with an automatic closing symbol.

Proof. Content... blah blah blah blah blah blah blah blah blah blah blah blah blah blah... □

3.13 TikZ and more

`\usepackage{tikz}`
activates drawing capabilities[35] in TEX documents. Here is an example:




```
\begin{tikzpicture}
  \coordinate (origin) at (0,0);
  \draw[red, fill=red!20!yellow] (origin) circle(1);
  \draw(-0.1, -0.1) node {$0$};
  \draw[->] (0,0) -- (1.5,0) node[pos=0.9, below]{$x$};
  \draw[<-] (0,1.5) -- (0,0) node[near start, left]{$y$};
  \draw[thick, dashed] (0,0) -- (1.5,1.5);
  \draw (0.75,0) arc(0:45:0.75);
\end{tikzpicture}
```

– Inkscape[36] takes LATEX commands. It is simpler to draw within Inkscape and export a pdf+LATEX file to create two files: one pdf file and one `pdf_tex` file that can be incorporated into a document with command `\input{file.pdf_tex}`. Modify the TEX file (inside environment `\begin{picture}`). Inkscape can also export in PSTricks and in TikZ. The latter requires a lot more settings (install `\usepackage{tikz}`). Consult `github.com/kjellmf/svg2tikz`.
The simplest way is to export a simple pdf file (a drawing, a graph) and import the pdf file as a figure with command: `\includegraphics{plot.pdf}`.
– R generates graphics that can be exported as pdf files and included with command

[34] Package ntheorem with *options* thmmarks, amsmath, framed and package framed.
[35] Include its dependencies and extensions.
[36] The are other vector graphics software such as DIA.

\includegraphics{plot.pdf}. R can also generate TikZ files to be included with \input{plot.tex} (install \usepackage{tikz}). A example of R code (in R):

```
install.packages('filehash')
install.packages('tikzDevice')
library(tikzDevice)
tikz('plot.tex')
x <- c(1:7); y <- 2*x
plot(x,y,main='\\textbf{Graphic from $x\\maspsto 2x$}')
dev.off()
```

– LaTeX has its own drawing capabilities; combine usepackage{picins} with packages usepackage{epic}, and usepackage{eepic} to access the picture environments.
– For drawing schemas and other graphics, we can use XFig, a vectorial drawing software that takes LaTeX commands (an alternative to Inkscape).
– \usepackage{pstricks} and \usepackage{pgf}
are two packages that enables drawing functions; they are compatible with pdfLaTeX and with \usepackage{pdftricks}. These packages have manuals of their own with elaborate functionalities.
– vrac, jfigure, geogebra, eukleides and EasyChem (for chemists), pgf (an easier alternative to PSTricks) and winfig can be integrated to LaTeX with
\usepackage{tikz} and environment \begin{tikzpicture}.

4 Bibliography using BibTeX

There are 2 ways to make a bibliography:

– create a BibTeX database or
– manually format it (for short bibliographies).

BibTeX can automatically format various citation and bibliography styles, eliminating tedious manual re-formatting. Multiple tex files can use the same BibTeX database[37], eliminating redundant data entry. Let's see BibTeX first; manual formatting follows further down.

4.1 Enabling BibTeX

Keep the references in a BibTeX database (references.bib for example). A .tex file sets the bibliography style (see the table below). For 'plainnat', 'abbrvnat', 'unsrtnat', and 'custom-bib' styles, add `\usepackage[`*options*`]{natbib}`. For 'apalike' add `\usepackage{apalike}`.
In the document, set and print the bibliography with commands:

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

Change the title of the bibliography section (to 'References' for example) with commands:

```
\renewcommand{\refname}{References}    (for articles)
\renewcommand{\bibname}{References}    (for reports and books)
```

Compile the bibliography, run latex, then bibtex, then latex twice more!

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

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		

[37] For more customization, BibLaTeX is the other option.

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

Nicolas Markey. *Tame the BeaST*, 2005.

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

References, for style unsrt

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

Nicolas Markey. *Tame the BeaST*, 2005.

References, for style abbrv

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

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

References, for style alpha

Nicolas Markey. *Tame the BeaST*, 2005.

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{`*name*`}` and similar commands
makes a citation and includes its entry in the bibliography. The name is assigned by `bibitem`.
`\nocite{`*name*`}` and similar commands
includes an entry in the bibliography without citing it.
`\nocite{*}`
includes *all* BibTeX entries in the bibliography.

Examples:

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]

natbit

`\usepackage[`*options*`]{natbib}`
provides commands `\citet`, `\citep`, and other variants. Add it to the preamble and choose a natbib-compatible style. It has extensive commands and options (consult the documentation). Some natbib package *options*:

options	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 (see the table from section 4.1 on page 50). Depending on the options, natbib can generates author-year, numeric citations, or superscript citations (not shown). In the document, set and print the bibliography with commands:

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

Other citation packages

`\usepackage{jurabib}`
focuses on social sciences and possesses its own specific commands. We can cite a reference in the text and refer to the citation in the footnote (as it is the case with literary works).

`\usepackage{bibentry}`
makes it possible to cite with or without building a bibliography since we can write the entire entry at every citation.

`\usepackage{bibtopic}`
builds separate bibliographies (one for books, another for articles, etc.).

`\usepackage{biblatex}`
offers lots of customization and styles. We can build a bibliography at the end of each chapter and build separatehe bibliographies based on keywords (one for books, another for articles, etc.).

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 between `"..."` 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 [13].

See table 2 further down for entry types and fields. Here is an entry 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 (for short bibliographies), instead of `\bibliographystyle` and `\bibliography`, use environment `\begin{thebibliography}` within the document. The argument is the widest label[38], here "SJL05", so it can be indented properly. `\bibitem` takes the label as an optional argument; otherwise the label is just numeric. For example:

```
\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}
```

`\cite{Smith05}`, for example, calls the citation in the text.

BibTeX builds the bibliography 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.

[38] The usual parameter is {99} for 99 entries. It can be limited, for example, to {10}. Count 3 compilations.

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 (May for example)
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.

References

Patrick Daly. *Natural Sciences Citations and References*, 2006.

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