LaTeX Quick Reference Guide v1.1

Monte Anderson © 2009

Created for the Air Force Institute of Technology (AFIT), Department of Engineering Physics

LaTeX (pronounced "la-tek") is a technical document preparation system – particularly useful for typesetting large technical manuscripts, accurately representing mathematical symbols and structures, automatically generating table of contents, numbering tables and figures, and managing citations and the bibliography. LaTeX formats the structured document and allows the writer to concentrate on content rather than appearance. This *Quick Reference* is a very short introduction to LaTeX. For more information, go to http://tug.ctan.org or perform an appropriate Internet search. Two very useful references are *The LaTeX Companion* by Mittlebach and Goossens, and *More Math Into LaTeX* by Grätzer.
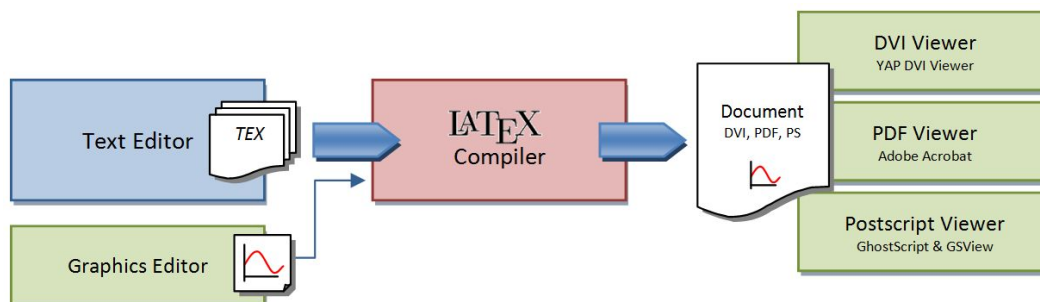
LaTeX Editors and Compilers

LaTeX is a document markup language and document preparation system. It is *not* a single word-processor program like **Microsoft Word®**. A LaTeX system consists of a TEX editor, LaTeX compiler and document viewer(s).

TEX Editors

The TEX editor is the front end user interface where you create the TEX file. TEX specific editors integrate with the LaTeX compiler and offer formatting shortcuts. A list of common TEX editors is given in Table 1.

Table 1: List of TEX editors and supporting websites.

Editor	Type	Platform	Web Site
Kile	Open Source	Mac, Linux	http://kile.sourceforge.net/
LEd (LaTeX Editor)	Freeware	Windows	http://www.latexeditor.org/
LyX	Open Source	Windows, Mac, Linux	http://www.lyx.org/Home
MeWa	Open Source	Windows	http://www.meshwalk.com/latexeditor/
Scientific WorkPlace	Retail	Windows	http://www.mackichan.com/
Texmaker	Open Source	Windows, Mac, Linux	http://www.xm1math.net/texmaker/
TeXnicCenter	Open Source	Windows	http://www.texniccenter.org/
WinEdt	Shareware	Windows	http://www.winedt.com/
WinShell	Freeware	Windows	http://www.winshell.de/

LaTeX Compiler

LaTeX compiler installation packages include all the language and code needed to interpret the TEX from the editor and create the document output. Links to several LaTeX installation packages are available online at `http://www.ctan.org/`. Alternatively go directly to **MikTeX** at `http://miktex.org/`, or **proTeXt** at `http://www.tug.org/protext/`.

Output

In general there are three output types from the LaTeX compiler – Device Independent (DVI), PostScript (PS), and Portable Document Format (PDF).

The standard output for LaTeX is DVI. DVI files are binary data files which are read by a DVI reader (known as a DVI driver). A DVI driver is normally included with each LaTeX installation, but may be downloaded separately.

Most TEX editors are capable of producing PS and PDF output (both now Adobe products). PS is a language that encodes the page description, which is in turn processed by a raster image processor (RIP), from which printers produce output. PS files can be viewed *on screen* using a PS viewer such as **GhostScript**/**GSView** (`http://pages.cs.wisc.edu/~ghost/gsview/index.htm`). PDF is built upon PS and is essentially a post-processed PS file. PDF files are enhanced PostScript documents describing the page layout and may contain features such as keywords or hyperlinks. PDF files can be viewed using **Adobe Acrobat**® (`http://get.adobe.com/reader/`).

Graphics Files and Editors

Including graphics in LaTeX documents depends on the output file type. DVI and PS outputs use PS or EPS graphics files, while PDF output uses bitmap image file types, including PDF, JPEG, PNG, TIFF and GIF. EPS and PDF produce vector graphics, which do not lose resolution when scaled to large sizes. Large high-resolution bitmap files are correspondingly large files. PDF document files, which use PDF and bitmap file types are more common and read more easily than PS documents. One must consider the resolution and end document output file type when creating LaTeX documents – and use the appropriate graphics file type for all the figures and images in the document.

Technical graphing programs allow data and functions to be plotted and labeled for use in technical documents. Retail program (such as **SigmaPlot** and **Origin**) and freeware (such as **Gnuplot**) programs create all the usable LaTeX graphic file types. Most LaTeX compilers come bundled with image file converters.

A graphics editor may be useful when figures are to be included in the document. **Adobe PhotoShop**® and **Adobe Illustrator**® are an excellent programs, but they are expensive. For most image file types, a fine alternative is **GIMP** (`http://www.gimp.org/`). **GIMP** or similar graphics programs allow you to edit and save images, or convert the file formats as needed.

To create vector graphics (EPS), similar to **Adobe Illustrator**® and **CorelDraw**®, a free alternative is **InkScape** (`http://www.inkscape.org/`).

Google SketchUp is a free three-dimensional (3D) computer-aided design (CAD) program created to allow users to design buildings and landmarks for **Google Earth**. **Google SketchUp** can be used to render technical illustrations (`http://sketchup.google.com/`) which can then be included in your LaTeX document.
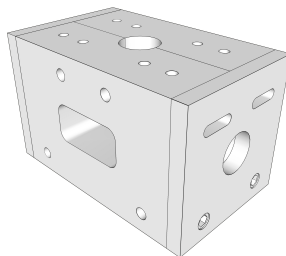
Sample 3D CAD image created with **Google SketchUp**.

Text, Math and Commands

When creating LaTeX document, the text in the TEX source document is interpreted by the LaTeX compiler as either normal *text*, *math* (formulas), or LaTeX *commands* (which are defined by special characters and reserved words). Normal text includes all normal keyboard characters and *must not contain* the following ten special characters used in LaTeX commands.

[*Symbol*]	*description*
#	Defines argument number in \newcommand statements
$	Brackets inline math
%	Marks beginning of non-printing remark–from % until end-of-line (return)
&	Align symbol used in tables (columns) and math align environment
~	Non-breaking space, does not allow line break (A.~Einstein)
_	Subscript command
^	Superscript command
\	Marks beginning of LaTeX command
{ and }	Non-printing "grouping" symbols

To use these symbols in normal text, these characters must be typed using LaTeX commands (text symbols) as shown on page 11. Additionally, the "quotation mark" character is not used. Single quotation marks are produced in LaTeX using ' (below the ESC key) and ' (left of the ENTER key). Double quotation marks are produced by typing '' and ''. Some TEX editors will insert the correct opening/closing pair when you type the "quotation mark" key.

Special math symbols (integrals, square root , etc) and formatting (fractions, exponents, etc) are only available in *math mode*. Math text can be added to a line of normal text by bracketing the math text within $ dollar signs or in math environments (discussed later in this guide). For example, $a^{2} + b^{2} = c^{2}$ creates the inline (embedded in the sentence) math text $a^2 + b^2 = c^2$.

LaTeX commands are reserved words preceded by the \ (backslash) symbol.

Sample Document
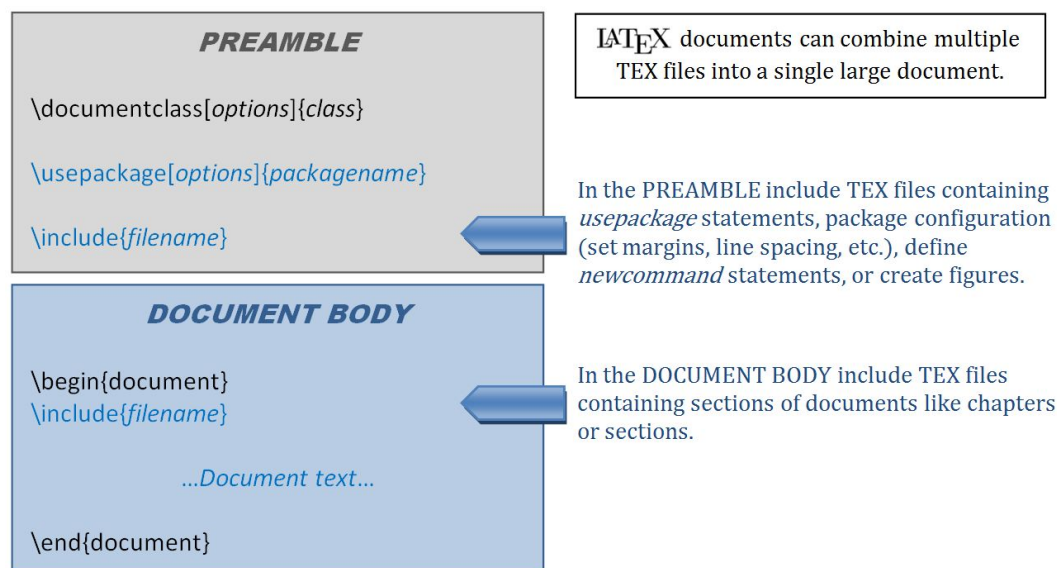
A LaTeX document is divided into two main sections, the *preamble* and the *document body*. If the document is quite large or complex with many equations, figure or tables, it may be advantageous to use the modular features of LaTeX. Multiple TEX files can be included in the main (master) document file.

The *preamble* contains the document class statement which tells LATEX the overall document type, structure and defaults to be used creating the document. It relies on style files to generate the document according to style rules so that the author can concentrate on content rather than formatting. In the preamble, you can include *packages* which define special commands and format options (like setting margins or line spacing). It is possible to create your own TEX files to customize the document or define new commands to simplify typing the main document.

The *document body* includes the text of the document between `\begin{document}` and `\end{document}` statements (creating the document *environment*). Here included files may contain large sections of the document like chapters.

Preamble

`\documentclass[options]{class}`

This is always the first statement in the LATEXdocument preamble which defines the overall structure and format of the document. The *options* in the square brackets apply optional settings for the document–if the square brackets are omitted default setting will be used. The document *class* in curly brackets (braces) defines the type of document. Brief description of document options and classes are included in Table 2. Custom classes can be defined by *style files* provided by some academic institutions and publishers.

Table 2: Document class options and class descriptions.

`[options]`	description
10pt, 11pt, 12pt	font size (10pt default, except on *slides*)
letterpaper, a4paper...	paper size
oneside, twoside	one- or twosided layout (oneside default, except for the book class)
landscape	selects landscape format (portrait default)
titlepage, notitlepage	selects if there should be a separate title page
leqno	equation number on left side of equations (right side default)
fleqn	displayed formulas flush left (centered default)
openright, openany	chapter should start on a right-hand page (openright default for book)
onecolumn, twocolumn	one or two columns (one column default)
`{class}`	description
book	default twosided
	allows for `\frontmatter` `\mainmatter` `\backmatter`
	no abstract environment included (must be added separately)
memoir	similar to book class - with abstract environment
report	no `\part` division
	includes abstract environment
article	no `\part` or `\chapter` division
letter	used to typeset personal or business letters
slides	Large sans serif font

Including Other TEX Files

One of the strengths of LATEX is the ability to include other TEX files in a "master" document, using the `\include{filename}`. For large documents, selected parts can be included using the `\includeonly` command. For example, to include a *section* use `\include{Chapter1/Introduction}` at the desired place in the *document body*. Customization files can be included in the *preamble* and *text sections* can be included in the *document body*. Appropriate *sectioning* commands can be included a the beginning of the TEX file. To avoid potential compilation errors, add the command `\endinput` at the end of the TEX file.

Defining Commands

It is possible to define LaTeX commands using `\newcommand{`*command name*`}[`*num args*`]{`*definition*`}` in the *preamble*. To redefine an existing command use `renewcommand`. This provides a convenient way to shorten frequently used or complicated sequences. For example...

```
\newcommand{\dirac}[3]{% creates Dirac bra-ket notation
    \ensuremath{\left\langle #1 \left| \, #2 \, \right| #3 \right\rangle}
    }%


\dirac{\psi}{\hat{x}}{\psi}                              ⟨ψ | x̂ | ψ⟩
```

The command `\ensuremath` allows the newly defined command/symbol to be used freely in either text or math mode.

A creative use of `\newcommand` is to build a TEX file included in the *preamble* which defines a command for each figure (or table). This creates a single location for all figures and abbreviates the commands required in the main document text.

Packages

`\usepackage[`*options*`]{`*packagename*`}`
Packages define sets of commands, special characters, or formatting options to be used in a document. Table 3 contains a list of packages found to be useful when creating a technical document. For a complete list of packages with detailed documentation and options, see `http://tug.ctan.org`, or Internet search "latex *name* package" .

Table 3: Package names and descriptions.

package	*description* `sample command`
amsmath	contains miscellaneous enhancements to displayed formulas
amsfonts	defines blackboard bold, Fraktur and a small set of symbols
amsthm	allows for creation of new theorem environments
amssymb	superset of AMS fonts
booktabs	clean standardized table formatting
threeparttable	allows for table notes (footnotes at end of table)
cancel	draws diagonal arrow through expression pointing to value
	ex. `\cancelto{0}{\sin x}` $\rightarrow \cancelto{0}{\sin x}$
enumerate	easy customized enumerated lists
eurosym	Euro symbol `\usepackage[official]{eurosym}`, `\euro`
geometry	margin and page setup
	`\geometry{letterpaper,top=1in,bottom=1in,left=1in, right=1in}`
graphicx	used to insert pictures or figures
hyperref	hyper-references in PDF documents
natbib	bibliography formatting
	`\usepackage[square,numbers]{natbib}`
setspace	`\singlespacing`, `\onehalfspacing`, `\doublespacing`
siunitx	*Le Système International d'Unités* (SI units) and fancy number formatting
	`\usepackage[alsoload=synchem]{siunitx}`
	ex. `\SI{2.99792458e8}{\meter\per\second}`$\rightarrow 2.99792458 \times 10^8\,\mathrm{m\,s^{-1}}$
titlesec, **titletoc**	formatting for section titles and table of contents
varioref	text like "on the following page" added automatically to references
url	special url text formatting, ex. `\url{address}`$\rightarrow$ `http://tug.ctan.org`

Document Body

The document body is contains all the text between `\begin{document}` and `\end {document}`. Separate TEX files may be included containing large portions of text such as chapters and appendices. Besides the structured normal text (section levels discussed on the next page), standard document parts are located in the document body, including *title page*, *table of contents*, *list of figures/tables*, *bibliography* and *index*.

Title Page

The `\maketitle` command generates a separate title page - except in the article style, where the title normally goes at the top of the first page. Information used to produce the title is obtained from the statements in Table 4, which should precede the `\maketitle` command in the *document body*.

Table 4: Statements used to set up the title page before `\maketitle`.

Required/Optional	Statement
(required)	`\author{`*name*`}`
(required)	`\title{`*title*`}`
(optional)	`\date{`*name*`}` [use `\today` as the *name* to use today's date]
	If `\date{`*name*`}` is omitted, today's date is used automatically.
(optional)	`\thanks{`*text*`}`

Alternatively one may create a custom the title page by including the *titlepage environment* in the preamble, before the `\maketitle` command in the *document body*.

```
\begin{titlepage}
...text and formatting...
\end{titlepage}
```

The *titlepage environment* creates a title page, i.e. a page with no printed page number or heading. It also causes the following page to be numbered page one.

Table of Contents, List of Figures and List of Tables

LaTeX can automatically generate a table of contents from the standard sectioning commands by using the `\tableofcontents` command wihtin the document body where the table of contents is desired (after the title page and abstract, before chapter one). Additional pages (like the table of contents itself or the bibliography) can be added manually using the `\addcontentsline` command. An example adding the the table of contents is shown below

```
\addcontentsline{toc}{chapter}{\contentsname}
\tableofcontents
```

Besides automatic numbering of figures and tables, LaTeX will generate standard list of figures and list of tables pages in the completed document, by invoking the `\listoffigures` and `\listoftables` commands.

Bibliography

LaTeX also makes managing bibliographic references very easy. Bibliography TEX files can be created by hand, but there are number of excellent (free) programs, like **JabRef** (`http://jabref.sourceforge.net/`), that will manage your references for you. Run *BiBTeX* from your LaTeX editor and build output before creating the document to synchronize references. Any citations used in the document are automatically added to the document when the `\bibliography` command is used. Several styles of bibliography can be used, base on standard format styles, alphabetical or ordered by appearance in the text. See **natbib**

package documentation for more information, or see `http://merkel.zoneo.net/Latex/natbib.php` for a brief summary.

Most technical style formats require square brackets around the reference number–load the package with the `\usepackage[square,numbers]{natbib}` command. To cite a reference from the bibliography TEX file (created with **JabRef** or similar program) in the document text type `\citep{bibkey}`. The *bibkey* is a unique reference name you provide created with the reference manager, normally *LastNameYear*, which BiBTeX uses to build the bibliography.

The following example for creating the bibliography, given a bibliography file named *BibFileName* located in the *path* folder. The `\addcontentsline` command adds the bibliography to the table of contents.

```
\bibliographystyle{plain}
     \addcontentsline{toc}{chapter}{\bibname}
\bibliography{path/BibFileName}
```

Bibliography

[1] A. Andalkar and R. B. Warrington. High-resolution measurement of the pressure broadening and shift of the Cs D_1 and D_2 lines by N_2 and He buffer gases. *Phys. Rev. A*, 65(3):032708, Feb 2002.

[2] Peter F. Bernath. *Spectra of Atoms and Molecules*. Oxford University Press, 2nd edition, 2005.

[3] Eric L. Bolda, Raymond Y. Chiao, and John C. Garrison. Two theorems for the group velocity in dispersive media. *Phys. Rev. A*, 48(5):3890–3894, Nov 1993.

[4] Max Born and Emil Wolf. *Principles of Optics*. Cambridge University Press, 7th edition, 1999.

Document Structure – Sectioning Commands

`\section[short title]{long title}`

One of the great features of LaTeX is the ability to define an ordered (outlined) document structure. The outlined structure allows LaTeX to create the table of contents. Document outline levels are shown in Table 5.

All document divisions are numbered by default. For an unnumbered section, which does not go into the Table of Contents, follow the section command name with an asterisk `\section*{title}`. The depth to which sections are numbered is set by `\setcounter{secnumdepth}{level}`. A related counting feature is *tocdepth*, which specifies the depth to make the Table of Contents, `\setcounter{tocdepth}{level}`.

Table 5: Section depth as used with `secnumdepth` and `tocdepth` counters.

Section command	`\setnumdepth` level	
`\part`	1	(report and book class only)
`\chapter`	2	(report and book class only)
`\section`	3	
`\subsection`	4	
`\subsubsection`	5	
`\paragraph`	6	
`\subparagraph`	7	

Book class provides additional commands for automatically formatting standard book (or dissertation) sections. They alter chapter headings and page numbers as you may expect in a book. `\frontmatter` should be the first command in the *document body*. It switches page numbering to lowercase Roman numerals and sections are unnumbered but appear in the table of contents. `\mainmatter` is used before the first chapter. It formats the page numbering to Arabic numerals and restarts page numbering. `\appendix` starts the appendix sections of your book. After this command all chapters are numbered using uppercase letters. `\backmatter` appears before the last (unnumbered) sections of the book such as the bibliography and the index.

Environments

Within LaTeX document, an environment defines special formatting which applies to the text between `\begin{`*`environment`*`}` and `\end{`*`environment`*`}`. For most technical documents the commonly used environments are equation, align, list, figure, and table. A list of standard environments is given in Table 6.

Table 6: Standard LaTeX environments and description

Environment	Description
align, equation	Aligned and numbered equations (math mode)
center, flushleft, flushright	Justification
description	Labeled lists
figure, table	Floating figure, table
list, enumerate, itemize	Generic list, numbered lists, bulleted list
minipage	Miniature page
quotation, quote	Indented text with/without paragraph indentation
tabular	Aligned text in columns
titlepage	Allows for customized title page
verabtim	Simulated typed text

Equation and Align Environments

The equation and align environments both delimit math mode segments (i.e. bracketing each equation with `$` is not necessary). *Equation* allows for a single numbered math mode line. *Align* allows for several numbered lines separated by the *end-of-line symbol*, `\\`. Align adds the additional feature where equations can be aligned vertically at the *align symbol*, `&`. For example, if equations are to be vertically aligned at the equal sign, type "`&=`" within the align environment. If you wish to omit the equation number, add `\nonumber` before the *end-of-line symbol*. An example of the align environment is given here.

```
\begin{align}
    a+b &=3^{2} + 4^{2} \nonumber \\
        &= 25 \label{eq:aplusb}
\end{align}
```

$$
\begin{aligned}
a + b &= 3^2 + 4^2 \\
&= 25
\end{aligned}
\tag{42}
$$

List Environment

Three list types are standard in LaTeX, *itemize*, *enumerate* and *description*. Using the commands `\begin{`*`list type`*`}` and `\end{`*`list type`*`}` – *itemize* created bulleted items, *enumerate* creates Arabic numbered lists and *description* allows for custom named lists. The **enumerate** package simplifies the customization process. For example,

```
\begin{enumerate}[(a)]
    \item First item.
    \item Second item.
    \item Third item.
\end{enumerate}
```

(a) First item.
(b) Second item.
(c) Third item.

Floats

Figures and tables are *floats*, which LaTeX will move to minimize whitespace. Normally the float object will appear where you inserted it in the text. However LaTeX may choose to move the float to the top of the

next page or a separate page at the end of the section or document. Be sure to watch your output for the formatting you desire.

Figure Environment

Figures are pictures or diagrams inserted into the document. Figures normally have the *caption* below the figure–this is controlled simply be the placement of the command line within the environment (if you want the caption before the figure, list the caption before the figure). LaTeX automatically tracks and numbers figures and tables separately. If you move the placement of a float, LaTeX will renumber the objects automatically.

The following is an example of adding a figure to a document.

```
\begin{figure}[htbp]
    \centering
        \fbox{\includegraphics[width=4.5in]{path/filename}
    \caption[Figure short title]{Figure long title.}
    \label{fig:FigLabelName}
\end{figure}
```

The optional statement `[htbp]` tells LaTeX where to add the figure, h-here, t-top, b-bottom or p-separate page. `\fbox` encloses the picture in a frame box. To include the picture without the frame, omit `\fbox` and the associated braces. `\caption` includes the optional [short title] which appears in the table of contents and the {long title} which appears at the top or bottom of the figure. If no optional [short title] is included, the {long title} is used in the table of contents. Since `\caption` appears after the `\includegraphics` command, the caption is after the figure.

Tabular Environment

Tables neatly present aligned information in a document. Tables normally have the *caption* above the table–this is controlled simply be the placement of the command line within the environment (if you want the caption after the table, list the caption after the table). LaTeX automatically tracks and numbers figures and tables separately. If you move the placement of a float, LaTeX will renumber the objects automatically.

The following is an example of adding a table to a document,using the **booktabs** package. See **booktabs** and **threepartable** package documentation for more table options. Besides providing number formatting and *Le Système International d'Unités* (SI) standardized units, the **siunitx** package also has commands to align numerical data on the decimal points in a column (not used in this example).

```
\begin{table}
    \centering
    \caption{Sample table.}
    \begin{tabular}{l c l}
        \toprule %requires booktabs pkg
          Item & Quantity & Cost \\
        \midrule %requires booktabs pkg
          Books & 4 & $39.99 each \\
          Paper & 6 & $6.49 each \\
          Pens & 12 & $0.25 each \\
          Pencils & 42 & $0.10 each \\
        \midrule %requires booktabs pkg
                & Total & $206.10 \\
        \bottomrule %requires booktabs pkg
    \end{tabular}
\end{table}
```

Table #: Sample Table.

Item	Quantity	Cost
Books	4	$ 39.99 each
Paper	6	$ 6.49 each
Pens	12	$ 0.25 each
Pencils	42	$ 0.10 each
	Total	$ 206.10

Referencing Objects Used in the Document

Any equation, figure, table, or section (chapter, appendix, etc.) can be labeled for future reference within the document using the `\label {labelname}` command. For convention, it is recommended to label equations as *eq:name*, tables as *tab:name*, and figures as *fig:name*. To reference tables or figures within the text, type `\ref{labelname}`. For equations, use `\eqref{eqnlabelname}`, which puts the equation number within parentheses. A neat package to use here is **varioref**, which adds text such as *"on the following page"* or *"on page #"* to the reference. For example...

```
\begin{equation}
    \int^{2\pi}_{0}\sin^{2}(x)dx = \pi
    \label{eq:SinSqrd}
\end{equation}
```

$$\int_0^{2\pi} \sin^2(x)dx = \pi \qquad (42)$$

```
...as shown in eqn \eqref{eq:SinSqrd}...
```

...as shown in eqn (42)...

Text Mode

Text mode describes any normal text that is neither math mode (inline between `$` or within a math environment) nor LaTeX command. This guide contains most of the commonly used text and math mode symbols. There are many specialized symbol and font sets available not listed here. CTAN maintains a comprehensive symbol list at `http://www.ctan.org/tex-archive/info/symbols/comprehensive/symbols-a4.pdf`.

Text Justification

Justification can be controlled using the environment structure as discussed previously in the environment section using the `center`, `flushright`, and `flushleft` environments. Only the text within the environment will be effected by the justification. Using *declarations* `\centering`, `\raggedleft`, and `\raggedright` has the same effect. By delimiting the declaration in braces (or the using the declaration within another environment) only text within the braces (or environment) will be effected. Otherwise the entire document from that point forward will be effected.

Text Mode – Font Face

Normal text font face can be changed using the following commands. Using the declaration without braces will effect the entire document from that point forward.

Table 7: Text mode font faces.

Command	Declaration	Sample
`\textrm{`*text*`}`	`{\rm `*text*`}`	Roman
`\textsf{`*text*`}`	`{\sf `*text*`}`	San Serif
`\texttt{`*text*`}`	`{\tt `*text*`}`	Typewriter
`\textmd{`*text*`}`	`{\md `*text*`}`	Medium
`\textbf{`*text*`}`	`{\bf `*text*`}`	**Bold**
`\textup{`*text*`}`	`{\up `*text*`}`	Upright
`\textit{`*text*`}`	`{\it `*text*`}`	*Italic*
`\textsl{`*text*`}`	`{\sl `*text*`}`	*Slanted*
`\textsc{`*text*`}`	`{\sc `*text*`}`	SMALL CAPS
`\emph{`*text*`}`	`{\em `*text*`}`	*Emphasized*
`\textnormal{`*text*`}`	`{\normalfont `*text*`}`	Normal Font
`\underline{`*text*`}`		<u>Underline</u>

Text Mode – Font Size

Normal text font size can be changed using the following commands. Using the declaration without braces will effect the entire document from that point forward.

Table 8: Text mode font sizes.

Declaration	Sample
{\tiny *text*}	tiny
{\scriptsize *text*}	scriptsize
{\footnotesize *text*}	footnotesize
{\small *text*}	small
{\normalsize *text*}	normalsize
{\large *text*}	large
{\Large *text*}	Large
{\LARGE *text*}	LARGE
{\huge *text*}	huge
{\Huge *text*}	Huge

Text Mode – Accents and Special Symbols

#	\#	$	\$	%	\%	&	\&
_	_{}	^	\^{}	~	\~{}		
{	\{	}	\}	@	@	✓	\checkmark
ó	\'{o}	ö	\"{o}	ò	\`{o}	õ	\~{o}
ô	\^{o}	ō	\={o}	ȯ	\.{o}	ŏ	\u{o}
ő	\'{o}	o͡o	\t{oo}	ǫ	\c{o}	ọ	\d{o}
o̲	\b{o}	Å	\AA	ø	\o	Ø	\O
¶	\P	§	\S	£	\pounds	€	\euro
†	\dag	‡	\ddag	©	\copyright	®	\circledR

Text Mode – Miscellaneous Commands

There are a few other text commands which may be useful.

\today	Gives today's date
~	Non-breaking space, does not allow line break (A.˜Einstein)
\textcircled{a}	Produces circled text ⓐ (up to one character length)
\hspace{*length*}	Horizontal space of *length* (ex. 0.5in, 12pt, 1.5cm,...)
\vspace{*length*}	Vertical space of *length* (ex. 0.5in, 12pt, 1.5cm,...)
\rule{*width*}{*length*}	Horizontal line of *width* and *length*

Math Mode

Math mode describes any formulas or symbols used inline between `$` or within a math environment (equation or align). This guide contains most of the commonly used text and math mode symbols–**amsfonts**, **amssymb** or **eurosym** may be required to use these symbols. There are many specialized symbol and font sets available not listed here. CTAN maintains a comprehensive symbol list at `http://www.ctan.org/tex-archive/info/symbols/comprehensive/symbols-a4.pdf`.

Math Mode – Font Face

Special math symbols and variables can be defined using different math mode fonts. Similar to text font faces, math mode fonts can be changed using the following declarations.

Table 9: Math mode font faces.

Declaration	Sample
`\mathbb{A}`	$\mathbb{ABCDEFG}$...
`\mathbf{A}`	$\mathbf{ABCDEFG}$...
`\mathcal{A}`	$\mathcal{ABCDEFG}$...
`\mathfrak{A}`	$\mathfrak{ABCDEFG}$...
`\mathit{A}`	$\mathit{ABCDEFG}$...
`\mathnormal{A}`	$ABCDEFG$...
`\mathrm{A}`	$\mathrm{ABCDEFG}$...
`\mathsf{A}`	$\mathsf{ABCDEFG}$...
`\mathtt{A}`	$\mathtt{ABCDEFG}$...
`\boldsymbol{\alpha}`	$\boldsymbol{\alpha}$

Math Mode – Font Size

LaTeX automatically selects the appropriate math font size. Normally you will not need to change the math font size manually, however math mode font size can be changed using the following declarations.

Table 10: Math mode font sizes.

Declaration	Sample
`\displaystyle \int f(x-a)dx`	$\displaystyle\int f(x-a)dx$
`\textstyle \int f(x-a)dx`	$\textstyle\int f(x-a)dx$
`\scriptstyle \int f(x-a)dx`	$\scriptstyle\int f(x-a)dx$
`\scriptscriptstyle \int f(x-a)dx`	$\scriptscriptstyle\int f(x-a)dx$

Math Mode – Math Constructs

$\frac{a}{b}$	`\frac{a}{b}`	$\overline{abc}$	`\overline{abc}`	$\overrightarrow{abc}$	`\overrightarrow{abc}`
f'	`f'`	$\underline{abc}$	`\underline{abc}`	$\overleftarrow{abc}$	`\overleftarrow{abc}`
$\sqrt{x}$	`\sqrt{x}`	$\widehat{abc}$	`\widehat{abc}`	$\overbrace{abc}$	`\overbrace{abc}`
$\sqrt[n]{x}$	`\sqrt[n]{x}`	$\widetilde{abc}$	`\widetilde{abc}`	$\underbrace{abc}$	`\underbrace{abc}`

To create superscripts and subscripts within math mode, use the ˆ and _ characters. For example, `$x^{2}_{0}$` creates x^2_0.

Math Mode – Variable-Sized Delimiters

Use the pair of variable-sized delimiters to match the height of math expressions using `\left + delimiter` and `\right + delimiter`.

For example `\left\{ \frac{a}{b} \right\}` yields $\left\{\frac{a}{b}\right\}$.

|	`|`	|	`\vert`	‖	`|`	‖	`\Vert`
{	`\{`	}	`\}`	⟨	`\langle`	⟩	`\rangle`
⌊	`\lfloor`	⌋	`\rfloor`	⌈	`\lceil`	⌉	`\rceil`
⌞	`\llcorner`	⌟	`\lrcorner`	⌜	`\ulcorner`	⌝	`\urcorner`
[	`[`	]	`]`	(	`(`	)	`)`

Math Mode – Variable-Sized Operators

These operator symbols change size and positioning of subscript/superscript depending on their use (inline or displayed function).

$\int$	`\int`	$\oint$	`\oint`	$\iint$	`\iint`	$\iiint$	`\iiint`
$\iiiint$	`\iiiint`	$\int\cdots\int$	`\idotsint`	$\prod$	`\prod`	$\coprod$	`\coprod`
$\bigcap$	`\bigcap`	$\bigcup$	`\bigcup`	$\bigwedge$	`\bigwedge`	$\bigvee$	`\bigvee`
$\bigsqcup$	`\bigsqcup`	$\biguplus$	`\biguplus`	$\bigoplus$	`\bigoplus`	$\bigotimes$	`\bigotimes`
$\bigodot$	`\bigodot`	$\sum$	`\sum`				

For example `\sum^{\infty}_{n=0} a_{n} x^{n}`

Inline form:

$\sum_{n=0}^{\infty} a_n x^n$

Displayed form:

$$\sum_{n=0}^{\infty} a_n x^n$$

Math Mode – Greek and Hebrew Letters

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

Math Mode − Accents

á	`\acute{a}`	ā	`\bar{a}`	ă	`\breve{a}`	ǎ	`\check{a}`
ȧ	`\dot{a}`	ä	`\ddot{a}`	⃛a	`\dddot{a}`	⃜a	`\ddddot{a}`
à	`\grave{a}`	â	`\hat{a}`	â	`\widehat{a}`	å	`\mathring{a}`
ã	`\tilde{a}`	ã	`\widetilde{a}`	a⃗	`\vec{a}`		

Math Mode − Function Names

Math function names provide proper character spacing and should appear in Roman, not *italics*. Correct $\sin(x)$; Incorrect $sin(x)$.

sin	`\sin`	arcsin	`\arcsin`	sinh	`\sinh`
cos	`\cos`	arccos	`\arccos`	cosh	`\cosh`
tan	`\tan`	arctan	`\arctan`	tanh	`\tanh`
cot	`\cot`	coth	`\coth`	csc	`\csc`
sec	`\sec`	arg	`\arg`	exp	`\exp`
deg	`\deg`	dim	`\dim`	hom	`\hom`
ker	`\ker`	lg	`\lg`	ln	`\ln`
log	`\log`	det	`\det`	gcd	`\gcd`
inf	`\inf`	max	`\max`	min	`\min`
Pr	`\Pr`	lim sup	`\limsup`	$\varlimsup$	`\varlimsup`
$\varliminf$	`\varliminf`	$\varinjlim$	`\varinjlim`	$\varprojlim$	`\varprojlim`
lim inf	`\liminf`	inj lim	`\injlim`	proj lim	`\projlim`

Math Mode − Miscellaneous Symbols

ℏ	`\hbar`	ℏ	`\hslash`	ı	`\imath`	ȷ	`\jmath`
∇	`\nabla`	∞	`\infty`	∂	`\partial`	ð	`\eth`
ℑ	`\Im`	ℜ	`\Re`	ℓ	`\ell`	℘	`\wp`
∀	`\forall`	∃	`\exists`	∄	`\nexists`	∫	`\smallint`
∅	`\emptyset`	∅	`\varnothing`	′	`\prime`	‵	`\backprime`
𝕜	`\Bbbk`	∁	`\complement`	£	`\pounds`	⅁	`\Game`
♣	`\clubsuit`	♢	`\diamondsuit`	♡	`\heartsuit`	♠	`\spadesuit`
□	`\Box`	□	`\square`	◇	`\lozenge`	◆	`\blacklozenge`
△	`\trianlge`	▽	`\triangledown`	▲	`\blacktriangle`	▼	`\blacktriangledown`
♭	`\flat`	♮	`\natural`	♯	`\sharp`	¶	`\P`
∠	`\angle`	∡	`\measuredangle`	⊲	`\sphericalangle`	§	`\S`
⊤	`\top`	⊥	`\bot`	†	`\dag`	‡	`\ddag`
√	`\surd`	╱	`\diagup`	╲	`\diagdown`	¬	`\neg`
Ⓢ	`\circledS`	★	`\bigstar`	℧	`\mho`	◇	`\Diamond`
✓	`\checkmark`	⅂	`\Finv`	®	`\circledR`		
⋯	`\cdots`	⋮	`\vdots`	…	`\ldots`	⋱	`\ddots`
:	`\colon`	·	`\cdotp`	.	`\ldotp`		

Math Mode – Binary Relation Symbols

=	`=`	≠	`\neq`	∝	`\propto`	∝	`\varpropto`
∼	`\sim`	≁	`\nsim`	≅	`\cong`	≇	`\ncong`
∼	`\thicksim`	≃	`\sim`	∽	`\backsim`	≌	`\backsimeq`
≡	`\equiv`	≈	`\approx`	≈	`\thickapprox`	≊	`\approxeq`
≗	`\circeq`	≑	`\eqcirc`	≜	`\triangleq`		
≐	`\doteq`	≒	`\doteqdot`	≓	`\risingdotseq`	≒	`\fallingdotseq`
≏	`\bumpeq`	≎	`\Bumpeq`				

<	`<`	≮	`\nless`	>	`<`	≯	`\ngtr`
≦	`\leqq`	≨	`\nleqq`	≧	`\geqq`	≩	`\ngeqq`
⩽	`\leqslant`	⪇	`\nleqslant`	⩾	`\geqslant`	⪈	`\ngeqslant`
≨	`\lneq`	≨	`\lneqq`	≩	`\gneq`	≩	`\gneqq`
		≨	`\lvertneqq`			≩	`\gvertneqq`
⪕	`\eqslantless`	⋖	`\lessdot`	⪖	`\eqslantgtr`	⋗	`\gtrdot`
≲	`\lesssim`	⋦	`\lnsim`	≳	`\gtrsim`	⋧	`\gnsim`
⪅	`\lessapprox`	⪉	`\lnapprox`	⪆	`\gtrapprox`	⪊	`\gnapprox`
≪	`\ll`	⋘	`\lll`	≫	`\gg`	⋙	`\ggg`
≶	`\lessgtr`	≷	`\gtrless`				
⋚	`\lesseqgtr`	⋛	`\gtreqless`	⪋	`\lesseqqgtr`	⪌	`\gtreqqless`

≺	`\prec`	⊀	`\prec`	≻	`\succ`	⊁	`\nsucc`
⪯	`\preceq`	⋠	`\preceq`	⪰	`\succeq`	⋡	`\nsucceq`
≼	`\preccurlyeq`	⋞	`\curlyeqprec`	≽	`\succcurlyeq`	⋟	`\curlyeqsucc`
≾	`\precsim`	⋨	`\precnsim`	≿	`\succsim`	⋩	`\succnsim`
⪷	`\precapprox`	⪹	`\precnapprox`	⪸	`\succapprox`	⪺	`\succnapprox`

∈	`\in`	∉	`\notin`	∋	`\ni`	϶	`\backepsilon`
⊂	`\subset`	⋐	`\Subset`	⊃	`\supset`	⋑	`\Supset`
⊆	`\subseteq`	⊄	`\nsubseteq`	⊇	`\supseteq`	⊅	`\nsupseteq`
⊆	`\subseteqq`	⊈	`\nsubseteqq`	⊇	`\supseteqq`	⊉	`\nsupseteqq`
⊊	`\subsetneq`	⊊	`\varsubsetneq`	⊋	`\supsetneq`	⊋	`\varsupsetneq`
⊊	`\subsetneqq`	⊊	`\varsubsetneqq`	⊋	`\supsetneqq`	⊋	`\varsupsetneqq`
⊏	`\sqsubset`	⊑	`\sqsubseteq`	⊐	`\sqsupset`	⊒	`\sqsupseteq`
⊓	`\sqcap`	⊔	`\sqcup`				
◁	`\vartriangleleft`	⋪	`\ntriangleleft`	▷	`\vartriangleright`	⋫	`\ntriangleright`
⊴	`\trianglelefteq`	⋬	`\ntrianglelefteq`	⊵	`\trianglerighteq`	⋭	`\ntrianglerighteq`
◀	`\blacktriangleleft`	▶	`\blacktriangleright`	⋈	`\bowtie`	⋈	`\Join`

⊨	`\models`	⊣	`\dashv`	⊢	`\vdash`	⊬	`\nvdash`
⊨	`\vDash`	⊯	`\nvDash`	⊩	`\Vdash`	⊮	`\nVdash`
⊪	`\Vvdash`	⋔	`\pitchfork`	≍	`\asymp`		
⌣	`\smile`	⌣	`\smallsmile`	⌢	`\frown`	⌢	`\smallfrown`
∣	`\mid`	∤	`\nmid`	⊥	`\perp`	≬	`\between`
∥	`\parallel`	∥	`\shortparallel`	∦	`\nparallel`	∦	`\nshortparallel`
∴	`\therefore`	∵	`\because`				

Math Mode – Binary Operation Symbols

$+$	+	$-$	-	$\pm$	\pm	$\mp$	\mp
$\times$	\times	$\cdot$	\cdot	$\circ$	\circ	$\bigcirc$	\bigcirc
$\div$	\div	$\bmod$	\bmod	$\wedge$	\wedge	$\vee$	\vee
$\cap$	\cap	$\cup$	\cup	$\Cap$	\Cap	$\Cup$	\Cup
$\triangleleft$	\triangleleft	$\triangleright$	\triangleright	$\bigtriangleup$	\bigtriangleup	$\bigtriangledown$	\bigtriangledown
$\oplus$	\oplus	$\ominus$	\ominus	$\otimes$	\otimes	$\oslash$	\oslash
$\odot$	\odot	$\bullet$	\bullet	$\dagger$	\dagger	$\ddagger$	\ddagger
$\setminus$	\setminus	$\smallsetminus$	\smallsetminus	$\wr$	\wr	$\amalg$	\amalg
$\ast$	\ast	$\star$	\star	$\diamond$	\diamond	$\And$	\And
$\lhd$	\lhd	$\rhd$	\rhd	$\unlhd$	\unlhd	$\unrhd$	\unrhd
$\dotplus$	\dotplus	$\centerdot$	\centerdot	$\ltimes$	\ltimes	$\rtimes$	\rtimes
$\circleddash$	\circleddash	$\uplus$	\uplus	$\barwedge$	\barwedge	$\doublebarwedge$	\doublebarwedge
$\curlywedge$	\curlywedge	$\curlyvee$	\curlyvee	$\veebar$	\veebar	$\intercal$	\intercal
$\circledast$	\circledast	$\circledcirc$	\circledcirc	$\leftthreetimes$	\leftthreetimes	$\rightthreetimes$	\rightthreetimes
$\boxminus$	\boxminus	$\boxtimes$	\boxtimes	$\boxdot$	\boxdot	$\boxplus$	\boxplus
$\divideontimes$	\divideontimes	$\vartriangle$	\vartriangle	$\sqcap$	\sqcap	$\sqcup$	\sqcup

Math Mode – Arrows

$\leftarrow$	\leftarrow	$\rightarrow$	\rightarrow	$\Leftarrow$	\Leftarrow	$\Rightarrow$	\Rightarrow
$\nleftarrow$	\nleftarrow	$\nrightarrow$	\nrightarrow	$\nLeftarrow$	\nLeftarrow	$\nRightarrow$	\nRightarrow
$\longleftarrow$	\longleftarrow	$\longrightarrow$	\longrightarrow	$\Longleftarrow$	\Longleftarrow	$\Longrightarrow$	\Longrightarrow
$\leftrightarrow$	\leftrightarrow	$\longleftrightarrow$	\longleftrightarrow	$\Leftrightarrow$	\Leftrightarrow	$\Longleftrightarrow$	\Longleftrightarrow
$\uparrow$	\uparrow	$\downarrow$	\downarrow	$\Uparrow$	\Uparrow	$\Downarrow$	\Downarrow
$\updownarrow$	\updownarrow	$\nleftrightarrow$	\nleftrightarrow	$\Updownarrow$	\Updownarrow	$\nLeftrightarrow$	\nLeftrightarrow
$\nearrow$	\nearrow	$\searrow$	\searrow	$\swarrow$	\swtarrow	$\nwarrow$	\nwarrow
$\multimap$	\multimap	$\mapstochar$	\mapstochar	$\mapsto$	\mapsto	$\longmapsto$	\longmapsto
$\hookleftarrow$	\hookleftarrow	$\hookrightarrow$	\hookrightarrow	$\leadsto$	\leadsto	$\leftrightsquigarrow$	\leftrightsquigarrow
$\leftharpoonup$	\leftharpoonup	$\rightharpoonup$	\rightharpoonup	$\leftharpoondown$	\leftharpoondown	$\rightharpoondown$	\rightharpoondown
$\leftleftarrows$	\leftleftarrows	$\rightrightarrows$	\rightrightarrows	$\leftrightarrows$	\leftrightarrows	$\rightleftarrows$	\rightleftarrows
$\Lleftarrow$	\Lleftarrow	$\Rrightarrow$	\Rrightarrow	$\twoheadleftarrow$	\twoheadleftarrow	$\twoheadrightarrow$	\twoheadrightarrow
$\leftarrowtail$	\leftarrowtail	$\rightarrowtail$	\rightarrowtail	$\looparrowleft$	\looparrowleft	$\looparrowright$	\looparrowright
$\upuparrows$	\upuparrows	$\downdownarrows$	\downdownarrows	$\leftrightharpoons$	\leftrightharpoons	$\rightleftharpoons$	\rightleftharpoons
$\upharpoonleft$	\upharpoonleft	$\upharpoonright$	\upharpoonright	$\downharpoonleft$	\downharpoonleft	$\downharpoonright$	\downharpoonright
$\curvearrowleft$	\curvearrowleft	$\curvearrowright$	\curvearrowright	$\circlearrowleft$	\circlearrowleft	$\circlearrowright$	\circlearrowright
$\dashleftarrow$	\dashleftarrow	$\dashrightarrow$	\dashrightarrow	$\Lsh$	\Lsh	$\Rsh$	\Rsh