# Essential LaTeX++: LaTeX2$_\varepsilon$ and LaTeX 2.09

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*Annotations for LaTeX 2.09 Users by Brian Junker*
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## What is TeX? What is LaTeX?

What they are not:

- A word processor (e.g. MicroSoft Word)
- A text editor (e.g. `emacs`)
- A visual desktop publishing system (e.g. Aldous PageMaker)

What they are:

- A typesetting system consisting of
  - A macro programming language for typesetting, called TeX
  - A subroutine (macro) package, called LaTeX
  - A typesetting program, called TeX82, which converts your TeX code into a formatted document.
- Not WYSIWYG

You will also need:

- Any old text editor
- A TeX-compatible screen previewing program
- A TeX-compatible printing program

## How it works

On the UNIX workstation in my office

1. Create a source file with `emacs` or `vi`. Lots of running text, only a few TeX or LaTeX commands. Call the file `example.tex`.

2. Run TeX/LaTeX by typing `latex example`. Creates the files

   - `example.dvi`, a *device-independent*, formatted document.

   - `example.log`, a record of the `latex` run, including any errors or warnings.

3. Preview `example.dvi` on my screen by typing `xdvi example`.

4. Print `example.dvi` on paper by typing `dvips example`.



On a MS-DOS machine

- DOS: Just like UNIX, except that the names of the previewing and printing commands may be different.

  The most popular DOS implementation is a free (non-commercial) TeX system called *EMTeX*.

- WINDOWS: There is a commercial integrated package called *Scientific Word* that combines many of these operations.

On a Macintosh

- There are several integrated packages for the Mac. Two of the most popular are

  – A free (non-commercial) package called *OzTeX*.

  – A commercial package called *TeXtures*.

Consult your local guide or TeX Guru

# An Example

## The Source File

```
% SMALL.TEX -- Released 5 July 1985
% USE THIS FILE AS A MODEL FOR MAKING YOUR OWN LaTeX
% INPUT FILE. EVERYTHING TO THE RIGHT OF A  %  IS A
% REMARK TO  YOU AND IS IGNORED BY LaTeX.
%
% WARNING!  DO NOT TYPE ANY OF THE FOLLOWING 10 CHARACTERS
% EXCEPT AS DIRECTED:       &   $   #   %   _   {   }   ^   ~   \

\documentclass[11pt]{article}                                 % LaTeX 2.09: \documentstyle[11pt]{article}

\begin{document}   % YOUR INPUT FILE MUST CONTAIN A \documentclass OR \documentstyle
                   % LINE, AS WELL AS \begin{document} AND \end{document} LINES.
\section{Simple Text}                                         % THIS COMMAND MAKES A SECTION TITLE.

Words are separated by one or    more      spaces.  Paragraphs are
    separated by one or more blank lines.  The output is not affected
by adding extra spaces or extra blank lines to the input file.


Double quotes are typed like this: ``quoted text''.
Single quotes are typed like this: `single-quoted text'.

Long dashes are typed as three dash characters---like this.

Italic text is typed like this: \emph{this is italic text}.   % LaTeX 2.09: {\em this is italic text}.
Bold   text is typed like this: \textbf{this is  bold  text}. % LaTeX 2.09: {\bf this is bold text}.

\subsection{A Warning or Two}                                 % THIS MAKES A SUBSECTION TITLE.

If you get too much space after a mid-sentence period---abbreviations
like etc.\ are the common culprits)---then type a backslash followed by
a space after the period, as in this sentence.

Remember, don't type the 10 special characters (such as dollar sign and
backslash) except as directed!  The following seven are printed by
typing a backslash in front of them:  \$  \&  \#  \%  \_  \{  and  \}.
The manual tells how to make other symbols.

\end{document}                    % THE INPUT FILE ENDS LIKE THIS
```



## The Result

### 1 Simple Text

Words are separated by one or more spaces. Paragraphs are separated by one or more blank lines. The output is not affected by adding extra spaces or extra blank lines to the input file.

Double quotes are typed like this: “quoted text”. Single quotes are typed like this: ‘single-quoted text’.

Long dashes are typed as three dash characters—like this.

Italic text is typed like this: *this is italic text*. Bold text is typed like this: **this is bold text**.

#### 1.1 A Warning or Two

If you get too much space after a mid-sentence period—abbreviations like etc. are the common culprits)—then type a backslash followed by a space after the period, as in this sentence.

Remember, don't type the 10 special characters (such as dollar sign and backslash) except as directed! The following seven are printed by typing a backslash in front of them: $ & # % _ { and }. The manual tells how to make other symbols.

## Document Classes (Styles) and Options

Document Classes (LaTeX2ε) and Styles (LaTeX2.09)

- `article`
- `report`
- `book`
- `letter`

Style Options

- `11pt`
- `12pt`
- `twoside`
- `twocolumn`
- `titlepage`

Examples

| | |
|---|---|
| LaTeX2ε: | `\documentclass[12pt,titlepage]{article}` |
| LaTeX 2.09: | `\documentstyle[12pt,titlepage]{article}` |



## Environments

Quotations

US presidents have been known for their pithy remarks:

> The buck stops here.
>
> I am not a crook.

```
US presidents have been known for
their pithy remarks:
\begin{quote}
The buck stops here.

I am not a crook.
\end{quote}
```

Here is some advice to remember:

> Environments for making quotations can be used for other things as well.
>
> Many problems can be solved by novel applications of existing environments.

```
Here is some advice to remember:
\begin{quotation}
Environments for making quotations
can be used for other things as well.

Many problems can be solved by
novel applications of existing
environments.
\end{quotation}
```

Centering

one two three
four
five

```
\begin{center}
one
two
three \\
four \\
five
\end{center}
```

## Lists

- Itemized lists are handy.
- However, don't forget
  1. The 'item' command.
  2. The 'end' command.

```
\begin{itemize}
\item Itemized lists are handy.
\item However, don't forget
  \begin{enumerate}
  \item The 'item' command.
  \item The 'end' command.
  \end{enumerate}
\end{itemize}
```

Three animals that you should know about are:

**gnat** A small animal that causes no end of trouble.

**armadillo** A medium-sized animal.

```
Three animals that you should
know about are:
\begin{description}
  \item[gnat] A small animal that causes
    no end of trouble.
  \item[armadillo] A medium-sized animal.
\end{description}
```

## Verbatim Output

The section of program in question is:

```
for i := 1 to 27 do
   begin
   table[i] := fn(i);
   process(i)
   end;
```

```
The section of program in
question is:
\begin{verbatim}
for i := 1 to 27 do
   begin
   table[i] := fn(i);
   process(i)
   end;
\end{verbatim}
```



# Type Styles

## Styles

| LaTeX2ε *Command* | *or* | LaTeX 2.09 *Command* | *Effect on Text* |
|---|---|---|---|
| `\textrm{...}` | `{\rmfamily...}` | `{\rm...}` | Text is set in roman family |
| `\textsf{...}` | `{\sffamily...}` | `{\sf...}` | Text is set in sans serif family |
| `\texttt{...}` | `{\ttfamily...}` | `{\tt...}` | Text is set in `typewriter` family |
| `\textmd{...}` | `{\mdseries...}` | | Text is set in medium series |
| `\textbf{...}` | `{\bfseries...}` | `{\bf...}` | Text is set in **bold** series |
| `\textup{...}` | `{\upshape...}` | | Text is set in upright shape |
| `\textit{...}` | `{\itshape...}` | `{\it...}` | Text is set in *italic* shape |
| `\textsl{...}` | `{\slshape...}` | `{\sl...}` | Text is set in *slanted* shape |
| `\textsc{...}` | `{\scshape...}` | `{\sc...}` | Text is set in SMALL CAPS shape |
| `\emph{...}` | `{\em...}` | `{\em...}` | Text is set *emphasized* |
| `\textnormal{...}` | `{\normalfont...}` | | Text is set in the document font |
| `\mathrm{...}` | | `{\rm...}` | Math text is set in roman family |
| `\mathbf{...}` | | `{\bf...}` | Math text is set in **bold** series |
| `\mathcal{...}` | | `{\cal...}` | Math text is set in $\mathcal{CALLIGRAPHIC}$ family |

## Sizes

tiny scriptsize footnotesize small normalsize large Large LARGE huge Huge

```
\tiny tiny
\scriptsize scriptsize
\footnotesize footnotesize
\small small
\normalsize normalsize
\large large
\Large Large
\LARGE LARGE
\huge huge
\Huge Huge
```

## Sectioning Commands and Tables of Contents

You can mark sections, subsections, etc. with the commands

| | | |
|---|---|---|
| \chapter | \subsection | \paragraph |
| \section | \subsubsection | \subparagraph |

A Table of Contents and other frontmatter can be created with

- \tableofcontents
- \listoftables
- \listoffigures

<u>Warning</u>

Because of the way LaTeX collects information for these tables and other cross-referencing, it may be necessary to process the document through LaTeX *twice*, or even *three times*, to get a correct table of contents and cross-references.



## Producing Special Symbols

- Letter Accents

| | | | | | |
|---|---|---|---|---|---|
| ò | \`{o} | õ | \~{o} | ǒ | \v{o} |
| o̧ | \c{o} | ó | \'{o} | ō | \={o} |
| ő | \H{o} | ọ | \d{o} | ô | \^{o} |
| ȯ | \.{o} | o͡o | \t{oo} | o̲ | \b{o} |
| ö | \"{o} | ŏ | \u{o} | | |

- Special Symbols

| | | | | | |
|---|---|---|---|---|---|
| † | \dag | § | \S | © | \copyright |
| ‡ | \ddag | ¶ | \P | £ | \pounds |
| œ | \oe | Œ | \OE | æ | \AE |
| Æ | \AE | å | \aa | Å | \AA |
| ø | \o | Ø | \O | ł | \l |
| Ł | \E | ß | \ss | ¿ | ?` |
| ¡ | !` | . . . | \ldots | LaTeX | \LaTeX |

- Many, many, many mathematical symbols (see handout).

<u>The "space" after a command</u>

- '\LaTeX is wonderful' produces 'LaTeXis wonderful'
- '\LaTeX\ is wonderful' produces 'LaTeX is wonderful'
- '\LaTeX{} is wonderful' produces 'LaTeX is wonderful'

## The Title Page

```
\title{Essential \LaTeX}
\author{Jon Warbrick \and A N Other}
\date{14th February 1988}
\maketitle
```

Essential LaTeX

Jon Warbrick    A N Other

14th February 1988

- Use `\and` between authors to separate them on the same line.
- Use `\\` between authors to put them on different lines.
- If `\date` is omitted, today's date will be used.
- In the `report` and `book` styles, the title appears on a separate page.
- In the `article` style, it appears at the top of the first page.
- Use the `titlepage` option to force the title onto a separate page.



## Tabular Material

Tabbing

| Income | Expenditure | Result |
|---|---|---|
| 20s 0d | 19s 11d | Happiness |
| 20s 0d | 20s 1d | Misery |

```
\begin{tabbing}
Income \=Expenditure \=         \kill
Income \>Expenditure \>Result \\
20s 0d \>19s 11d \>Happiness  \\
20s 0d \>20s 1d  \>Misery
\end{tabbing}
```

Tabular

| *Name* | *Age* | *Height* |
|:---|---:|---:|
| Sebastian | 45 | 195cm |
| Mathew | 1 | 68cm |

```
\begin{tabular}{lrr}
\em Name & \em Age &\em Height \\
Sebastian & 45 & 195cm        \\
Mathew    & 1 & 68cm
\end{tabular}
```

The template after the `\begin{tabular}` tells how to set each column:

| | |
|---|---|
| `l` | means the column will be left justified |
| `r` | means the column will be right justified |
| `c` | means the column will be centred |

- Items within a row are separated by the & character
- Rows are ended, as before, with `\\`.

## {tabular} Bells and Whistles

- You can put `\hline` between rows to draw a line across the table.
- Type a `|` in the template where you want a vertical bar down every row of the table.
- `p{...}` sets the column width to "`...`" and wraps text within the column.

| *Group* | *Type* | Sherds |
|---|---|---|
| Groups 1–9 | Grey wares | 218 |
| Groups 40–44 | Black (mostly 'black burnished') wares | 116 |
| Groups 61–67 | Buff-red-orange wares | 46 |
| Groups 81–85 | Colour-coated fine wares | 67 |
| Groups 91–2, 93–4 | Mortaria and miscellaneous | 35 |
| Group 96 | Samian | 56 |
| | | 538 |

```
\begin{tabular}{|l|p{1in}|r|}  \hline
  \em Group &\em Type &Sherds  \\\hline
  Groups 1--9   &Grey wares&218\\
  Groups 40--44 &Black (mostly
  'black burnished')  wares&116\\
  Groups 61--67 &Buff-red-orange
  wares & 46                   \\
  Groups 81--85 &Colour-coated
  fine wares & 67              \\
  Groups 91--2, 93--4&Mortaria
  and miscellaneous & 35       \\
  Group 96 &Samian & 56        \\\hline
   &&538                       \\\hline
\end{tabular}
```



## Tables and Figures

### Floats

- LaTeX will normally leave a page less than full if it has to go to the next page to find room for a table or figure.
- Instead you can ask LaTeX to fill the page with text, and find a place ***near*** where you have asked, to place the table or figure.
- Such "floating" tables and figures are called ***floats***.
- As a side effect, you can generate a list of tables and figures with the `\listoftables` and `\listoffigures` commands.

### An Example

The following shows how you would set up space for a figure in which you wanted to leave 3 inches of space, for a photograph to be pasted in later, followed by a caption:

```
\begin{figure}
\vspace{3in}
\caption{A Photograph of my Subject}
\end{figure}
```

Note that the `figure` environment does *not* actually set up the figure for you. It just gives LaTeX permission to move the figure you set up (in this case just some blank vertical space where you will paste in photo) around in the document to fill the pages up.

## Cross-References and Citations

Labels and References

LaTeX can automatically generate a section, page, figure, table, or equation number in a cross-reference.

For example,

```
to refer to Section~\ref{sec:styles} of this report (on document
styles) and Figure~\ref{fig:result} (the output of processing...
```

would make a passage like

> to refer to Section 4 of this report (on document styles) and Figure 2 (the output of processing...

To mark something for use with `\ref`, place a `\label` command next to or immediately after it:

```
\section{Document Classes and Options}
\label{sec:styles}
```

```
\caption{The Result of Processing the Sample File}
\label{fig:result}
```



Bibliography

LaTeX can also help automate citations and bibliography-making.

```
The book by Lamport \cite{Lamport-LaTeX} is the principal
reference work on \LaTeX.
```

You can generate a list of references by including the commands

```
\bibliographystyle{plain}
\bibliography{mybib1,mybib2}
```

Bibliography styles include

- `plain`
- `unsrt`
- `alpha`
- `abbrev`

> `statlib@stat.cmu.edu` *will soon publish bibliography styles matching many major statistical journals.*

The argument of the `\bibliography` command is a comma-separated list of filenames, which should end in `.bib` (i.e., `mybib1.bib` and `mybib2.bib` in the example above). These files contain the expanded references referred to by the `\cite` commands.

## Mathematical Typesetting

Math mode and Display-Math mode

There are two special *modes* for mathematics, known as *math mode* and *display math mode*.

- Math mode commands are surrounded by `\(...\)` or by `$...$`.

Some mathematics set inline $2\times 3 = 6$. Note that spaces in the input file are ignored in math mode.

```
Some mathematics set inline
\( 2\times 3 =   6 \).
Note that spaces in the input file
are ignored in math mode.
```

- Display math mode commands are surrounded by `\[...\]` or by `$$...$$`.

A larger equation to be displayed on a line by itself.

$$f(x) = \sum_{i=0}^{\infty} \frac{f^{(i)}(x)}{i!}$$

```
A larger equation to be displayed
on a line by itself.
\[ f(x) = \sum_{i=0}^{\infty}
\frac{f^{(i)}(x)}{i!} \]
```



- There is a variant of display math mode, the `equation` environment, which automatically generates an equation number.

$$\left(\begin{array}{cc}1 & 2 \\ 0 & 1\end{array}\right)\left(\begin{array}{cc}2 & 0\\ 1 & 3\end{array}\right)=\left(\begin{array}{cc}4 & 6 \\ 1 & 3\end{array}\right) \quad (1)$$

```
\begin{equation}
\left(\begin{array}{cc}
1 & 2 \\0 & 1
\end{array}\right)
\left(\begin{array}{cc}
2 & 0\\1 & 3
\end{array}\right)
=
\left(\begin{array}{cc}
4 & 6 \\1 & 3
\end{array}\right)
\end{equation}
```

A few things to note

1. Make subscripts and superscripts with `_` and `^`:

   e.g., `x_{1} = p^{2}` for $x_1 = p^2$.

2. Make fractions with `\frac`:

   e.g., `\(\frac{a + b}{c}\)` gives $\frac{a+b}{c}$.

3. Most math symbols are LaTeX commands (see handout):

   e.g., `\infty \Rightarrow \sqrt{64} \bigotimes`
   generate: $\infty$ $\Rightarrow$ $\sqrt{64}$ $\bigotimes$ .

4. Make arrays with the `array` environment (similar to `tabular`). Brackets can be added (or not) as needed.

5. The commands `\left` and `\right` produce delimiters that grow as large as needed.

   e.g., `\left(`, `\left\{`, `\right]`, `\left|`.

Spacing

In math modes, all spaces are ignored. To help adjust spacing in math mode, use these commands:

| | |
|---|---|
| `\,` thin space | `\:` medium space |
| `\!` negative thin space | `\;` thick space |

A good example of where LaTeX needs some help with spacing is

$\int\!\!\int z\, dx\, dy$ .. $\int\int z dx dy$

```
\(\int\!\!\int z\, dx dy
.. \int\int z dx dy\)
```

Changing Fonts in Math Mode

- The default math mode font is *math italic*, different from ordinary *text italic*.
- LaTeX2$_\varepsilon$: `\mathbf` produces **bold face roman** letters. For bold face math italic letters, and bold face Greek letters and mathematical symbols, use the `\boldmath` command *before* going into math mode.

$x = 2\pi \Rightarrow x \simeq 6.28$ $\mathbf{x} = 2\pi \Rightarrow x \simeq 6.28$ $\boldsymbol{x = 2\pi \Rightarrow x \simeq 6.28}$

```
\( x = 2\pi \Rightarrow x \simeq 6.28 \)
\(\mathbf{x} = 2\pi \Rightarrow x \simeq 6.28 \)
{\boldmath \(x = \mathbf{2}\pi \Rightarrow x
        \simeq{\mathbf{6.28}}              \)}
```

There is also a calligraphic font for upper case letters:

$\mathcal{F}$

```
\( \mathcal{F} \)
```

- LaTeX 2.09: Use `{\rm...}`, `{\bf...}` and `{\cal...}` in place of `\mathrm{...}`, `\mathbf{...}` and `\mathcal{...}`.



What about $'s?

If you have worked with Plain TeX or AMSTeX before, you are probably wondering why there has been no mention of $ and $$.

- Math mode commands are surrounded by `\(...\)` or by `$...$`.
- Display math mode commands are surrounded by `\[...\]` or by `$$...$$`.

$'s and $$'s have certain drawbacks, vs. `\(...\)` and `\[...\]`:

- It is difficult for your text editor to match `$`'s, since it is hard to tell which ones are starting math mode and which are ending it.
- TeX will also get confused if you forget a $, and the error message usually comes much later than where you've forgotten the $.

However,

- $ is sometimes useful for small sections of math.

Let $G$ be a $p$-group

```
Let $G$ be a $p$-group
```

- It is possible to use $$ in LaTeX too, but it is not completely equivalent to `\[ ... \]`.
- To be compatible with standard LaTeX style and option files, stick with `\[...\]`.

# Horrible Mathematical Examples to Study

$$\Phi(t)=\frac{1}{\sqrt{2\pi}}\int_\infty^t e^{-x^2/2}dx \tag{2}$$

```
\begin{equation}
  \Phi(t)=\frac{1}{\sqrt{2\pi}}
  \int_\infty^t e^{-x^2/2} dx
\end{equation}
```

$$\prod_{j\geq 0}\left(\sum_{k\geq 0}a_{jk}z^k\right)=\sum_{k\geq 0}z^n\left(\sum_{\substack{k_0,k_1,\ldots\geq 0\\ k_0+k_1+\ldots=n}}a_0k_0a_{1k_1}\ldots\right) \tag{3}$$

```
\begin{equation}
  \prod_{j\geq 0}
  \left(\sum_{k\geq 0}a_{jk} z^k\right)
  = \sum_{k\geq 0} z^n
  \left( \sum_{{k_0,k_1,\ldots\geq 0}
          \atop{k_0+k_1+\ldots=n}    }
        a{_0k_0}a_{1k_1}\ldots  \right)
\end{equation}
```

$$\pi(n)=\sum_{m=2}^{n}\left\lfloor\left(\sum_{k=1}^{m-1}\lfloor(m/k)/\lceil m/k\rceil\rfloor\right)^{-1}\right\rfloor \tag{4}$$

```
\begin{equation}
\pi(n) = \sum_{m=2}^{n}
  \left\lfloor \left(\sum_{k=1}^{m-1}
       \lfloor(m/k)/\lceil m/k\rceil
       \rfloor \right)^{-1}
  \right\rfloor
\end{equation}
```

$$\{\underbrace{\overbrace{a,\ldots,a}^{k\ a's},\overbrace{b,\ldots,b}^{l\ b's}}_{k+l\ \mathrm{elements}}\} \tag{5}$$

```
\begin{equation}
\{\underbrace{%
    \overbrace{\mathstrut a,\ldots,a}^{k\ a's},
    \overbrace{\mathstrut b,\ldots,b}^{l\ b's}}
  _{k+l\ \mathrm{elements}}                    \}
\end{equation}
```

$$\mbox{W}^+\ \begin{array}{l}\nearrow\mu^+ + \nu_{\mu}\\ \rightarrow\pi^+ +\pi^0\\ \rightarrow\kappa^+ +\pi^0\\ \searrow\mathrm{e}^+ +\nu_{\mathrm{e}}\end{array}$$

```
\begin{displaymath}
\mbox{W}^+\
\begin{array}{l}
\nearrow\raise5pt\hbox{$\mu^+ + \nu_{\mu}$}\\
\rightarrow         \pi^+ +\pi^0         \\[5pt]
\rightarrow \kappa^+ +\pi^0              \\
\searrow\lower5pt\hbox{$\mathrm{e}^+
          +\nu_{\scriptstyle\mathrm{e}}$}
\end{array}
\end{displaymath}
```



$$F(x,y)=0\quad\mathrm{and}\quad\left|\begin{array}{ccc}F''_{xx} & F''_{xy} & F'_x\\ F''_{yx} & F''_{yy} & F'_y\\ F'_x & F'_y & 0\end{array}\right|=0$$

```
\begin{displaymath}
{F}(x,y)=0\quad\mathrm{and}\quad
 \left|\begin{array}{ccc}
  F_{xx}'' & F_{xy}'' & F_{x}' \\
  F_{yx}'' & F_{yy}'' & F_{y}' \\
  F_{x}'   & F_{y}'   & 0
       \end{array}      \right| =0
\end{displaymath}
```

$$\frac{\pm\left|\begin{array}{ccc}x_1-x_2 & y_1-y_2 & z_1-z_2\\ l_1 & m_1 & n_1\\ l_2 & m_2 & n_2\end{array}\right|}{\sqrt{\left|\begin{array}{cc}l_1&m_1\\ l_2&m_2\end{array}\right|^2+\left|\begin{array}{cc}m_1&n_1\\ n_1&l_1\end{array}\right|^2+\left|\begin{array}{cc}m_2&n_2\\ n_2&l_2\end{array}\right|^2}}$$

```
\begin{displaymath}
\frac{\pm
\left|\begin{array}{ccc}
x_1-x_2  & y_1-y_2 & z_1-z_2 \\
l_1      & m_1     & n_1     \\
l_2      & m_2     & n_2
\end{array}\right|}{
\sqrt{\left|\begin{array}{cc}l_1&m_1\\
l_2&m_2\end{array}\right|^2
+     \left|\begin{array}{cc}m_1&n_1\\
n_1&l_1\end{array}\right|^2
+     \left|\begin{array}{cc}m_2&n_2\\
n_2&l_2\end{array}\right|^2}}
\end{displaymath}
```

$$\begin{aligned}\sigma^f_0(Q,T_{3R},\beta,s) \quad = \quad & \frac{4\pi\alpha^2}{3s}\beta\times\left[\frac{Q^2\left\{\dfrac{3-\beta^2}{2}\right\}-2QC_{\rm V}{C'}_{\rm V}s(s-M^2_{\rm Z})}{(s-M^2_{\rm Z})^2+M^2_{\rm Z}\Gamma^2_{\rm Z}\left\{\dfrac{3-\beta^2}{2}\right\}}\right.\\ & + \left.\frac{(C_{\rm V}^2+C_{\rm A}^2)s^2}{(s-M^2_{\rm Z})^2+M^2_{\rm Z}\Gamma^2_{\rm Z}\left\{{C'}^2_{\rm V}\left\{\dfrac{3-\beta^2}{2}\right\}+{C'}^2_{\rm A}\{\beta^2\}\right\}}\right]\end{aligned} \tag{6}$$

```
\newcommand{\CA}{C_{\rm A}}     \newcommand{\CV}{C_{\rm V}}
\newcommand{\CPA}{{C'}_{\rm A}} \newcommand{\CPV}{{C'}_{\rm V}}
\newcommand{\GZ}{\Gamma^2_{\rm Z}}
\newcommand{\MZ}{M^2_{\rm Z}}   \newcommand{\MZs}{{(s-M^2_{\rm Z})}}
\newcommand{\BE}{\left\{\frac{\displaystyle 3-\beta^2}{\displaystyle 2}\right\}}
\begin{eqnarray}
\sigma^f_0(Q,T_{3R},\beta,s) & = &
      \frac{4\pi\alpha^2}{3s}\beta \times
        \left[ \frac{Q^2 \BE - 2Q \CV \CPV s \MZs}{\MZs^2 + \MZ \GZ \BE}
            \right.                                    \nonumber \\[-3mm]
                             &   &                               \\[-3mm]
                             & + &
      \left.\frac{(\CV^2 + \CA^2) s^2}%
                {\MZs^2+\MZ\GZ\left\{\CPV^2 \BE+\CPA^2 \{\beta^2\}\right\}}
        \right]                                        \nonumber
\end{eqnarray}
```

## Letters

### An Example

```
\documentstyle{letter}
\begin{document}

\address{1234 Avenue of the Armadillos \\
         Gnu York, G.Y. 56789}
\signature{R. (Ma) Dillo \\ Director of Cuisine}

\begin{letter}{G. Natheniel Picking \\
               Acme Exterminators \\
               Illinois}

\opening{Dear Nat,}

I'm afraid that the armadillo problem is still with us.
I did everything ...

... and I hope that you can get rid of the nasty
beasts this time.

\closing{Best Regards,}
\cc{Jimmy Carter\\Richard M. Nixon}
\end{letter}

\end{document}
```



### The Result

1234 Avenue of the Armadillos
Gnu York, G.Y. 56789

June 15, 1995

G. Natheniel Picking
Acme Exterminators
Illinois

Dear Nat,

I'm afraid that the armadillo problem is still with us. I did everything ...

... and I hope that you can get rid of the nasty beasts this time.

Best Regards,

R. (Ma) Dillo
Director of Cuisine

cc: Jimmy Carter
Richard M. Nixon

## Errors

Your LaTeX file is basically a *computer program* and LaTeX is basically the *compiler*. The error messages can be

- Cryptic!
- Frightening!
- *But Decipherable!*

Suppose you mistyped `\begin{itemize}` as `\begin{itemie}`. LaTeX will say:

```
LaTeX error.  See LaTeX manual for explanation.
              Type  H <return>  for immediate help.
! Environment itemie undefined.
\@latexerr ...for immediate help.}\errmessage {#1}
                                                  \endgroup
l.140 \begin{itemie}

?
```

- The first two lines just tell you that LaTeX found an error.
- The line that starts '!' tells you the error, in LaTeX-speak.
- The next two lines tell you what LaTeX was doing internally when it found the error. *Usually cryptic and ignorable.*
- The line that starts `l.140` says what line of your file LaTeX was processing when it found the error. *Usually helpful.*
- If the error was in the middle of the line, it will be shown broken at the point where LaTeX realized that there was an error.



<u>What to type at the '?' prompt</u>

- If you just hit the return key LaTeX will ignore the error and continue processing your file. (All errors are collected in a *log file* for you.)
- At some point you may have to type `X` to abort LaTeX.
- After LaTeX is done, fix the offending lines in your file, try again!

<u>Some common mistakes</u>

- A mis-spelled command or environment name.
- Improperly matched '`{`' and '`}`'.
- Trying to print one of the ten special characters `# $ % & _ { } ~ ^` and `\` as normal characters.
- A missing `\end` command.
- A missing command argument (the part inside '`{`' and '`}`' after a command).

<u>Some further pointers</u>

- LaTeX sometimes stops past the point where the real error was.
- A single error can generate a whole stream of spurious LaTeX errors. Try correcting the first error—the rest may vanish.
- Sometimes LaTeX may write a `*` and stop without an error message. If this happens type `\stop` and press the return key.
- Finally, LaTeX will sometimes print *warning* messages. You can often ignore them; see your handout for some examples.

## Defining New Commands

We will denote the set of Real numbers by $\mathbb{R}$, the Natural numbers by $\mathbb{N}$, and the Rational numbers by $\mathcal{Q}$. Similarly, Euclidean $n$-space will be denoted $\mathbb{R}^n$.

```
\newcommand{\Reals}{{\rm I\kern-.1667em{}R}}
\newcommand{\Nats}{{\rm I\kern-.1667em{}N}}
\newcommand{\Rats}{{\cal Q}}

We will denote the set of Real numbers by
$\Reals$, the Natural numbers by $\Nats$,
and the Rational numbers by $\Rats$.
Similarly, Euclidean $n$-space
will be denoted $\Reals^n$.
```

If you <u>really</u> want to save time you can make a macro that accepts arguments. And a macro can accept more than one argument.

```
\newcommand{\ul}[1]{\underline{#1}}
\newcommand{\combos}[2]
{\left(\begin{array}{@{}c@{}}
#1 \\ #2 \end{array}\right)}

If you \ul{really} want to save time you
can make a macro that accepts arguments.
And a macro can accept more than one argument.
```

For example, <u>everyone</u> knows that

$$\binom{n-1}{k-1} + \binom{n-1}{k} = \binom{n}{k}.$$

```
\vspace{1.2em}

For example, \ul{everyone} knows that
\begin{displaymath}
    \combos{n-1}{k-1} + \combos{n-1}{k}
    = \combos{n}{k} .
\end{displaymath}
```

- `\renewcommand` is used to redefine a command that has already been defined (by you or by LaTeX).
- `\def` is used to define commands in many TeX and some LaTeX documents. Use `\newcommand` and `\renewcommand` unless you have a really good reason for switching to `\def`.



## Defining New Environments

> *The only difference between LaTeX's quote and my declaration is that I have defined a declaration to automatically emphasize the text.*

```
\newenvironment{declaration}
{\begin{quote}\em}{\end{quote}}

\begin{declaration}
The only difference between \LaTeX's quote
and my declaration is that I have defined
a declaration to automatically emphasize
the text.
\end{declaration}
```

CONVENTIONAL BOOKS

Lamport. L. (1985). LaTeX— *A Document Preparation System—User's Guide and Reference Manual.* Addison-Wesley, Reading, MA, USA.

Goossens, M., Mittelbach, F., and Samarin, A. (1993). *The LaTeX Companion.* Addison-Wesley, Reading, MA, USA.

---

```
\newenvironment{references}[1]
{\begin{center}\sc #1\end{center}
 \begin{description}\labelsep=0pt}%
{\end{description}\hrule}

\begin{references}{Conventional Books}
   \item Lamport. L. (1985). {\em
     \LaTeX---A Document Preparation
     System---User's  Guide and Reference
     Manual}.  Addison-Wesley, Reading,
     MA, USA.
   \item Goossens, M., Mittelbach, F.,
     and Samarin, A. (1993).  {\em The
     \LaTeX\ Companion.} Addison-Wesley,
     Reading, MA, USA.
\end{references}
```

- `\renewenvironment` is used to redefine an environment already defined by you (or LaTeX).

## Defining New Theorems (!)

- `\newtheorem` is a special shorthand which is helpful for defining environments for theorems, definitions, corollaries, etc.

- Theorem-like objects defined in this way will be automatically numbered and can be referred to with `\label` and `\ref`.

**Theorem 1** *Be careful, or you will get what you ask for.*

**Corollary 1** *Never volunteer to teach a LaTeX course unless you intend to do it.*

**Proof.** As everyone knows, this follows directly from Theorem 1. □

```
\newtheorem{theorem}{Theorem}
\newtheorem{cor}{Corollary}

\newenvironment{proof}
{\par\noindent{\bf Proof. }}{$\Box$\par}

\begin{theorem}\label{careful}
Be careful, or you will get what you ask for.
\end{theorem}

\begin{cor}
Never volunteer to teach a \LaTeX\ course
unless you intend to do it.
\end{cor}

\begin{proof}
As everyone knows, this follows
directly from Theorem~\ref{careful}.
\end{proof}
```



## Style Files

**Theorem 1** *For every pair of integers $n$ and $k$ such that* $0 \leq k-1 \leq n-1$,

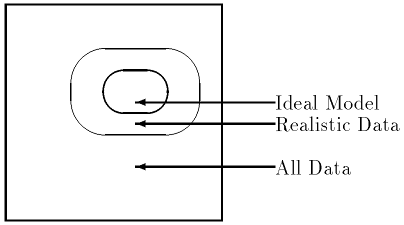
$$\binom{n-1}{k-1} + \binom{n-1}{k} = \binom{n}{k}.$$

**Proof.** This can be proved by <u>induction</u>. □

```
> type bj.sty

%%%%%%%%%%%%%% beginning of bj.sty

\newcommand{\ul}[1]{\underline{#1}}
\newcommand{\combos}[2]%
{\left(\begin{array}{@{}c@{}}
#1 \\ #2 \end{array}\right)}

\newtheorem{theorem}{Theorem}

\newenvironment{proof}%
{\par\noindent{\bf Proof. }}{$\Box$\par}

> type my-example.tex

%%%%%%%%%%%%%% beginning of my-example.tex

\documentstyle[12pt,bj]{article}
\begin{document}

\begin{theorem}
For every pair of integers $n$ and $k$
such that $0\leq k-1 \leq n-1$,
\begin{displaymath}
   \combos{n-1}{k-1} + \combos{n-1}{k}
   = \combos{n}{k} .
\end{displaymath}
\end{theorem}

\begin{proof}
This can be proved by \ul{induction}.
\end{proof}

\end{document}

> latex my-example
```

## Creating and Importing Figures

The Picture Environment




```
\setlength{\unitlength}{1.25pt}
\begin{picture}(100,100)(0,0)
\thicklines
\put(0,0){\framebox(100,100){}}
%
\thinlines
\put(60,60){\oval(60,40)}
%
\thicklines
\put(60,60){\oval(30,20)}
%
\put(125,55){\vector(-1,0){65}}
\put(125,55){\makebox(0,0)[l]{Ideal Model}}
%
\put(125,45){\vector(-1,0){65}}
\put(125,45){\makebox(0,0)[l]{Realistic Data}}
%
\put(125,25){\vector(-1,0){65}}
\put(125,25){\makebox(0,0)[l]{All Data}}
\end{picture}
```

Including PostScript Images

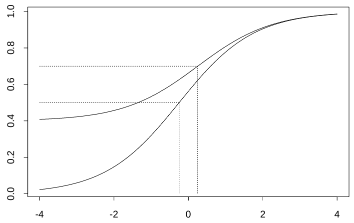
To include an external image in a LaTeX document:

- Tell TeX or LaTeX where to place the figure and how much space to reserve for it.
- "Include" the figure using a TeX command that the program you use to process your `.dvi` file for printing or screen viewing will understand.

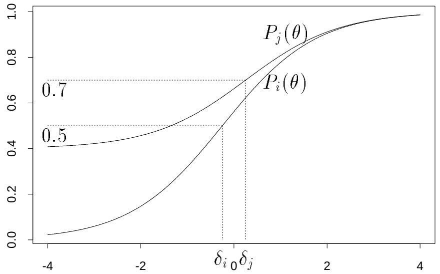
Details change from computer to computer and your mileage may vary. Consult your *local guide*, or ask your favorite LaTeX guru.



*These work with* `dvips` *on my workstation*




```
\vspace*{3.0in}
\hspace*{-0.5in}
\special{psfile=fig2.ps hscale=40 vscale=40}
\vspace*{-1.25in}
```




Two IRF's for which $P_i(\theta) \leq P_j(\theta)$ but $\delta_i < \delta_j$ using the definition of $\delta$ in logistic IRT models.

```
\begin{center}
\setlength{\unitlength}{0.66in}
\begin{picture}(4,3)(0.3,-0.2)
\put(-1.05,-2.8)%
 {\special{psfile=fig2.ps hscale=50 vscale=50}}
\put(2.1,-0.25){\mbox{$\delta_i$}}
\put(0,1.25){\mbox{0.5}}
\put(2.4,-0.25){\mbox{$\delta_j$}}
\put(0,1.80){\mbox{0.7}}
\put(2.7,1.9){\mbox{$P_i(\theta)$}}
\put(2.7,2.5){\mbox{$P_j(\theta)$}}
\end{picture}\\[0.5em]
Two IRF's for which $P_i(\theta)$ $\leq$
$P_j(\theta)$ but $\delta_i$ $<$ $\delta_j$
using the definition of $\delta$ in
logistic IRT models.
\end{center}
```

*Some people like* `psfig`

- `\documentclass[12pt,psfig]{article}`
- `\psfig{figure=filename}`
- Your *local guide* or TeX guru will have more info on `psfig`.

## Whitespace and Hyphenation

Lengths

| *Name* | *Unit* | *Meaning* |
|---|---|---|
| Millimeter | `1mm` | 0.001 meter |
| Centimeter | `1cm` | 10 mm |
| Inch | `1in` | 2.54 cm |
| Point | `1pt` | 1/72.27 inch. |
| Em | `1em` | About the width of a capital “M”. |
| Ex | `1ex` | Approx. `0.5em`, about the height of a lower-case “x”. |
| Fill | `\fill` | Shrinks to `0pt` and expands to full page width or height, as needed. |

Page Margins

```
\documentstyle[12pt,titlepage]{article}
\setlength{\topmargin}{0in}
\setlength{\oddsidemargin}{0in}
\setlength{\evensidemargin}{0in}
\setlength{\textheight}{8in}
\setlength{\textwidth}{6.5in}
```

TeX measures the `\topmargin` and `\sidemargin` from a point one inch down and one inch to the right of the upper left corner of the page.



Vertical Space

- `\vspace{0.25in}` requests `0.25in` of vertical space but allows LaTeX to ignore at top and bottom of page.
- `\vspace*{0.25in}` is a non-ignorable request.
- `\vspace{-1in}` goes backwards up the page.
- To center something vertically on the page:

```
\vspace*{\fill}
This will be centered on the page
\vspace*{\fill}
```

Horizontal Space

- `\hspace{0.25in}` requests `0.25in` of horizontal space but allows LaTeX to ignore at beginning and end of line.
- `\hspace*{0.25in}` is a non-ignorable request.
- `\hspace{-1in}` goes backwards in the line.
- To center something horizontally on a line:

```
\hspace*{\fill}
This will be centered on the line
\hspace*{\fill}
```

Space Between Lines

For space-and-a-half:

```
\renewcommand{\baselinestretch}{1.5}\tiny\normalsize
```

For double-spacing, use 2 instead of 1.5, etc.

Hyphenation

*Too Little Hyphenation*

LaTeX has been taught that is bad form to hyphenate hyphenated words. You can force LaTeX to consider hyphenation with "`\-`".

Every example like "x-radiation" frustrates LaTeX's hyphenation rules. This can be fixed by inserting possible hyphenation points, e.g. "x-radiation".

```
Every example like ``x-radiation''
frustrates \LaTeX's hyphenation rules.
This can be fixed by inserting possible
hyphenation points, e.g. ``x-ra\-di\-a\-tion''.
```

*Too Much Hyphenation*

There are times when you ***don't*** want LaTeX to hyphenate a word.

If you don't want "major-domo," hyphenated, it's worth trying `mbox`: "major-domo."

```
If you don't want ``major-domo,'' hyphenated,
it's worth trying {\tt mbox}:
``\mbox{major-domo}.''
```



## References

Conventional Books

Leslie Lamport. LaTeX—*A Document Preparation System—User's Guide and Reference Manual.* Addison-Wesley, Reading, MA, USA, 1985.

Donald E. Knuth. *The TeXbook*, volume A of *Computers and Typesetting.* Addison-Wesley, Reading, MA, USA, 1986.

Michel Goossens, Frank Mittelbach and Alexander Samarin. *The LaTeX Companion* Addison-Wesley, Reading, MA, USA, 1993.

Electronic Resources

- The Comprehensive TeX Archive Network at Sam Houston State University:
`ftp://ftp.SHSU.edu/tex-archive/`
- UCLA Department of Statistics TeX and LaTeX documentation:
`http://www.stat.ucla.edu/develop/tex/`
- `Statlib` at Carnegie Mellon University, Department of Statistics (will soon publish bibliography style files for many major statistical journals): `http://lib.stat.cmu.edu/` or
`http://lib.stat.cmu.edu/.index.html`