This document is an unofficial reference manual for \LaTeX, a document preparation system, version of May 2014.

This manual was originally translated from \texttt{LATEX.HLP} v1.0a in the VMS Help Library. The pre-translation version was written by George D. Greenwade of Sam Houston State University. The \LaTeX 2.09 version was written by Stephen Gilmore. The \LaTeX2e version was adapted from this by Torsten Martinsen. Karl Berry made further updates and additions, and gratefully acknowledges using \textit{Hypertext Help with \LaTeX}, by Sheldon Green, and \textit{\LaTeX Command Summary} (for \LaTeX 2.09) by L. Botway and C. Biemesderfer (published by the \TeX Users Group as \textit{\TeXniques} number 10), as reference material (no text was directly copied).


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This document is an unofficial reference manual for \TeX, a document preparation system, version as of May 2014. It is intended to cover \TeX\,2e, which has been the standard version of \TeX for many years.
1 About this document

The \LaTeX{} document preparation system is implemented as a macro package for Donald E. Knuth’s \TeX{} typesetting program. \LaTeX{} was originally created by Leslie Lamport; it is now maintained by a group of volunteers (http://latex-project.org). The official documentation written by the \LaTeX{} project is available from their web site.

The present document is completely unofficial and has not been reviewed by the \LaTeX{} maintainers. Do not send bug reports or anything else about this document to them. Instead, please send all comments to latexrefman-discuss@gna.org.

The home page for this document is http://home.gna.org/latexrefman. That page has links to the current output in various formats, sources, mailing lists, and other infrastructure.

Of course, there are many, many other sources of information about \LaTeX{}. Here are a few:

http://www.ctan.org/pkg/latex-doc-ptr
Two pages of recommended references to \LaTeX{} documentation.

http://www.ctan.org/pkg/first-latex-doc
Writing your first document, with a bit of both text and math.

http://www.ctan.org/pkg/usrguide
The guide for document authors maintained as part of \LaTeX{}; there are several others.

http://tug.org/begin.html
Introduction to the \TeX{} system, including \LaTeX{}. 
2 Overview of \LaTeX

What is \LaTeX?

\LaTeX typesets a file of text using the \TeX program and the \LaTeX “macro package” for \TeX. That is, it processes an input file containing the text of a document with interspersed commands that describe how the text should be formatted. \LaTeX files are plain text that can be written in any reasonable editor. It produces at least three files as output:

1. The main output file, which is one of:
   - \texttt{.dvi} If invoked as \texttt{latex}, a “Device Independent” (\texttt{.dvi}) file is produced. This contains commands that can be translated into commands for virtually any output device. You can view such \texttt{.dvi} output of \LaTeX by using a program such as \texttt{xdvi} (display directly), \texttt{dvips} (convert to PostScript), or \texttt{dvipdfmx} (convert to PDF).
   - \texttt{.pdf} If invoked as \texttt{pdflatex}, a “Portable Document Format” (\texttt{.pdf}) file. Typically, this is a self-contained file, with all fonts and images embedded. This can be very useful, but it does make the output much larger than the \texttt{.dvi} produced from the same document. If invoked as \texttt{lualatex}, a \texttt{.pdf} file is created using the Lua\TeX engine (\texttt{http://luatex.org}).
     If invoked as \texttt{xelatex}, a \texttt{.pdf} file is created using the Xe\TeX engine (\texttt{http://tug.org/xetex}).

Many other less-common variants of \LaTeX (and \TeX) exist, which can produce HTML, XML, and other things.

2. The “transcript” or \texttt{.log} file that contains summary information and diagnostic messages for any errors discovered in the input file.

3. An “auxiliary” or \texttt{.aux} file. This is used by \LaTeX itself, for things such as cross-references.

An open-ended list of other files might be created. We won’t try to list them all. Xxx components?

In the \LaTeX input file, a command name starts with a \texttt{\}, followed by either (a) a string of letters or (b) a single non-letter. Arguments contained in square brackets, [], are optional while arguments contained in braces, {}, are required.

\LaTeX is case sensitive. Enter all commands in lower case unless explicitly directed to do otherwise.
Chapter 3: Starting & ending

3 Starting & ending

A minimal input file looks like the following:

\documentclass{class}
\begin{document}
your text
\end{document}

where the class is a valid document class for \TeX. See Chapter 4 [Document classes], page 5, for details of the various document classes available locally.

You may include other \TeX commands between the \documentclass and the \begin{document} commands (this area is called the preamble).
4 Document classes

The class of a given document is defined with the command:

\documentclass[options]{class}

The \documentclass command must be the first command in a \LaTeX\ source file.

Built-in \LaTeX\ document class names are (many other document classes are available as add-ons; see Chapter 2 [Overview], page 3):

article  report  book  letter  slides

Standard options are described below.

4.1 Document class options

You can specify so-called global options or class options to the \documentclass command by enclosing them in square brackets as usual. To specify more than one option, separate them with a comma:

\documentclass[option1,option2,...]{class}

Here is the list of the standard class options.

All of the standard classes except slides accept the following options for selecting the typeface size (default is 10pt):

10pt  11pt  12pt

All of the standard classes accept these options for selecting the paper size (default is letterpaper):

a4paper  a5paper  b5paper  executivepaper  legalpaper  letterpaper

Miscellaneous other options:

draft, final
mark/do not mark overfull boxes with a big black box; default is final.
fleqn Put displayed formulas flush left; default is centered.
landscape Selects landscape format; default is portrait.
leqno Put equation numbers on the left side of equations; default is the right side.
openbib Use “open” bibliography format.
titlepage, notitlepage
Specifies whether the title page is separate; default depends on the class.

These options are not available with the slides class:

onecolumn
twocolumn
Typeset in one or two columns; default is onecolumn.
oneside twoside
Selects one- or two-sided layout; default is oneshide, except for the book class.
The \evensidemargin (\oddsidemargin parameter determines the distance on even (odd) numbered pages between the left side of the page and the
text’s left margin. The defaults vary with the paper size and whether one- or two-side layout is selected. For one-sided printing the text is centered, for two-sided, \texttt{oddsidemargin} is 40\% of the difference between \texttt{paperwidth} and \texttt{textwidth}, with \texttt{evensidemargin} the remainder.

\texttt{openright} \hfill \texttt{openany}

Determines if a chapter should start on a right-hand page; default is \texttt{openright} for book.

The \texttt{slides} class offers the option \texttt{clock} for printing the time at the bottom of each note.

Additional packages are loaded like this:

\texttt{\usepackage[options]{pkg}}

To specify more than one \texttt{pkg}, you can separate them with a comma, or use multiple \texttt{\usepackage} commands.

Any options given in the \texttt{documentclass} command that are unknown by the selected document class are passed on to the packages loaded with \texttt{\usepackage}. 
5 Fonts

Two important aspects of selecting a font are specifying a size and a style. The \LaTeX commands for doing this are described here.

5.1 Font styles

The following type style commands are supported by \LaTeX.

This first group of commands is typically used with an argument, as in \textit{italic text}. In the table below, the corresponding command in parenthesis is the “declaration form”, which takes no arguments. The scope of the declaration form lasts until the next type style command or the end of the current group.

These commands, in both the argument form and the declaration form, are cumulative; e.g., you can say either \sffamily\bfseries or \bfseries\sffamily to get bold sans serif.

You can alternatively use an environment form of the declarations; for instance, \begin{ttfamily}...\end{ttfamily}.

These commands automatically supply an italic correction if needed.

\textbf (\bfseries)
Boldface.

\textup (\upshape)
Upright (default). The opposite of slanted.

\texttt (\ttfamily)
Typewriter.

\textnormal (\normalfont)
Main document font.

\textrm (\rmfamily)
Roman.

\textit (\itshape)
Italics.

\emph
Emphasis (switches between \textit and \textrm).

\textmd (\mdseries)
Medium weight (default).

\textsf (\sffamily)
Sans serif.

\textsc (\scshape)
Small caps.

\texttt (\ttfamily)
Typewriter.

\textbf (\bfseries)
Boldface, for use in math mode.

\textrm (\rmfamily)
Roman, for use in math mode.
\textsf{Sans serif, for use in math mode.}
\texttt{Typewriter, for use in math mode.}
\textit{(\mit) Italics, for use in math mode.}
\textnormal{For use in math mode, e.g. inside another type style declaration.}
\textcal{‘Calligraphic’ letters, for use in math mode.}

In addition, the command \texttt{\textversion{bold}} can be used for switching to bold letters and symbols in formulas. \texttt{\textversion{normal}} restores the default.

Finally, the command \texttt{\textoldstyle{numerals}} will typeset so-called “old-style” numerals, which have differing heights and depths (and sometimes widths) from the standard “lining” numerals. \LaTeX{}’s default fonts support this, and will respect \texttt{\textbf{textbf}} (but not other styles; there are no italic old-style numerals in Computer Modern). Many other fonts have old-style numerals also; sometimes the \texttt{textcomp} package must be loaded, and sometimes package options are provided to make them the default. FAQ entry: \url{http://www.tex.ac.uk/cgi-bin/texfaq2html?label=osf}.

\LaTeX{} also provides the following commands, which unconditionally switch to the given style, that is, are \texttt{not} cumulative. Also, they are used differently than the above commands: \texttt{\textbf{cmd \ldots}} instead of \texttt{\textbf{cmd}{\ldots}}. These are two very different things.
\textbf{Switch to bold face.}
\textcal{Switch to calligraphic letters for math.}
\textemph{Emphasis (italics within roman, roman within italics).}
\textit{Italics.}
\textbf{Roman.}
\textsc{Small caps.}
\textsf{Sans serif.}
\textsl{Slanted (oblique).}
\texttt{Typewriter (monospace, fixed-width).}

Some people consider the unconditional font-switching commands, such as \texttt{tt}, obsolete and \texttt{only} the cumulative commands (\texttt{texttt}) should be used. I (Karl) do not agree. There are perfectly reasonable situations when an unconditional font switch is precisely what you need to get the desired output; for one example, see Section 9.4 [description], page 17. Both sets of commands have their place.

5.2 Font sizes

The following standard type size commands are supported by \LaTeX{}. The table shows the command name and the corresponding actual font size used (in points) with the ‘10pt’, ‘11pt’, and ‘12pt’ document size options, respectively (see Section 4.1 [Document class options], page 5).
<table>
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<th>10pt</th>
<th>11pt</th>
<th>12pt</th>
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</thead>
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<td>\tiny</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>\scriptsize</td>
<td>7</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>\footnotesize</td>
<td>8</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>\small</td>
<td>9</td>
<td>10</td>
<td>10.95</td>
</tr>
<tr>
<td>\normalsize (default)</td>
<td>10</td>
<td>10.95</td>
<td>12</td>
</tr>
<tr>
<td>\large</td>
<td>12</td>
<td>12</td>
<td>14.4</td>
</tr>
<tr>
<td>\Large</td>
<td>14.4</td>
<td>14.4</td>
<td>17.28</td>
</tr>
<tr>
<td>\LARGE</td>
<td>17.28</td>
<td>17.28</td>
<td>20.74</td>
</tr>
<tr>
<td>\huge</td>
<td>20.74</td>
<td>20.74</td>
<td>24.88</td>
</tr>
<tr>
<td>\Huge</td>
<td>24.88</td>
<td>24.88</td>
<td>24.88</td>
</tr>
</tbody>
</table>

The commands as listed here are “declaration forms”. The scope of the declaration form lasts until the next type style command or the end of the current group. You can also use the environment form of these commands; for instance, \begin{tiny}...\end{tiny}.

### 5.3 Low-level font commands

These commands are primarily intended for writers of macros and packages. The commands listed here are only a subset of the available ones.

\fontencoding{enc}

Select font encoding. Valid encodings include OT1 and T1.

\fontfamily{family}

Select font family. Valid families include:
- cmr for Computer Modern Roman
- cmss for Computer Modern Sans Serif
- cmtt for Computer Modern Typewriter

and numerous others.

\fontseries{series}

Select font series. Valid series include:
- m Medium (normal)
- b Bold
- c Condensed
- bc Bold condensed
- bx Bold extended

and various other combinations.

\fontshape{shape}

Select font shape. Valid shapes are:
- n Upright (normal)
- it Italic
- sl Slanted (oblique)
- sc Small caps
• ui Upright italics
• ol Outline

The two last shapes are not available for most font families.

\fontsize{size}{skip}
Set font size. The first parameter is the font size to switch to and the second is the line spacing to use; this is stored in a parameter named \baselineskip. The unit of both parameters defaults to pt. The default \baselineskip for the Computer Modern typeface is 1.2 times the \fontsize.
The line spacing is also multiplied by the value of the \baselinestretch parameter when the type size changes; the default is 1. However, the best way to “double space” a document, if you should be unlucky enough to have to produce such, is to use the setspace package; see http://www.tex.ac.uk/cgi-bin/texfaq2html?label=linespace.

\linespread{factor}
Equivalent to \renewcommand{\baselinestretch}{factor}, and therefore must be followed by \selectfont to have any effect. Best specified in the preamble, or use the setspace package, as described just above.
The changes made by calling the font commands described above do not come into effect until \selectfont is called.

\usefont{enc}{family}{series}{shape}
The same as invoking \fontencoding, \fontfamily, \fontseries and \fontshape with the given parameters, followed by \selectfont.
6 Layout

Miscellaneous commands for controlling the general layout of the page.

6.1 \onecolumn

The \onecolumn declaration starts a new page and produces single-column output. This is the default.

6.2 \twocolumn

Synopsis:

\twocolumn[\text1col]

The \twocolumn declaration starts a new page and produces two-column output. If the optional \text1col argument is present, it is typeset in one-column mode before the two-column typesetting starts.

These parameters control typesetting in two-column output:

\columnsep
The distance between columns (35pt by default).

\columnseprule
The width of the rule between columns; the default is 0pt, so there is no rule.

\columnwidth
The width of the current column; this is equal to \textwidth in single-column text.

These parameters control float behavior in two-column output:

\dbltopfraction
Maximum fraction at the top of a two-column page that may be occupied by floats. Default ‘.7’, can be usefully redefined to (say) ‘.9’ to avoid going to float pages so soon.

\dblfloatpagefraction
The minimum fraction of a float page that must be occupied by floats, for a two-column float page. Default ‘.5’.

\dblfloatsep

\dbltextfloatsep
Distance between a multi-column float at the top or bottom of a page and the main text. Default ‘20pt plus2pt minus4pt’.
6.3 \flushbottom

The \flushbottom declaration makes all text pages the same height, adding extra vertical space where necessary to fill out the page.

This is the default if twocolumn mode is selected (see Section 4.1 [Document class options], page 5).

6.4 \raggedbottom

The \raggedbottom declaration makes all pages the natural height of the material on that page. No rubber lengths will be stretched.

6.5 Page layout parameters

\headheight
Height of the box that contains the running head. Default is ‘30pt’, except in the book class, where it varies with the type size.

\headsep
Vertical distance between the bottom of the header line and the top of the main text. Default is ‘25pt’, except in the book class, where it varies with the type size.

\footskip
Distance from the baseline of the last line of text to the baseline of the page footer. Default is ‘30pt’, except in the book class, where it varies with the type size.

\linewidth
Width of the current line, decreased for each nested list (see Section 9.16 [list], page 24). Specifically, it is smaller than \textwidth by the sum of \leftmargin and \rightmargin (see Section 9.14 [itemize], page 22). The default varies with the font size, paper width, two-column mode, etc. For an article document in ‘10pt’, it’s set to ‘345pt’; in two-column mode, that becomes ‘229.5pt’.

\textheight
The normal vertical height of the page body; the default varies with the font size, document class, etc. For an article or report document in ‘10pt’, it’s set to ‘43\baselineskip’; for book, it’s ‘41\baselineskip’. For ‘11pt’, it’s ‘38\baselineskip’ and for ‘12pt’, ‘36\baselineskip’.

\textwidth
The full horizontal width of the entire page body; the default varies as usual. For an article or report document, it’s ‘345pt’ at ‘10pt’, ‘360pt’ at ‘11pt’, and ‘390pt’ at ‘12pt’. For a book document, it’s ‘4.5in’ at ‘10pt’, and ‘5in’ at ‘11pt’ or ‘12pt’.

In multi-column output, \textwidth remains the width of the entire page body, while \columnwidth is the width of one column (see Section 6.2 [twocolumn], page 11).

In lists (see Section 9.16 [list], page 24), \textwidth remains the width of the entire page body (and \columnwidth the width of the entire column), while \linewidth may decrease for nested lists.
Inside a minipage (see Section 9.18 \texttt{[minipage]}, page 25) or \texttt{parbox} (see Section 21.5 \texttt{[parbox]}, page 69), all the width-related parameters are set to the specified width, and revert to their normal values at the end of the \texttt{minipage} or \texttt{parbox}.

For completeness: \texttt{hsize} is the \TeX{} primitive parameter used when text is broken into lines. It should not be used in normal \LaTeX{} documents.

\texttt{\topmargin}  
Space between the top of the \TeX{} page (one inch from the top of the paper, by default) and the top of the header. The default is computed based on many other parameters: $\texttt{\paperheight} - \texttt{2in} - \texttt{\headheight} - \texttt{\headsep} - \texttt{\textheight} - \texttt{\footskip}$, and then divided by two.

\texttt{\topskip}  
Minimum distance between the top of the page body and the baseline of the first line of text. For the standard classes, the default is the same as the font size, e.g., ‘10\texttt{pt}’ at ‘10\texttt{pt}’.
7 Sectioning

Sectioning commands provide the means to structure your text into units:

\part
\chapter  (report and book class only)
\section
\subsection
\subsubsection
\paragraph
\subparagraph

All sectioning commands take the same general form, e.g.,

\chapter[toctitle]{title}

In addition to providing the heading \textit{title} in the main text, the section title can appear in two other places:

1. The table of contents.
2. The running head at the top of the page.

You may not want the same text in these places as in the main text. To handle this, the sectioning commands have an optional argument \textit{toctitle} that, when given, specifies the text for these other places.

Also, all sectioning commands have *-forms that print \textit{title} as usual, but do not include a number and do not make an entry in the table of contents. For instance:

\section*{Preamble}

The \texttt{\appendix} command changes the way following sectional units are numbered. The \texttt{\appendix} command itself generates no text and does not affect the numbering of parts. The normal use of this command is something like

\chapter{A Chapter}
...\appendix
\chapter{The First Appendix}

The \texttt{secnumdepth} counter controls printing of section numbers. The setting

\setcounter{secnumdepth}{level}

suppresses heading numbers at any depth $> \text{level}$, where \texttt{chapter} is level zero. (See Section 14.4 \texttt{\setcounter}, page 46.)
8 Cross references

One reason for numbering things like figures and equations is to refer the reader to them, as in “See Figure 3 for more details.”

8.1 \label

Synopsis:

\label{key}

A \label command appearing in ordinary text assigns to key the number of the current sectional unit; one appearing inside a numbered environment assigns that number to key.

A key name can consist of any sequence of letters, digits, or punctuation characters. Upper and lowercase letters are distinguished.

To avoid accidentally creating two labels with the same name, it is common to use labels consisting of a prefix and a suffix separated by a colon or period. Some conventionally-used prefixes:

- ch for chapters
- sec for lower-level sectioning commands
- fig for figures
- tab for tables
- eq for equations

Thus, a label for a figure would look like \texttt{fig:snark} or \texttt{fig.snark}.

8.2 \pageref{key}

Synopsis:

\pageref{key}

The \pageref{key} command produces the page number of the place in the text where the corresponding \label{key} command appears.

8.3 \ref{key}

Synopsis:

\ref{key}

The \ref command produces the number of the sectional unit, equation, footnote, figure, . . ., of the corresponding \label command (see Section 8.1 \label, page 15). It does not produce any text, such as the word ‘Section’ or ‘Figure’, just the bare number itself.
9 Environments

\LaTeX provides many environments for marking off certain text. Each environment begins and ends in the same manner:

\begin{envname}
...
\end{envname}

9.1 abstract

Synopsis:
\begin{abstract}
...
\end{abstract}

Environment for producing an abstract, possibly of multiple paragraphs.

9.2 array

Synopsis:
\begin{array}{} \text{template} \\
\text{col1 text}&\text{col1 text}&\text{coln}\\
\end{array}

Math arrays are produced with the \texttt{array} environment, normally within an equation environment (see Section 9.9 \texttt{equation}, page 19). It has a single mandatory \texttt{template} argument describing the number of columns and the alignment within them. Each column \texttt{col} is specified by a single letter that tells how items in that row should be formatted, as follows:

\begin{itemize}
  \item \texttt{c} centered
  \item \texttt{l} flush left
  \item \texttt{r} flush right
\end{itemize}

Column entries are separated by \texttt{&}. Column entries may include other \LaTeX commands. Each row of the array is terminated with \texttt{\textbackslash }.

In the template, the construct \texttt{@\{text\}} puts \texttt{text} between columns in each row.

Here's an example:

\begin{equation}
\begin{array}{} \text{template} \\
\text{col1 text}&\text{col1 text}&\text{coln}\\
\end{array}
\end{equation}

The \texttt{arraycolsep} parameter defines half the width of the space separating columns; the default is ‘\texttt{5pt}’. See Section 9.24 \texttt{[tabular]}, page 31, for other parameters which affect formatting in \texttt{array} environments, namely \texttt{arrayrulewidth} and \texttt{arraystretch}.

The \texttt{array} environment can only be used in math mode.
9.3 center

Synopsis:

\begin{center}
line1 \\
line2 \\
\end{center}

The center environment allows you to create a paragraph consisting of lines that are centered within the left and right margins on the current page. Each line is terminated with the string `\`.

9.3.1 \texttt{centering}

The \texttt{centering} declaration corresponds to the center environment. This declaration can be used inside an environment such as \texttt{quote} or in a \texttt{parbox}. Thus, the text of a figure or table can be centered on the page by putting a \texttt{centering} command at the beginning of the figure or table environment.

Unlike the \texttt{center} environment, the \texttt{centering} command does not start a new paragraph; it simply changes how \LaTeX formats paragraph units. To affect a paragraph unit’s format, the scope of the declaration must contain the blank line or \texttt{end} command (of an environment such as \texttt{quote}) that ends the paragraph unit.

Here’s an example:

\begin{quote}
\texttt{centering}
first line \\
second line \\
\end{quote}

9.4 description

Synopsis:

\begin{description}
\item [label1] item1
\item [label2] item2
... \\
\end{description}

The description environment is used to make labelled lists. Each label is typeset in bold, flush right. The item text may contain multiple paragraphs.

Another variation: since the bold style is applied to the labels, if you typeset a label in typewriter using \texttt{tt}, you’ll get bold typewriter: \texttt{item[\texttt{bold and typewriter}]}. This may be too bold, among other issues. To get just typewriter, use \texttt{tt}, which resets all other style variations: \texttt{item[\texttt{plain typewriter}]}.

For details about list spacing, see Section 9.14 [itemize], page 22.
9.5 \texttt{displaymath}

Synopsis:

\begin{displaymath}
  \text{math}
\end{displaymath}

or

\[
  \text{math}
\]

The \texttt{displaymath} environment (\[
\] is a synonym) typesets the \texttt{math} text on its own line, centered by default. The global \texttt{fleqn} option makes equations flush left; see Section 4.1 [Document class options], page 5.

No equation number is added to \texttt{displaymath} text; to get an equation number, use the \texttt{equation} environment (see Section 9.9 [equation], page 19).

9.6 \texttt{document}

The \texttt{document} environment encloses the body of a document. It is required in every \LaTeX\ document. See Chapter 3 [Starting & ending], page 4.

9.7 \texttt{enumerate}

Synopsis:

\begin{enumerate}
  \item item1
  \item item2
  ...
\end{enumerate}

The \texttt{enumerate} environment produces a numbered list. Enumerations can be nested within one another, up to four levels deep. They can also be nested within other paragraph-making environments, such as \texttt{itemize} (see Section 9.14 [itemize], page 22) and \texttt{description} (see Section 9.4 [description], page 17).

Each item of an enumerated list begins with an \texttt{item} command. There must be at least one \texttt{item} command within the environment.

By default, the numbering at each level is done like this:

1. 1., 2., ...
2. (a), (b), ...
3. i., ii., ...
4. A., B., ...

The \texttt{enumerate} environment uses the counters \texttt{enumi} through \texttt{enumiv} counters (see Chapter 14 [Counters], page 45). If the optional argument to \texttt{item} is given, the counter is not incremented for that item.

The \texttt{enumerate} environment uses the commands \texttt{labeledenumi} through \texttt{labeledenumiv} to produce the default label. So, you can use \texttt{renewcommand} to change the labels (see Section 13.1 [\texttt{newcommand} & \texttt{renewcommand}], page 42). For instance, to have the first level use uppercase letters:
9.8 eqnarray

First, a caveat: the eqnarray environment has some infelicities which cannot be overcome; the article “Avoid eqnarray!” by Lars Madsen describes them in detail (http://tug.org/TUGboat/tb33-1/tb103madsen.pdf). The bottom line is that it is better to use the align environment (and others) from the amsmath package.

Nevertheless, here is a description of eqnarray:

\begin{eqnarray} (or eqnarray*)
  formula1 \\%
  formula2 \\%
  ... \\
\end{eqnarray}

The eqnarray environment is used to display a sequence of equations or inequalities. It is very much like a three-column array environment, with consecutive rows separated by \ and consecutive items within a row separated by an &.

\* can also be used to separate equations, with its normal meaning of not allowing a page break at that line.

An equation number is placed on every line unless that line has a \nonumber command. Alternatively, The *-form of the environment (\begin{eqnarray*} ... \end{eqnarray*}) will omit equation numbering entirely, while otherwise being the same as eqnarray.

The command \lefteqn is used for splitting long formulas across lines. It typesets its argument in display style flush left in a box of zero width.

9.9 equation

Synopsis:

\begin{equation}
  math \\
\end{equation}

The equation environment starts a displaymath environment (see Section 9.5 [displaymath], page 18), e.g., centering the math text on the page, and also places an equation number in the right margin.

9.10 figure

\begin{figure\[*\]}
  \figbody \\
  \label{label} \\
  \caption[loftitle]{text} \\
\end{figure}

Figures are objects that are not part of the normal text, and are instead “floated” to a convenient place, such as the top of a page. Figures will not be split between two pages.

When typesetting in double-columns, the starred form produces a full-width figure (across both columns).
The optional argument \[placement\] determines where \LaTeX{} will try to place your figure. There are four places where \LaTeX{} can possibly put a float:

\begin{itemize}
  \item \texttt{t} (Top)—at the top of a text page.
  \item \texttt{b} (Bottom)—at the bottom of a text page. However, \texttt{b} is not allowed for full-width floats (\texttt{figure*}) with double-column output. To ameliorate this, use the \texttt{stfloats} or \texttt{dblfloatfix} package, but see the discussion at caveats in the FAQ: \url{http://www.tex.ac.uk/cgi-bin/texfaq2html?label=2colfloat}.
  \item \texttt{h} (Here)—at the position in the text where the figure environment appears. However, this is not allowed by itself; \texttt{t} is automatically added.
  \item \texttt{p} (Page of floats)—on a separate float page, which is a page containing no text, only floats.
\end{itemize}

\begin{itemize}
  \item \texttt{!} Used in addition to one of the above; for this float only, \LaTeX{} ignores the restrictions on both the number of floats that can appear and the relative amounts of float and non-float text on the page. The \texttt{!} specifier does \textit{not} mean “put the float here”; see above.
\end{itemize}

The standard report and article classes use the default placement \texttt{tbp}.

The body of the figure is made up of whatever text, \LaTeX{} commands, etc. you wish.

The \texttt{\caption} command specifies caption text for the figure. The caption is numbered by default. If \texttt{loftitle} is present, it is used in the list of figures instead of text (see Section 24.1 \[Tables of contents\], page 78).

Parameters relating to fractions of pages occupied by float and non-float text:

The maximum fraction of the page allowed to be occupied by floats at the bottom; default ‘.3’.

\texttt{\floatpagefraction}

The minimum fraction of a float page that must be occupied by floats; default ‘.5’.

\texttt{\textfraction}

Minimum fraction of a page that must be text; if floats take up too much space to preserve this much text, floats will be moved to a different page. The default is ‘.2’.

\texttt{\topfraction}

Maximum fraction at the top of a page that may be occupied before floats; default ‘.7’.

Parameters relating to vertical space around floats:

\texttt{\floatsep}

Space between floats at the top or bottom of a page; default ‘12pt plus2pt minus2pt’.
\textfloatsep

\textfloatsep
Space between the last (first) float at the top (bottom) of a page; default ‘20pt plus2pt minus4pt’.

Parameters relating to the number of floats on a page:

\bottomnumber
Maximum number of floats that can appear at the bottom of a text page; default 1.

\topnumber
Maximum number of floats that can appear at the top of a text page; default 2.

\totalnumber
Maximum number of floats that can appear on a text page; default 3.

The principal \TeX FAQ entry relating to floats: http://www.tex.ac.uk/cgi-bin/texfaq2html?label=floats.

9.11 filecontents: Create external files

Synopsis:
\begin{filecontents}{filename}
contents-of-file
\end{filecontents}

...\documentclass{my-document-class}

The filecontents environment is an initial command, meaning that it can be used only before the \documentclass command, as in the synopsis above.

\LaTeX will create a file named filename with the content contents-of-file preceded by a header comment indicating how and when the file was generated. If the file already exists then nothing will happen.

You can also use the filecontents package, which has the following advantages:

- If the file already exists, then it will be overwritten.
- You can use the filecontents environment at any point after the declaration \usepackage[filecontents], not just before \documentclass.
- The filecontents package also provides a filecontents* environment which is used in the same way as the filecontents environment except that it won’t insert any leading comment, so it is better suited to create files which aren’t in \LaTeX format.

The filecontents environment only creates the file, and is unrelated to using the created file. So you need to use, for instance, \input or \usepackage or \bibliography or whatever is applicable, to use the created file.

This environment is also useful to make a self-contained document, for example, for a bug report, or to keep a .bib file with the main document.
Chapter 9: Environments

9.12 flushleft

\begin{flushleft}
  line1 \\ \\
  line2 \\ \\
  ... \\
\end{flushleft}

The flushleft environment allows you to create a paragraph consisting of lines that are flush to the left-hand margin and ragged right. Each line must be terminated with the string \\.

9.12.1 \raggedright

The \raggedright declaration corresponds to the flushleft environment. This declaration can be used inside an environment such as quote or in a parbox.

Unlike the flushleft environment, the \raggedright command does not start a new paragraph; it only changes how \LaTeX{} formats paragraph units. To affect a paragraph unit’s format, the scope of the declaration must contain the blank line or \end command that ends the paragraph unit.

9.13 flushright

\begin{flushright}
  line1 \\ \\
  line2 \\ \\
  ... \\
\end{flushright}

The flushright environment allows you to create a paragraph consisting of lines that are flush to the right-hand margin and ragged left. Each line must be terminated with the string \\.

9.13.1 \raggedleft

The \raggedleft declaration corresponds to the flushright environment. This declaration can be used inside an environment such as quote or in a parbox.

Unlike the flushright environment, the \raggedleft command does not start a new paragraph; it only changes how \LaTeX{} formats paragraph units. To affect a paragraph unit’s format, the scope of the declaration must contain the blank line or \end command that ends the paragraph unit.

9.14 itemize

Synopsis:

\begin{itemize}
  \item item1
  \item item2
  ... \\
\end{itemize}
The `itemize` environment produces an “unordered”, “bulleted” list. Itemizations can be nested within one another, up to four levels deep. They can also be nested within other paragraph-making environments, such as `enumerate` (see Section 9.7 [enumerate], page 18).

Each item of an `itemize` list begins with an `\item` command. There must be at least one `\item` command within the environment.

By default, the marks at each level look like this:
1. • (bullet)
2. -- (bold en-dash)
3. * (asterisk)
4. · (centered dot)

The `itemize` environment uses the commands `\labelitemi` through `\labelitemiv` to produce the default label. So, you can use `\renewcommand` to change the labels. For instance, to have the first level use diamonds:

```
\renewcommand{\labelitemi}{$\diamond$}
```

The `\leftmargini` through `\leftmarginvi` parameters define the distance between the left margin of the enclosing environment and the left margin of the list. By convention, `\leftmargin` is set to the appropriate `\leftmarginiN` when a new level of nesting is entered.

The defaults vary from ‘.5em’ (highest levels of nesting) to ‘2.5em’ (first level), and are a bit reduced in two-column mode. This example greatly reduces the margin space for outermost lists:

```
\setlength{\leftmargini}{1.25em} % default 2.5em
```

Some parameters that affect list formatting:

- `\itemindent`: Extra indentation before each item in a list; default zero.
- `\labelsep`: Space between the label and text of an item; default ‘.5em’.
- `\labelwidth`: Width of the label; default ‘2em’, or ‘1.5em’ in two-column mode.
- `\listparindent`: Extra indentation added to second and subsequent paragraphs within a list item; default ‘0pt’.
- `\rightmargin`: Horizontal distance between the right margin of the list and the enclosing environment; default ‘0pt’, except in the `quote`, `quotation`, and `verse` environments, where it is set equal to `\leftmargin`.

Parameters affecting vertical spacing between list items (rather loose, by default):

- `\itemsep`: Vertical space between items. The default is `2pt plus1pt minus1pt` for 10pt documents, `3pt plus2pt minus1pt` for 11pt, and `4.5pt plus2pt minus1pt` for 12pt.
- `\parsep`: Extra vertical space between paragraphs within a list item. Defaults are the same as `\itemsep`. 
\topsep Vertical space between the first item and the preceding paragraph. For top-level lists, the default is \texttt{8pt plus2pt minus4pt} for 10pt documents, \texttt{9pt plus3pt minus5pt} for 11pt, and \texttt{10pt plus4pt minus6pt} for 12pt. These are reduced for nested lists.

\partopsep Extra space added to \topsep when the list environment starts a paragraph. The default is \texttt{2pt plus1pt minus1pt} for 10pt documents, \texttt{3pt plus1pt minus1pt} for 11pt, and \texttt{3pt plus2pt minus2pt} for 12pt.

Especially for lists with short items, it may be desirable to elide space between items. Here is an example defining an itemize* environment with no extra spacing between items, or between paragraphs within a single item (\texttt{\parskip} is not list-specific, see Section 16.3 [\parskip], page 48):

\begin{verbatim}
\newenvironment{itemize*}\
{\begin{itemize}\
\setlength{\itemsep}{0pt}\n\setlength{\parsep}{0pt}\
\end{itemize}}
\end{verbatim}

\section{letter environment: writing letters}

This environment is used for creating letters. See Chapter 25 [Letters], page 80.

\section{list}

The list environment is a generic environment which is used for defining many of the more specific environments. It is seldom used in documents, but often in macros.

\begin{verbatim}
\begin{list}{\labeling}{\spacing}
\item item1
\item item2
...
\end{list}
\end{verbatim}

The mandatory \texttt{labeling} argument specifies how items should be labelled (unless the optional argument is supplied to \texttt{\item}). This argument is a piece of text that is inserted in a box to form the label. It can and usually does contain other \LaTeX\ commands.

The mandatory \texttt{spacing} argument contains commands to change the spacing parameters for the list. This argument will most often be empty, i.e., \texttt{\{}\texttt{\}}, which leaves the default spacing.

The width used for typesetting the list items is specified by \texttt{\linewidth} (see Section 6.5 [Page layout parameters], page 12).

\section{math}

Synopsis:

\begin{verbatim}
\begin{math}
math
\end{math}
\end{verbatim}
The \textit{math} environment inserts the given \textit{math} within the running text. $\{(\ldots\})$ and \$,\ldots\,$ are synonyms. See Chapter 17 [Math formulas], page 50.

9.18 \texttt{minipage}

\begin{minipage}[position][height][inner-pos]{width}
text
\end{minipage}

The \texttt{minipage} environment typesets its body \textit{text} in a block that will not be broken across pages. This is similar to the \texttt{parbox} command (see Section 21.5 \texttt{parbox}, page 69), but unlike \texttt{parbox}, other paragraph-making environments can be used inside a minipage.

The arguments are the same as for \texttt{parbox} (see Section 21.5 \texttt{parbox}, page 69).

By default, paragraphs are not indented in the \texttt{minipage} environment. You can restore indentation with a command such as \texttt{\setlength{\parindent}{1pc}} command.

Footnotes in a \texttt{minipage} environment are handled in a way that is particularly useful for putting footnotes in figures or tables. A \texttt{\footnote} or \texttt{\footnotetext} command puts the footnote at the bottom of the minipage instead of at the bottom of the page, and it uses the \texttt{\mpfootnote} counter instead of the ordinary \texttt{footnote} counter (see Chapter 14 [Counters], page 45).

However, don't put one minipage inside another if you are using footnotes; they may wind up at the bottom of the wrong minipage.

9.19 \texttt{picture}

\begin{picture}(width,height)(x offset,y offset)
... picture commands ...
\end{picture}

The \texttt{picture} environment allows you to create just about any kind of picture you want containing text, lines, arrows and circles. You tell \LaTeX\ where to put things in the picture by specifying their coordinates. A coordinate is a number that may have a decimal point and a minus sign—a number like 5, 0.3 or -3.1416. A coordinate specifies a length in multiples of the unit length \texttt{\unitlength}, so if \texttt{\unitlength} has been set to 1cm, then the coordinate 2.54 specifies a length of 2.54 centimeters.

You should only change the value of \texttt{\unitlength}, using the \texttt{\setlength} command, outside of a \texttt{picture} environment. The default value is \texttt{1pt}.

A position is a pair of coordinates, such as (2.4,-5), specifying the point with x-coordinate 2.4 and y-coordinate -5. Coordinates are specified in the usual way with respect to an origin, which is normally at the lower-left corner of the picture. Note that when a position appears as an argument, it is not enclosed in braces; the parentheses serve to delimit the argument.

The \texttt{picture} environment has one mandatory argument, which is a \texttt{position}. It specifies the size of the picture. The environment produces a rectangular box with width and height determined by this argument’s x- and y-coordinates.

The \texttt{picture} environment also has an optional \texttt{position} argument, following the \texttt{size} argument, that can change the origin. (Unlike ordinary optional arguments, this argument
is not contained in square brackets.) The optional argument gives the coordinates of the point at the lower-left corner of the picture (thereby determining the origin). For example, if \texttt{unitlength} has been set to 1mm, the command
\begin{picture}(100,200)(10,20)
produces a picture of width 100 millimeters and height 200 millimeters, whose lower-left corner is the point (10,20) and whose upper-right corner is therefore the point (110,220). When you first draw a picture, you typically omit the optional argument, leaving the origin at the lower-left corner. If you then want to modify your picture by shifting everything, you can just add the appropriate optional argument.

The environment’s mandatory argument determines the nominal size of the picture. This need bear no relation to how large the picture really is; \LaTeX{} will happily allow you to put things outside the picture, or even off the page. The picture’s nominal size is used by \LaTeX{} in determining how much room to leave for it.

Everything that appears in a picture is drawn by the \texttt{put} command. The command
\begin{verbatim}
\put (11.3,-.3){...}
\end{verbatim}
puts the object specified by \texttt{...} in the picture, with its reference point at coordinates (11.3,−.3). The reference points for various objects will be described below.

The \texttt{put} command creates an LR box. You can put anything that can go in an \texttt{mbox} (see Section 21.1 [\texttt{mbox}], page 68) in the text argument of the \texttt{put} command. When you do this, the reference point will be the lower left corner of the box.

The \texttt{picture} commands are described in the following sections.

9.19.1 \texttt{\textbackslash circle}
\begin{verbatim}
\circle[*]{diameter}
\end{verbatim}
The \texttt{circle} command produces a circle with a diameter as close to the specified one as possible. The *-form of the command draws a solid circle.

Circles up to 40 pt can be drawn.

9.19.2 \texttt{\textbackslash makebox}
\begin{verbatim}
\makebox(width,height)[position]{...}
\end{verbatim}
The \texttt{makebox} command for the picture environment is similar to the normal \texttt{makebox} command except that you must specify a width and height in multiples of \texttt{unitlength}.

The optional argument, \texttt{position}, specifies the quadrant that your text appears in. You may select up to two of the following:
\begin{itemize}
\item \texttt{t} Moves the item to the top of the rectangle.
\item \texttt{b} Moves the item to the bottom.
\item \texttt{l} Moves the item to the left.
\item \texttt{r} Moves the item to the right.
\end{itemize}

See Section 21.4 [\texttt{makebox}], page 68.
9.19.3 \framebox

Synopsis:
\framebox(width,height)[pos]{...}

The \framebox command is like \makebox (see previous section), except that it puts a frame around the outside of the box that it creates.

The \framebox command produces a rule of thickness \fboxrule, and leaves a space \fboxsep between the rule and the contents of the box.

9.19.4 \dashbox

Draws a box with a dashed line. Synopsis:
\dashbox{dlen}(rwidth,rheight)[pos]{text}

\dashbox creates a dashed rectangle around text in a picture environment. Dashes are dlen units long, and the rectangle has overall width rwidth and height rheight. The text is positioned at optional pos.

A dashed box looks best when the rwidth and rheight are multiples of the dlen.

9.19.5 \frame

Synopsis:
\frame{text}

The \frame command puts a rectangular frame around text. The reference point is the bottom left corner of the frame. No extra space is put between the frame and the object.

9.19.6 \line

Synopsis:
\line(xslope,yslope){length}

The \line command draws a line with the given length and slope xslope/yslope.

Standard \LaTeX can only draw lines with slope \(x/y\), where \(x\) and \(y\) have integer values from \(-6\) through 6. For lines of any slope, not to mention other shapes, see the curve2e and many many other packages on CTAN.

9.19.7 \linethickness

The \linethickness{dim} command declares the thickness of horizontal and vertical lines in a picture environment to be dim, which must be a positive length.

\linethickness does not affect the thickness of slanted lines, circles, or the quarter circles drawn by \oval.

9.19.8 \thicklines

The \thicklines command is an alternate line thickness for horizontal and vertical lines in a picture environment; cf. Section 9.19.7 [\linethickness], page 27 and Section 9.19.9 [\thinlines], page 28.
9.19.9 \texttt{\textbackslash thinlines}

The \texttt{\textbackslash thinlines} command is the default line thickness for horizontal and vertical lines in a picture environment; cf. Section 9.19.7 \texttt{\textbackslash linethickness}, page 27 and Section 9.19.8 \texttt{\textbackslash thicklines}, page 27.

9.19.10 \texttt{\textbackslash multiput}

Synopsis:

\begin{verbatim}
\texttt{\textbackslash multiput}(x,y)(\delta_x,\delta_y){n}\{obj}
\end{verbatim}

The \texttt{\textbackslash multiput} command copies the object \texttt{obj} in a regular pattern across a picture. \texttt{obj} is first placed at position \((x, y)\), then at \((x + \delta x, y + \delta y)\), and so on, \texttt{n} times.

9.19.11 \texttt{\textbackslash oval}

Synopsis:

\begin{verbatim}
\texttt{\textbackslash oval}(width,height)[portion]
\end{verbatim}

The \texttt{\textbackslash oval} command produces a rectangle with rounded corners. The optional argument \texttt{portion} allows you to select part of the oval via the following:

- \texttt{t} selects the top portion;
- \texttt{b} selects the bottom portion;
- \texttt{r} selects the right portion;
- \texttt{l} selects the left portion.

The “corners” of the oval are made with quarter circles with a maximum radius of 20 pt, so large “ovals” will look more like boxes with rounded corners.

9.19.12 \texttt{\textbackslash put}

\texttt{\textbackslash put}(x\ coord,y\ coord){ \ldots }\texttt{\ldots}

The \texttt{\textbackslash put} command places the item specified by the mandatory argument at the given coordinates.

9.19.13 \texttt{\textbackslash shortstack}

Synopsis:

\begin{verbatim}
\texttt{\textbackslash shortstack}[position]{\ldots\ldots\ldots\ldots}
\end{verbatim}

The \texttt{\textbackslash shortstack} command produces a stack of objects. The valid positions are:

- \texttt{r} Move the objects to the right of the stack.
- \texttt{l} Move the objects to the left of the stack.
- \texttt{c} Move the objects to the centre of the stack (default)

Objects are separated with \texttt{\ldots\ldots}

9.19.14 \texttt{\textbackslash vector}

Synopsis:

\begin{verbatim}
\texttt{\textbackslash vector}(x\text{-slope},y\text{-slope})\{length\}
\end{verbatim}

The \texttt{\textbackslash vector} command draws a line with an arrow of the specified length and slope. The \texttt{x} and \texttt{y} values must lie between −4 and +4, inclusive.
9.20 quotation

Synopsis:
\begin{quotation}
\text
\end{quotation}

The margins of the quotation environment are indented on both the left and the right. The text is justified at both margins. Leaving a blank line between text produces a new paragraph.

Unlike the quote environment, each paragraph is indented normally.

9.21 quote

Synopsis:
\begin{quote}
\text
\end{quote}

The margins of the quote environment are indented on both the left and the right. The text is justified at both margins. Leaving a blank line between text produces a new paragraph.

Unlike the quotation environment, paragraphs are not indented.

9.22 tabbing

Synopsis:
\begin{tabbing}
row1col1 \= row1col2 \= row1col3 \= row1col4 \=" row2col1 \> \> row2col3 \=" \> \> \> \> \> \> ... \\
\end{tabbing}

The tabbing environment provides a way to align text in columns. It works by setting tab stops and tabbing to them much as was done on an ordinary typewriter. It is best suited for cases where the width of each column is constant and known in advance.

This environment can be broken across pages, unlike the tabular environment.

The following commands can be used inside a tabbing environment:

\\ (tabbing)
End a line.

\= (tabbing)
Sets a tab stop at the current position.

\> (tabbing)
Advances to the next tab stop.

\<
Put following text to the left of the local margin (without changing the margin). Can only be used at the start of the line.
\+  Moves the left margin of the next and all the following commands one tab stop to the right, beginning tabbed line if necessary.

\-  Moves the left margin of the next and all the following commands one tab stop to the left, beginning tabbed line if necessary.

\' (tabbing)  Moves everything that you have typed so far in the current column, i.e. everything from the most recent \>, \<, \’, \, or \kill command, to the right of the previous column, flush against the current column’s tab stop.

\' (tabbing)  Allows you to put text flush right against any tab stop, including tab stop 0. However, it can’t move text to the right of the last column because there’s no tab stop there. The \’ command moves all the text that follows it, up to the \\ or \end{tabbing} command that ends the line, to the right margin of the tabbing environment. There must be no \> or \’ command between the \’ and the command that ends the line.

\a (tabbing)  In a \tabbing environment, the commands \=, \‘ and \’ do not produce accents as usual (see Section 22.3 [Accents], page 74). Instead, the commands \a=, \a‘ and \a’ are used.

\kill  Sets tab stops without producing text. Works just like \ except that it throws away the current line instead of producing output for it. The effect of any \=, \+ or \- commands in that line remain in effect.

\poptabs  Restores the tab stop positions saved by the last \pushtabs.

\pushtabs  Saves all current tab stop positions. Useful for temporarily changing tab stop positions in the middle of a \tabbing environment.

\tabbingsep  Distance to left of tab stop moved by \’.

This example typesets a Pascal function in a traditional format:

\begin{tabbing}
\= fact(n : integer) : integer;\\ 
\> begin \\ 
\> if \= n \>$>$ 1 then \+ \\ 
\> fact := n \* fact(n-1) \- \\ 
\> else \+ \\ 
\> fact := 1; \-\- \\ 
\end{tabbing}

\section*{9.23 table}

Synopsis:
Tables are objects that are not part of the normal text, and are usually “floated” to a convenient place, like the top of a page. Tables will not be split between two pages.

The optional argument \[placement\] determines where \LaTeX{} will try to place your table. There are four places where \LaTeX{} can possibly put a float; these are the same as that used with the \texttt{figure} environment, and described there (see Section 9.10 \[figure\], page 19).

The standard \texttt{report} and \texttt{article} classes use the default placement \[tbp\].

The body of the table is made up of whatever text, \LaTeX{} commands, etc., you wish. The \texttt{\caption} command allows you to title your table.

\subsection{9.24 tabular}

Synopsis:

\begin{quote}
\texttt{\begin{tabular}\[pos\]{cols}\tabularnewline column 1 entry & column 2 entry ... & column n entry \tabularnewline ...
\end{tabular}}
\end{quote}

or

\begin{quote}
\texttt{\begin{tabular*}\[width\]{cols}\tabularnewline column 1 entry & column 2 entry ... & column n entry \tabularnewline ...
\end{tabular*}}
\end{quote}

These environments produce a box consisting of a sequence of rows of items, aligned vertically in columns.

\tabularnewline must be used to specify the end of each row of the table, except for the last, where it is optional—unless an \texttt{\hline} command (to put a rule below the table) follows.

The mandatory and optional arguments consist of:

- \texttt{width} Specifies the width of the \texttt{tabular*} environment. There must be rubber space between columns that can stretch to fill out the specified width.
- \texttt{pos} Specifies the vertical position; default is alignment on the centre of the environment.
  - \texttt{t} align on top row
  - \texttt{b} align on bottom row
- \texttt{cols} Specifies the column formatting. It consists of a sequence of the following specifiers, corresponding to the sequence of columns and intercolumn material.
  - \texttt{l} A column of left-aligned items.
  - \texttt{r} A column of right-aligned items.
A column of centered items.

| A vertical line the full height and depth of the environment.

@{text} This inserts text in every row. An @-expression suppresses the intercolumn space normally inserted between columns; any desired space before the adjacent item must be included in text.

To insert commands that are automatically executed before a given column, you have to load the array package and use the >{\ldots} specifier.

An \extracolsep{wd} command in an @-expression causes an extra space of width wd to appear to the left of all subsequent columns, until countermanded by another \extracolsep command. Unlike ordinary intercolumn space, this extra space is not suppressed by an @-expression. An \extracolsep command can be used only in an @-expression in the cols argument.

p{wd} Produces a column with each item typeset in a pbox of width wd, as if it were the argument of a \parbox[t]{wd} command. However, a \ may not appear in the item, except in the following situations:

1. inside an environment like minipage, array, or tabular.
2. inside an explicit \parbox.
3. in the scope of a \centering, \raggedright, or \raggedleft declaration. The latter declarations must appear inside braces or an environment when used in a p-column element.

*{num}e{cols} Equivalent to num copies of cols, where num is a positive integer and cols is any list of column-specifiers, which may contain another *-expression.

Parameters that control formatting:

\arrayrulewidth

Thickness of the rule created by |, \hline, and \vline in the tabular and array environments; the default is ‘.4pt’.

\arraystretch

Scaling of spacing between rows in the tabular and array environments; default is ‘1’, for no scaling.

\doublerulesep

Horizontal distance between the vertical rules produced by || in the tabular and array environments; default is ‘2pt’.

\tabcolsep

Half the width of the space between columns; default is ‘6pt’.

The following commands can be used inside a tabular environment:
9.24.1 \multicolumn

Synopsis:

\multicolumn{cols}{pos}{text}

The \multicolumn command makes an entry that spans several columns. The first mandatory argument, cols, specifies the number of columns to span. The second mandatory argument, pos, specifies the formatting of the entry; c for centered, l for flushleft, r for flushright. The third mandatory argument, text, specifies what text to put in the entry.

Here's an example showing two columns separated by an en-dash; \multicolumn is used for the heading:

\begin{tabular}{r@{--}l}
\multicolumn{2}{c}{\bf Unicode}
0x80&0x7FF \\
0x800&0xFFFF \\
0x10000&0x1FFFF \\
\end{tabular}

9.24.2 \cline

Synopsis:

\cline{i-j}

The \cline command draws horizontal lines across the columns specified, beginning in column i and ending in column j, which are specified in the mandatory argument.

9.24.3 \hline

The \hline command draws a horizontal line the width of the enclosing tabular or array environment. It's most commonly used to draw a line at the top, bottom, and between the rows of a table.

9.24.4 \vline

The \vline command will draw a vertical line extending the full height and depth of its row. An \hfill command can be used to move the line to the edge of the column. It can also be used in an @-expression.

9.25 thebibliography

Synopsis:

\begin{thebibliography}{widest-label}
\bibitem[label]{cite_key}
...
\end{thebibliography}

The thebibliography environment produces a bibliography or reference list.

In the article class, this reference list is labelled “References”; in the report class, it is labelled “Bibliography”. You can change the label (in the standard classes) by redefining the command \refname. For instance, this eliminates it entirely:
The mandatory \texttt{widest-label} argument is text that, when typeset, is as wide as the widest item label produced by the \texttt{\bibitem} commands. It is typically given as 9 for bibliographies with less than 10 references, 99 for ones with less than 100, etc.

\subsection*{9.25.1 \texttt{\bibitem}}

Synopsis:

\texttt{\bibitem}[\texttt{label}]{\texttt{cite_key}}

The \texttt{\bibitem} command generates an entry labelled by \texttt{label}. If the \texttt{label} argument is missing, a number is automatically generated using the \texttt{enumi} counter. The \texttt{cite_key} is any sequence of letters, numbers, and punctuation symbols not containing a comma.

This command writes an entry to the \texttt{.aux} file containing the item’s \texttt{cite_key} and label. When the \texttt{.aux} file is read by the \texttt{\begin{document}} command, the item’s \texttt{label} is associated with \texttt{cite_key}, causing references to \texttt{cite_key} with a \texttt{\cite} command (see next section) to produce the associated label.

\subsection*{9.25.2 \texttt{\cite}}

Synopsis:

\texttt{\cite[\texttt{subcite}]{\texttt{keys}}}

The \texttt{keys} argument is a list of one or more citation keys, separated by commas. This command generates an in-text citation to the references associated with \texttt{keys} by entries in the \texttt{.aux} file.

The text of the optional \texttt{subcite} argument appears after the citation. For example, \texttt{\cite[p. \texttt{314}]{knuth}} might produce ‘[Knuth, p. 314]’.

\subsection*{9.25.3 \texttt{\nocite}}

\texttt{\nocite{\texttt{key_list}}}

The \texttt{\nocite} command produces no text, but writes \texttt{key_list}, which is a list of one or more citation keys, on the \texttt{.aux} file.

\subsection*{9.25.4 Using Bib\TeX}

If you use the Bib\TeX program by Oren Patashnik (highly recommended if you need a bibliography of more than a couple of titles) to maintain your bibliography, you don’t use the \texttt{thebibliography} environment (see Section 9.25 \texttt{thebibliography}, page 33). Instead, you include the lines

\texttt{\bibliographystyle{\texttt{bibstyle}}}
\texttt{\bibliography{\texttt{bibfile1},\texttt{bibfile2}}}.

The \texttt{\bibliographystyle} command does not produce any output of its own. Rather, it defines the style in which the bibliography will be produced: \texttt{bibstyle} refers to a file \texttt{bibstyle.bst}, which defines how your citations will look. The standard style names distributed with Bib\TeX are:

\texttt{alpha} \hspace{1cm} Sorted alphabetically. Labels are formed from name of author and year of publication.
plain  Sorted alphabetically. Labels are numeric.
unsrt  Like plain, but entries are in order of citation.
abbrv Like plain, but more compact labels.

In addition, numerous other BibTeX style files exist tailored to the demands of various publications. See http://www.ctan.org/tex-archive/biblio/bibtex/contrib.

The \bibliography command is what actually produces the bibliography. The argument to \bibliography refers to files named \texttt{bibfile.bib}, which should contain your database in BibTeX format. Only the entries referred to via \cite and \nocite will be listed in the bibliography.

9.26 theorem

Synopsis:
\begin{verbatim}
\begin{theorem}
\text{theorem-text}
\end{theorem}
\end{verbatim}

The \texttt{theorem} environment produces “Theorem \textit{n}” in boldface followed by \texttt{theorem-text}, where the numbering possibilities for \textit{n} are described under \texttt{\newtheorem} (see Section 13.6 [\texttt{\newtheorem}], page 43).

9.27 titlepage

Synopsis:
\begin{verbatim}
\begin{titlepage}
\text{text}
\end{titlepage}
\end{verbatim}

The \texttt{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. Formatting the title page is left to you. The \texttt{\today} command may be useful on title pages (see Section 22.6 [\texttt{\today}], page 76).

You can use the \texttt{\maketitle} command (see Section 19.1 [\texttt{\maketitle}], page 63) to produce a standard title page without a \texttt{titlepage} environment.

9.28 verbatim

Synopsis:
\begin{verbatim}
\begin{verbatim}
\texttt{literal-text}
\end{verbatim}
\end{verbatim}

The \texttt{verbatim} environment is a paragraph-making environment in which \LaTeX{} produces exactly what you type in; for instance the \texttt{\ character produces a printed \texttt{`\}. It turns \LaTeX{} into a typewriter with carriage returns and blanks having the same effect that they would on a typewriter.

The \texttt{verbatim} uses a monospaced typewriter-like font (\texttt{tt}).
9.28.1 \verb

Synopsis:
\verbcharliteral-textchar
\verb*charliteral-textchar

The \verb command typesets literal-text as it is input, including special characters and spaces, using the typewriter (\tt) font. No spaces are allowed between \verb or \verb* and the delimiter char, which begins and ends the verbatim text. The delimiter must not appear in literal-text.

The *-form differs only in that spaces are printed with a “visible space” character. (Namely, \␣.)

9.29 verse

Synopsis:
\begin{verse}
line1 \\ \\
line2 \\ \\
\ldots
\end{verse}

The verse environment is designed for poetry, though you may find other uses for it.

The margins are indented on the left and the right, paragraphs are not indented, and the text is not justified. Separate the lines of each stanza with \\, and use one or more blank lines to separate the stanzas.
10 Line breaking

The first thing \TeX does when processing ordinary text is to translate your input file into a sequence of glyphs and spaces. To produce a printed document, this sequence must be broken into lines (and these lines must be broken into pages).

\TeX usually does the line (and page) breaking for you, but in some environments, you do the line breaking yourself with the `\` command, and you can always manually force breaks.

10.1 `\[*\]morespace`

The `\` command tells \TeX to start a new line. It has an optional argument, `morespace`, that specifies how much extra vertical space is to be inserted before the next line. This can be a negative amount.

The `\*` command is the same as the ordinary `\` command except that it tells \TeX not to start a new page after the line.

10.2 `\obeycr & \restorecr`

The `\obeycr` command makes a return in the input file (```M```, internally) the same as `\` (followed by `\relax`). So each new line in the input will also be a new line in the output.

`\restorecr` restores normal line-breaking behavior.

10.3 `\newline`

The `\newline` command breaks the line at the present point, with no stretching of the text before it. It can only be used in paragraph mode.

10.4 `\-` (discretionary hyphen)

The `\-` command tells \TeX that it may hyphenate the word at that point. \TeX is very good at hyphenating, and it will usually find most of the correct hyphenation points, and almost never use an incorrect one. The `\-` command is used for the exceptional cases.

When you insert `\-` commands in a word, the word will only be hyphenated at those points and not at any of the hyphenation points that \TeX might otherwise have chosen.

10.5 `\fussy`

The declaration `\fussy` (which is the default) makes \TeX picky about line breaking. This usually avoids too much space between words, at the cost of an occasional overfull box.

This command cancels the effect of a previous `\sloppy` command (see Section 10.6 [\sloppy], page 37).

10.6 `\sloppy`

The declaration `\sloppy` makes \TeX less fussy about line breaking. This will avoid overfull boxes, at the cost of loose interword spacing.

Lasts until a `\fussy` command is issued (see Section 10.5 [\fussy], page 37).
10.7 \texttt{\hyphenation}

Synopsis:

\texttt{\hyphenation{word-one word-two}}

The \texttt{\hyphenation} command declares allowed hyphenation points with a \texttt{-} character in the given words. The words are separated by spaces. \TeX{} will only hyphenate if the word matches exactly, no inflections are tried. Multiple \texttt{\hyphenation} commands accumulate. Some examples (the default \TeX{} hyphenation patterns misses the hyphenations in these words):

\texttt{\hyphenation{ap-pen-dix col-umns data-base data-bases}}

10.8 \texttt{\linebreak \& \nolinebreak}

Synopses:

\texttt{\linebreak[priority]}
\texttt{\nolinebreak[priority]}

By default, the \texttt{\linebreak} (\texttt{\nolinebreak}) command forces (prevents) a line break at the current position. For \texttt{\linebreak}, the spaces in the line are stretched out so that it extends to the right margin as usual.

With the optional argument \texttt{priority}, you can convert the command from a demand to a request. The \texttt{priority} must be a number from 0 to 4. The higher the number, the more insistent the request.
Chapter 11: Page breaking

11 Page breaking

\LaTeX{} starts new pages asynchronously, when enough material has accumulated to fill up a page. Usually this happens automatically, but sometimes you may want to influence the breaks.

11.1 \texttt{\cleardoublepage}

The \texttt{\cleardoublepage} command ends the current page and causes all figures and tables that have so far appeared in the input to be printed. In a two-sided printing style, it also makes the next page a right-hand (odd-numbered) page, producing a blank page if necessary.

11.2 \texttt{\clearpage}

The \texttt{\clearpage} command ends the current page and causes all figures and tables that have so far appeared in the input to be printed.

11.3 \texttt{\newpage}

The \texttt{\newpage} command ends the current page, but does not clear floats (see \texttt{\clearpage} above).

11.4 \texttt{\enlargethispage}

\texttt{\enlargethispage\{size\}}

\texttt{\enlargethispage*\{size\}}

Enlarge the \texttt{\textheight} for the current page by the specified amount; e.g. \texttt{\enlargethispage\{\baselineskip\}} will allow one additional line.

The starred form tries to squeeze the material together on the page as much as possible. This is normally used together with an explicit \texttt{\pagebreak}.

11.5 \texttt{\pagebreak} & \texttt{\nopagebreak}

Synopses:

\texttt{\pagebreak[priority]}

\texttt{\nopagebreak[priority]}

By default, the \texttt{\pagebreak} (\texttt{\nopagebreak}) command forces (prevents) a page break at the current position. With \texttt{\pagebreak}, the vertical space on the page is stretched out where possible so that it extends to the normal bottom margin.

With the optional argument \texttt{priority}, you can convert the \texttt{\pagebreak} command from a demand to a request. The number must be a number from 0 to 4. The higher the number, the more insistent the request is.
12 Footnotes

Footnotes can be produced in one of two ways. They can be produced with one command, the \footnote command. They can also be produced with two commands, the \footnotemark and the \footnotetext commands.

12.1 \footnote

Synopsis:

\footnote[number]{text}

The \footnote command places the numbered footnote text at the bottom of the current page. The optional argument number changes the default footnote number.

This command can only be used in outer paragraph mode; i.e., you cannot use it in sectioning commands like \chapter, in figures, tables or in a tabular environment. (See following sections.)

12.2 \footnotemark

With no optional argument, the \footnotemark command puts the current footnote number in the text. This command can be used in inner paragraph mode. You give the text of the footnote separately, with the \footnotetext command.

This command can be used to produce several consecutive footnote markers referring to the same footnote with

\footnotemark[value{footnote}]

after the first \footnote command.

12.3 \footnotetext

Synopsis:

\footnotetext[number]{text}

The \footnotetext command places text at the bottom of the page as a footnote. This command can come anywhere after the \footnotemark command. The \footnotetext command must appear in outer paragraph mode.

The optional argument number changes the default footnote number.

12.4 Symbolic footnotes

If you want to use symbols for footnotes, rather than increasing numbers, redefine the \footnote like this:

\renewcommand{\footnote}{\fnsymbol{footnote}}

The \fnsymbol command produces a predefined series of symbols (see Section 14.1 [\alph \Alph \arabic \roman \Roman \fnsymbol], page 45). If you want to use a different symbol as your footnote mark, you’ll need to also redefine \fnsymbol.
12.5 Footnote parameters

\footnoterule
Produces the rule separating the main text on a page from the page’s footnotes. Default dimensions: 0.4pt thick (or wide), and 0.4\columnwidth long in the standard document classes (except slides, where it does not appear).

\footnotesep
The height of the strut placed at the beginning of the footnote. By default, this is set to the normal strut for \footnotesize fonts (see Section 5.2 [Font sizes], page 8), therefore there is no extra space between footnotes. This is ‘6.65pt’ for ‘10pt’, ‘7.7pt’ for ‘11pt’, and ‘8.4pt’ for ‘12pt’.
Chapter 13: Definitions

\LaTeX{} has support for making new commands of many different kinds.

### 13.1 \texttt{\newcommand} \& \texttt{\renewcommand}

\newcommand and \renewcommand define and redefine a command, respectively. Synopses:

\begin{verbatim}
\newcommand[*]{cmd}[nargs][optarg]{defn}
\renewcommand[*]{cmd}[nargs][optarg]{defn}
\end{verbatim}

* The \texttt{*}-form of these commands requires that the arguments not contain multiple paragraphs of text (not \texttt{\long}, in plain \TeX{} terms).

\texttt{cmd} The command name beginning with \texttt{\}. For \texttt{\newcommand}, it must not be already defined and must not begin with \texttt{\end}; for \texttt{\renewcommand}, it must already be defined.

\texttt{nargs} An optional integer from 1 to 9 specifying the number of arguments that the command will take. The default is for the command to have no arguments.

\texttt{optarg} If this optional parameter is present, it means that the command’s first argument is optional. The default value of the optional argument (i.e., if it is not specified in the call) is \texttt{optarg}, or, if that argument is present in the \texttt{\newcommand} but has an empty value, the string ‘\texttt{def}’.

\texttt{defn} The text to be substituted for every occurrence of \texttt{cmd}; a construct of the form \texttt{#n} in \texttt{defn} is replaced by the text of the \texttt{n}th argument.

### 13.2 \texttt{\newcounter}

Synopsis:

\begin{verbatim}
\newcounter{cnt}[counternamex]
\end{verbatim}

The \texttt{\newcounter} command defines a new counter named \texttt{cnt}. The new counter is initialized to zero.

Given the optional argument \texttt{[counternamex]}, \texttt{cnt} will be reset whenever \texttt{counternamex} is incremented.

See Chapter 14 [Counters], page 45, for more information about counters.

### 13.3 \texttt{\newlength}

Synopsis:

\begin{verbatim}
\newlength{\argx}
\end{verbatim}

The \texttt{\newlength} command defines the mandatory argument as a \texttt{length} command with a value of 0 in. The argument must be a control sequence, as in \texttt{\newlength{\foo}}. An error occurs if \texttt{\foo} is already defined.

See Chapter 15 [Lengths], page 47, for how to set the new length to a nonzero value, and for more information about lengths in general.
13.4 \texttt{\newsavebox}

Synopsis:

\texttt{\newsavebox\{cmd\}}

Defines \texttt{cmd}, which must be a command name not already defined, to refer to a new bin for storing boxes.

13.5 \texttt{\newenvironment \& \renewenvironment}

Synopses:

\texttt{\newenvironment\[*\]\{env\}\{nargs\}\{default\}\{begdef\}\{enddef\}}

\texttt{\renewenvironment\[*\]\{env\}\{nargs\}\{begdef\}\{enddef\}}

These commands define or redefine an environment \texttt{env}, that is, \texttt{\begin{env} ... \end{env}}.

* The *-form of these commands requires that the arguments (not the contents of the environment) not contain multiple paragraphs of text.

\texttt{env} The name of the environment. For \texttt{\newenvironment}, \texttt{env} must not be an existing environment, and the command \texttt{\newenvironment} must be undefined. For \texttt{\renewenvironment}, \texttt{env} must be the name of an existing environment.

\texttt{nargs} An integer from 1 to 9 denoting the number of arguments of the newly-defined environment. The default is no arguments.

\texttt{default} If this is specified, the first argument is optional, and \texttt{default} gives the default value for that argument.

\texttt{begdef} The text expanded at every occurrence of \texttt{\begin\{env\}}; a construct of the form \texttt{#n} in \texttt{begdef} is replaced by the text of the \texttt{n}th argument.

\texttt{enddef} The text expanded at every occurrence of \texttt{\end\{env\}}. It may not contain any argument parameters.

13.6 \texttt{\newtheorem}

\texttt{\newtheorem\{newenv\}\{label\}\{within\}}

\texttt{\newtheorem\{newenv\}\{numbered\_like\}\{label\}}

This command defines a theorem-like environment. Arguments:

\texttt{newenv} The name of the environment to be defined; must not be the name of an existing environment or otherwise defined.

\texttt{label} The text printed at the beginning of the environment, before the number. For example, ‘Theorem’.

\texttt{numbered\_like} (Optional.) The name of an already defined theorem-like environment; the new environment will be numbered just like \texttt{numbered\_like}.

\texttt{within} (Optional.) The name of an already defined counter, a sectional unit. The new theorem counter will be reset at the same time as the \texttt{within} counter.

At most one of \texttt{numbered\_like} and \texttt{within} can be specified, not both.
13.7 \texttt{\textbackslash newfont}

Synopsis:

\texttt{\textbackslash newfont\{cmd\}\{fontname\}}

Defines a control sequence \texttt{cmd}, which must not already be defined, to make \texttt{fontname} be the current font. The file looked for on the system is named \texttt{fontname.tfm}.

This is a low-level command for setting up to use an individual font. More commonly, fonts are defined in families through \texttt{.fd} files.

13.8 \texttt{\textbackslash protect}

Footnotes, line breaks, any command that has an optional argument, and many more are so-called fragile commands. When a fragile command is used in certain contexts, called moving arguments, it must be preceded by \texttt{\textbackslash protect}. In addition, any fragile commands within the arguments must have their own \texttt{\textbackslash protect}.

Some examples of moving arguments are \texttt{\textbackslash caption} (see Section 9.10 [figure], page 19), \texttt{\textbackslash thanks} (see Section 19.1 [\texttt{\textbackslash maketitle}], page 63), and expressions in \texttt{tabular} and \texttt{array} environments (see Section 9.24 [\texttt{tabular}], page 31).

Commands which are not fragile are called robust. They must not be preceded by \texttt{\textbackslash protect}.

See also:

http://www-h.eng.cam.ac.uk/help/tpl/textprocessing/teTeX/latex/latex2e-html/fragile.html
http://www.tex.ac.uk/cgi-bin/texfaq2html?label=protect
14 Counters

Everything \LaTeX numbers for you has a counter associated with it. The name of the counter is the same as the name of the environment or command that produces the number, except with no \. (\texttt{enumi–enumiv} are used for the nested enumerate environment.) Below is a list of the counters used in \LaTeX's standard document classes to control numbering.

<table>
<thead>
<tr>
<th>part</th>
<th>paragraph</th>
<th>figure</th>
<th>enumi</th>
</tr>
</thead>
<tbody>
<tr>
<td>chapter</td>
<td>subparagraph</td>
<td>table</td>
<td>enumii</td>
</tr>
<tr>
<td>section</td>
<td>page</td>
<td>footnote</td>
<td>enumiii</td>
</tr>
<tr>
<td>subsection</td>
<td>equation</td>
<td>mpfootnote</td>
<td>enumiv</td>
</tr>
<tr>
<td>subsubsection</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

14.1 \texttt{\textbackslash alph \textbackslash Alph \textbackslash arabic \textbackslash roman \textbackslash Roman \textbackslash fnsymbol}: Printing counters

All of these commands take a single counter as an argument, for instance, \texttt{\textbackslash alph\{enumi\}}.

- \texttt{\textbackslash arabic} uses Arabic numbers: ‘1’, ‘2’, . . .
- \texttt{\textbackslash roman} uses lowercase roman numerals: ‘i’, ‘ii’, . . .
- \texttt{\textbackslash fnsymbol} prints the value of \textit{counter} in a specific sequence of nine symbols (conventionally used for labeling footnotes). The value of \textit{counter} must be between 1 and 9, inclusive.

Here are the symbols:

\*\†\‡\§\¶\∥\∗\†\‡\§\¶\∥\∗\†\‡\§\¶\∥\∗\†\‡

14.2 \texttt{\textbackslash usecounter\{counter\}}

Synopsis:

\texttt{\textbackslash usecounter\{counter\}}

The \texttt{\textbackslash usecounter} command is used in the second argument of the \texttt{list} environment to specify \textit{counter} to be used to number the list items.

14.3 \texttt{\textbackslash value\{counter\}}

Synopsis:

\texttt{\textbackslash value\{counter\}}

The \texttt{\textbackslash value} command produces the value of \textit{counter}. It can be used anywhere \LaTeX expects a number, for example:

\texttt{\textbackslash setcounter\{myctr\}\{3\}}
\texttt{\textbackslash addtocounter\{myctr\}\{1\}}
\texttt{\textbackslash hspace\{\textbackslash value\{myctr\}\parindent\}}
14.4 \setcounter{counter}{value}

Synopsis:
\setcounter{counter}{value}
The \setcounter command sets the value of \texttt{counter} to the value argument.

14.5 \addtocounter{counter}{value}

The \addtocounter command increments \texttt{counter} by the amount specified by the value argument, which may be negative.

14.6 \refstepcounter{counter}

The \refstepcounter command works in the same way as \stepcounter See Section 14.7 [\stepcounter], page 46, except it also defines the current \texttt{ref} value to be the result of \the\texttt{counter}.

14.7 \stepcounter{counter}

The \stepcounter command adds one to \texttt{counter} and resets all subsidiary counters.

14.8 \day \month \year: Predefined counters

\LaTeX{} defines counters for the day of the month (\texttt{day}, 1–31), month of the year (\texttt{month}, 1–12), and year (\texttt{year}, Common Era). When \TeX{} starts up, they are set to the current values on the system where \TeX{} is running. They are not updated as the job progresses.

The related command \texttt{today} produces a string representing the current day (see Section 22.6 [\today{}], page 76).
15 Lengths

A length is a measure of distance. Many \TeX commands take a length as an argument.

15.1 \texttt{\setlength{\len}{value}}

The \texttt{\setlength} sets the value of \len to the value argument, which can be expressed in any units that \TeX understands, i.e., inches (\texttt{in}), millimeters (\texttt{mm}), points (\texttt{pt}), big points (bp), etc.

15.2 \texttt{\addtolength{\len}{amount}}

The \texttt{\addtolength} command increments a “length command” \len by the amount specified in the amount argument, which may be negative.

15.3 \texttt{\settodepth}

\texttt{\settodepth{\gnat}{text}}

The \texttt{\settodepth} command sets the value of a \texttt{length} command equal to the depth of the \texttt{text} argument.

15.4 \texttt{\settoheight}

\texttt{\settoheight{\gnat}{text}}

The \texttt{\settoheight} command sets the value of a \texttt{length} command equal to the height of the \texttt{text} argument.

15.5 \texttt{\settowidth{\len}{text}}

The \texttt{\settowidth} command sets the value of the command \len to the width of the \texttt{text} argument.

15.6 Predefined lengths

\texttt{\width}

\texttt{\height}

\texttt{\depth}

\texttt{\totalheight}

These length parameters can be used in the arguments of the box-making commands (see Chapter 21 [Boxes], page 68). They specify the natural width, etc., of the text in the box. \texttt{\totalheight} equals \texttt{\height} + \texttt{\depth}. To make a box with the text stretched to double the natural size, e.g., say

\texttt{\makebox[2\width]{Get a stretcher}}
16 Making paragraphs

A paragraph is ended by one or more completely blank lines—lines not containing even a \% . A blank line should not appear where a new paragraph cannot be started, such as in math mode or in the argument of a sectioning command.

16.1 \indent
\indent produces a horizontal space whose width equals the width of the \parindent length, the normal paragraph indentation. It is used to add paragraph indentation where it would otherwise be suppressed.

The default value for \parindent is 1em in two-column mode, otherwise 15pt for 10pt documents, 17pt for 11pt, and 1.5em for 12pt.

16.2 \noindent
When used at the beginning of the paragraph, \noindent suppresses any paragraph indentation. It has no effect when used in the middle of a paragraph.

16.3 \parskip
\parskip is a rubber length defining extra vertical space added before each paragraph. The default is 0pt plus1pt.

16.4 Marginal notes

Synopsis:

\marginpar[\emph{left}]{\emph{right}}

The \marginpar command creates a note in the margin. The first line of the note will have the same baseline as the line in the text where the \marginpar occurs.

When you only specify the mandatory argument \emph{right}, the text will be placed
• in the right margin for one-sided layout;
• in the outside margin for two-sided layout;
• in the nearest margin for two-column layout.

The command \reversemarginpar places subsequent marginal notes in the opposite (inside) margin. \normalmarginpar places them in the default position.

When you specify both arguments, \emph{left} is used for the left margin, and \emph{right} is used for the right margin.

The first word will normally not be hyphenated; you can enable hyphenation there by beginning the node with \hspace{0pt}.

These parameters affect the formatting of the note:

\marginparpush
Minimum vertical space between notes; default ‘7pt’ for ‘12pt’ documents, ‘5pt’ else.
\marginparsep
Horizontal space between the main text and the note; default ‘11pt’ for ‘10pt’ documents, ‘10pt’ else.

\marginparwidth
Width of the note itself; default for a one-sided ‘10pt’ document is ‘90pt’, ‘83pt’ for ‘11pt’, and ‘68pt’ for ‘12pt’; ‘17pt’ more in each case for a two-sided document. In two column mode, the default is ‘48pt’.

The standard \LaTeX routine for marginal notes does not prevent notes from falling off the bottom of the page.
17 Math formulas

There are three environments that put \LaTeX in math mode:

- **math** For formulas that appear right in the text.
- **displaymath** For formulas that appear on their own line.
- **equation** The same as the displaymath environment except that it adds an equation number in the right margin.

The `math` environment can be used in both paragraph and LR mode, but the `displaymath` and `equation` environments can be used only in paragraph mode. The `math` and `displaymath` environments are used so often that they have the following short forms:

\begin{verbatim}
(...) instead of \begin{math}...\end{math}
\[...\] instead of \begin{displaymath}...\end{displaymath}
\end{verbatim}

In fact, the `math` environment is so common that it has an even shorter form:

\$ ... \$ instead of \begin{math}...\end{math}

The `\boldmath` command changes math letters and symbols to be in a bold font. It is used outside of math mode. Conversely, the `\unboldmath` command changes math glyphs to be in a normal font; it too is used outside of math mode.

The `\displaystyle` declaration forces the size and style of the formula to be that of `displaymath`, e.g., with limits above and below summations. For example

\$\displaystyle \sum_{n=0}^\infty x_n \$

17.1 Subscripts & superscripts

To get an expression `exp` to appear as a subscript, you just type `{exp}_`. To get `exp` to appear as a superscript, you type `{exp}^`. \LaTeX handles superscripted superscripts and all of that stuff in the natural way. It even does the right thing when something has both a subscript and a superscript.

17.2 Math symbols

\LaTeX provides almost any mathematical symbol you’re likely to need. The commands for generating them can be used only in math mode. For example, if you include `\pi` in your source, you will get the pi symbol (\(\pi\)) in your output.

| \ |
| \aleph | \N |
| \alpha | \(\alpha\) |
| \amalg | \(\amalg\) (binary operation) |
| \angle | \(\angle\) |
| \approx | \(\approx\) (relation) |
| \ast | \(\ast\) (binary operation) |
\textbackslash{}asymp \asymp \text{ (relation)}
\textbackslash{}backslash \backslash \text{(delimiter)}
\textbackslash{}beta \beta
\textbackslash{}bigcap \bigcap \text{ (binary operation)}
\textbackslash{}bigcirc \bigcirc \text{ (binary operation)}
\textbackslash{}bigcup \bigcup \text{ (binary operation)}
\textbackslash{}bigodot \bigodot \text{ (binary operation)}
\textbackslash{}bigoplus \bigoplus \text{ (binary operation)}
\textbackslash{}bigotimes \bigotimes \text{ (binary operation)}
\textbackslash{}bigtriangledown \bigtriangledown \text{ (binary operation)}
\textbackslash{}bigtriangleup \bigtriangleup \text{ (binary operation)}
\textbackslash{}bigsqcup \bigsqcup \text{ (binary operation)}
\textbackslash{}biguplus \biguplus \text{ (binary operation)}
\textbackslash{}bigcap \bigcap \text{ (binary operation)}
\textbackslash{}bigwedge \bigwedge \text{ (binary operation)}
\textbackslash{}bot \bot \text{ (relation)}
\textbackslash{}bowtie \bowtie \text{ (relation)}
\textbackslash{}Box \Box \text{(square open box symbol)}
\textbackslash{}bullet \bullet \text{ (binary operation)}
\textbackslash{}cap \cap \text{ (binary operation)}
\textbackslash{}cdot \cdot \text{ (binary operation)}
\textbackslash{}chi \chi \text{ (relation)}
\textbackslash{}circ \circ \text{ (binary operation)}
\textbackslash{}clubsuit \clubsuit \text{ (relation)}
\textbackslash{}coprod \coprod \text{ (relation)}
\cup \quad \text{(binary operation)}
\dagger \quad \text{(binary operation)}
\dashv \quad \text{(relation)}
\ddagger \quad \text{(binary operation)}
\Delta \quad \Delta
\delta \quad \delta
\Diamond \quad \Diamond \quad \text{(binary operation)}
\diamond \quad \Diamond \quad \text{(binary operation)}
\diamondsuit \quad \text{bigger } \diamond
\div \quad \div \quad \text{(binary operation)}
\doteq \quad = \quad \text{(relation)}
\downarrow \quad \downarrow \quad \text{(delimiter)}
\Downarrow \quad \Downarrow \quad \text{(delimiter)}
\ell \quad \ell
\emptyset \quad \emptyset
\epsilon \quad \epsilon
\equiv \quad \equiv \quad \text{(relation)}
\eta \quad \eta
\exists \quad \exists
\flat \quad \flat
\forall \quad \forall
\frown \quad \frown \quad \text{(relation)}
\Gamma \quad \Gamma
\gamma \quad \gamma
\ge \quad \ge \quad \text{(relation)}
\geq \quad \geq \quad \text{(relation)}
\gets \quad \gets
\gg \quad \gg \quad \text{(relation)}
\hbar \quad \hbar
\heartsuit \quad \heartsuit
\diamondsuit \quad \text{bigger } \diamond
\hookleftarrow
←
\hookrightarrow
↪
\iff
⇐⇒
\Im
ℑ
\in
∈ (relation)
infty
∞
\int
∫
iota
ι
\Join condensed bowtie symbol (relation)
kappa
κ
\Lambda
Λ
\lambda
λ
\land
∧
\langle (delimiter)
\lbrace (delimiter)
\lbrack (delimiter)
\lceil (delimiter)
\leq
≤
\leadsto
\Leftarrow
⇐
\leftarrow
←
\leftharpoondown
↽
\leftharpoonup
↼
\Leftrightarrow
⇔
\leftrightarrow
↔
\leq (relation)
\lfloor (delimiter)
\lceil (delimiter)
\lhd \quad \text{(left-pointing arrow head)}
\ll \quad \ll (relation)
\lnot \quad \neg
\longleftarrow \quad \leftarrow
\longleftrightarrow \quad \longleftrightarrow
\longmapsto \quad \mapsto
\longrightarrow \quad \rightarrow
\lor \quad \lor
\mapsto \quad \mapsto
\mho \quad \mho
\mid \quad \mid (relation)
\models \quad \models\mid (relation)
\mp \quad \mp (binary operation)
\mu \quad \mu
\nabla \quad \nabla
\natural \quad \natural
\ne \quad \neq
\nearrow \quad \nearrow
\neg \quad \neg
\neq \quad \neq (relation)
\ni \quad \ni (relation)
\not \quad \text{Overstrike a following operator with a /, as in } \neq.
\notin \quad \ni
\nu \quad \nu
\narrow \quad \narrow
\odot \quad \odot (binary operation)
\oint \quad \oint
\Omega \quad \Omega
\omega \quad \omega
\ominus \quad \ominus (binary operation)
\oplus \oplus \textit{(binary operation)}
\oslash \oslash \textit{(binary operation)}
\otimes \otimes \textit{(binary operation)}
\owns \owns \ni \textit{(binary operation)}
\parallel \parallel \textit{(relation)}
\partial \partial \partial \textit{(relation)}
\perp \perp \perp \textit{(relation)}
\phi \phi \phi
\Pi \Pi \Pi
\pi \pi \pi
\pm \pm \pm \textit{(binary operation)}
\prec \prec \prec \textit{(relation)}
\preceq \preceq \preceq \textit{(relation)}
\prime \prime 
\prod \prod \prod
\propto \propto \propto \textit{(relation)}
\Psi \Psi \Psi
\psi \psi \psi
\rangle \rangle \rangle \textit{(delimiter)}
\rbrace \rbrace \rbrace \textit{(delimiter)}
\rbrack \rbrack \rbrack \textit{(delimiter)}
\rceil \rceil \rceil \textit{(delimiter)}
\Re \Re \Re
\rfloor \rfloor \rfloor \textit{(delimiter)}
\rhd \rhd \rhd \textit{(binary operation)}
\rho \rho \rho
\Rightarrow \Rightarrow \Rightarrow \textit{(relation)}
\rightarrow \rightarrow \rightarrow \textit{(relation)}
\rightharpoondown \rightharpoondown \rightharpoondown
\rightharpoonup \rightharpoonup \rightharpoonup
\rightleftharpoons \rightleftharpoons
\searrow \searrow
\setminus \setminus (binary operation)
\sharp \sharp
\Sigma \Sigma
\sigma \sigma
\sim \sim (relation)
\simeq \simeq (relation)
\smallint \smallint
\smile \smile (relation)
\spadesuit \spadesuit
\sqcap \sqcap (binary operation)
\sqcup \sqcup (binary operation)
\sqsubset \sqsubset (relation)
\sqsubseteq \sqsubseteq (relation)
\sqsupset \sqsupset (relation)
\sqsupseteq \sqsupseteq (relation)
\star \star (binary operation)
\subset \subset (relation)
\subseteq \subseteq (relation)
\succ \succ (relation)
\succeq \succeq (relation)
\sum \sum
\supset \supset (relation)
\supseteq \supseteq (relation)
\surd \surd (relation)
\surd \sqrt
\verb|\vert| | (delimiter)
\verb|\wedge| \wedge (binary operation)
\verb|\wp| \wp
\verb|\wr| \wr (binary operation)
\verb|\Xi| \Xi
\verb|\xi| \xi
\verb|\zeta| \zeta

17.3 Math functions

These commands produce roman function names in math mode with proper spacing.

\verb|\arccos| \arccos
\verb|\arcsin| \arcsin
\verb|\arctan| \arctan
\verb|\arg| \arg
\verb|\bmod| Binary modulo operator \((x \ mod \ y)\)
\verb|\cos| \cos
\verb|\cosh| \cosh
\verb|\cot| \cos
\verb|\coth| \cosh
\verb|\csc| \csc
\verb|\deg| \deg
\verb|\det| \deg
\verb|\dim| \dim
\verb|\exp| \exp
\verb|\gcd| \gcd
\verb|\hom| \hom
\verb|\inf| \inf
\verb|\ker| \ker
\verb|\lg| \lg
\verb|\lim| \lim
\verb|\liminf| \lim\ inf
\verb|\limsup| \lim\ sup
\verb|\ln| \ln
\log \log \\
\max \max \\
\min \min \\
\pmod \text{parenthesized modulus, as in } ( (\text{mod} 2)^n - 1) \\
\Pr \text{Pr} \\
\sec \text{sec} \\
\sin \text{sin} \\
\sinh \text{sinh} \\
\sup \text{sup} \\
\tan \text{tan} \\
\tanh \text{tanh} \\

\textbf{17.4 Math accents} \\
\LaTeX provides a variety of commands for producing accented letters in math. These are different from accents in normal text (see Section 22.3 [Accents], page 74).

\acute \text{Math acute accent: } \dot{x}.
\bar \text{Math bar-over accent: } \bar{x}.
\breve \text{Math breve accent: } \check{x}.
\check \text{Math h\'{a}cek (check) accent: } \check{x}.
\ddot \text{Math dieresis accent: } \ddot{x}.
\dot \text{Math dot accent: } \dot{x}.
\grave \text{Math grave accent: } \grave{x}.
\hat \text{Math hat (circumflex) accent: } \hat{x}.
\imath \text{Math dotless i.}
\jmath \text{Math dotless j.}
\mathring \text{Math ring accent: } \mathring{x}.
\tilde \text{Math tilde accent: } \tilde{x}.
\vec \text{Math vector symbol: } \vec{x}.
\widehat \text{Math wide hat accent: } \hat{x} + y.
\widetilde \text{Math wide tilde accent: } \tilde{x} + y.
17.5 Spacing in math mode

In a math environment, \LaTeX{} ignores the spaces you type and puts in the spacing according to the normal rules for mathematics texts. If you want different spacing, \LaTeX{} provides the following commands for use in math mode:

\begin{itemize}
  \item \texttt{\;} A thick space (\frac{5}{18}\text{quad}).
  \item \texttt{\:} Both of these produce a medium space (\frac{3}{9}\text{quad}).
  \item \texttt{\,} A thin space (\frac{1}{6}\text{quad}); not restricted to math mode.
  \item \texttt{\!} A negative thin space (\frac{-1}{6}\text{quad}).
\end{itemize}

17.6 Math miscellany

\begin{itemize}
  \item \texttt{\*} A “discretionary” multiplication symbol, at which a line break is allowed.
  \item \texttt{\cdots} A horizontal ellipsis with the dots raised to the center of the line. As in: ‘⋯’.
  \item \texttt{\ddots} A diagonal ellipsis: ⋅⋅⋅.
  \item \texttt{\frac{num}{den}} Produces the fraction $\frac{num}{den}$.
  \quad eg. $\frac{1}{4}$.
  \item \texttt{\left delim \ldots \right delim2}
  \quad The two delimiters need not match; ‘.’ acts as a null delimiter, producing no output. The delimiters are sized according to the math in between. Example: \left( \sum_{i=1}^{10} a_i \right).
  \item \texttt{\overbrace{text}}
  \quad Generates a brace over text. For example, $\overbrace{x + \cdots + x}^{k \text{ times}}$.
  \item \texttt{\overline{text}}
  \quad Generates a horizontal line over text. For example, $\overline{x + y}$.
  \item \texttt{\sqrt[root]{arg}}
  \quad Produces the representation of the square root of $arg$. The optional argument \texttt{root} determines what root to produce. For example, the cube root of $x+y$ would be typed as $\sqrt[3]{x+y}$. In \TeX{}, the result looks like this: $\sqrt[3]{x+y}$.
  \item \texttt{\stackrel{text}{relation}}
  \quad Puts text above relation. For example, $\stackrel{f}{\longrightarrow}$. In \TeX{}, the result looks like this: $f \rightarrow$.
  \item \texttt{\underbrace{math}}
  \quad Generates math with a brace underneath. In \TeX{}, the result looks like this: $\underbrace{x + y + z}_{>0}$.
\underline{\text{text}}

Causes text, which may be either math mode or not, to be underlined. The line is always below the text, taking account of descenders. In \TeX, the result looks like this: \underline{xyz}

\vdots

Produces a vertical ellipsis. In \TeX, the result looks like this: \vdots.
18 Modes

When \LaTeX{} is processing your input text, it is always in one of three modes:

- Paragraph mode
- Math mode
- Left-to-right mode, called LR mode for short

\LaTeX{} changes mode only when it goes up or down a staircase to a different level, though not all level changes produce mode changes. Mode changes occur only when entering or leaving an environment, or when \LaTeX{} is processing the argument of certain text-producing commands.

“Paragraph mode” is the most common; it’s the one \LaTeX{} is in when processing ordinary text. In that mode, \LaTeX{} breaks your text into lines and breaks the lines into pages. \LaTeX{} is in “math mode” when it’s generating a mathematical formula. In “LR mode”, as in paragraph mode, \LaTeX{} considers the output that it produces to be a string of words with spaces between them. However, unlike paragraph mode, \LaTeX{} keeps going from left to right; it never starts a new line in LR mode. Even if you put a hundred words into an \verb|\mbox|, \LaTeX{} would keep typesetting them from left to right inside a single box, and then complain because the resulting box was too wide to fit on the line.

\LaTeX{} is in LR mode when it starts making a box with an \verb|\mbox| command. You can get it to enter a different mode inside the box - for example, you can make it enter math mode to put a formula in the box. There are also several text-producing commands and environments for making a box that put \LaTeX{} in paragraph mode. The box made by one of these commands or environments will be called a \verb|parbox|. When \LaTeX{} is in paragraph mode while making a box, it is said to be in “inner paragraph mode”. Its normal paragraph mode, which it starts out in, is called “outer paragraph mode”.

19 Page styles

The \documentclass command determines the size and position of the page’s head and foot. The page style determines what goes in them.

19.1 \maketitle

The \maketitle command generates a title on a separate title page—except in the article class, where the title is placed at the top of the first page. Information used to produce the title is obtained from the following declarations:

\author{name \and name2}

The \author command declares the document author(s), where the argument is a list of authors separated by \and commands. Use \\ to separate lines within a single author’s entry—for example, to give the author’s institution or address.

\date{text}

The \date command declares text to be the document’s date. With no \date command, the current date (see Section 22.6 [\today], page 76) is used.

\thanks{text}

The \thanks command produces a \footnote to the title, usually used for credit acknowledgements.

\title{text}

The \title command declares text to be the title of the document. Use \\ to force a line break, as usual.

19.2 \pagenumbering

Synopsis:

\pagenumbering{style}

Specifies the style of page numbers, according to style:

arabic arabic numerals
roman lowercase Roman numerals
Roman uppercase Roman numerals
alph lowercase letters
Alph uppercase letters

19.3 \pagestyle

Synopsis:

\pagestyle{style}

The \pagestyle command specifies how the headers and footers are typeset from the current page onwards. Values for style:

plain Just a plain page number.
empty Empty headers and footers, e.g., no page numbers.

headings Put running headers on each page. The document style specifies what goes in the headers.

myheadings Custom headers, specified via the `\markboth` or the `\markright` commands.

Here are the descriptions of `\markboth` and `\markright`:

`\markboth{left}{right}`
Sets both the left and the right heading. A “left-hand heading” (left) is generated by the last `\markboth` command before the end of the page, while a “right-hand heading” (right) is generated by the first `\markboth` or `\markright` that comes on the page if there is one, otherwise by the last one before the page.

`\markright{right}`
Sets the right heading, leaving the left heading unchanged.

19.4 `\thispagestyle{style}`
The `\thispagestyle` command works in the same manner as the `\pagestyle` command (see previous section) except that it changes to `style` for the current page only.
20 Spaces

\LaTeX{} has many ways to produce white (or filled) space.

Another space-producing command is $\backslash$, to produce a “thin” space (usually 1/6 quad). It can be used in text mode, but is more often useful in math mode (see Section 17.5 [Spacing in math mode], page 60).

20.1 $\backslash$hspace

Synopsis:

$\backslash$hspace$[*] \{ length \}$

The $\backslash$hspace command adds horizontal space. The $length$ argument can be expressed in any terms that $\LaTeX{}$ understands: points, inches, etc. It is a rubber length. You can add both negative and positive space with an $\backslash$hspace command; adding negative space is like backspacing.

$\LaTeX{}$ normally removes horizontal space that comes at the beginning or end of a line. To preserve this space, use the optional $*$ form.

20.2 $\backslash$hfill

The $\backslash$hfill fill command produces a “rubber length” which has no natural space but can stretch or shrink horizontally as far as needed.

The $\backslash$hfill parameter is the rubber length itself (technically, the glue value ‘$0pt \plus1fill$’); thus, $\backslash$hspace$\backslash$hfill is equivalent to $\backslash$hfill.

20.3 $\backslash$SPACE

The $\backslash$ (space) command produces a normal interword space. It’s useful after punctuation which shouldn’t end a sentence. For example Knuth’s article in Proc.\ Amer.\ Math\. Soc.\ is fundamental. It is also often used after control sequences, as in $\LaTeX{}$ is a nice system.

In normal circumstances, $\backslash$tab and $\backslash$newline are equivalent to $\backslash$.

20.4 $\backslash@$

The $\backslash@$ command makes the following punctuation character end a sentence even if it normally would not. This is typically used after a capital letter. Here are side-by-side examples with and without $\backslash@$:

... in C$@$. Pascal, though ...

... in C. Pascal, though ...

produces

... in C. Pascal, though ...

... in C. Pascal, though ...

20.5 $\backslash$thinspace

$\backslash$thinspace produces an unbreakable and unstretchable space that is 1/6 of an em. This is the proper space to use in nested quotes, as in ‘’.”
20.6 \(/

The \(\backslash /\) command produces an *italic correction*. This is a small space defined by the font designer for a given character, to avoid the character colliding with whatever follows. The italic \(f\) character typically has a large italic correction value.

If the following character is a period or comma, it’s not necessary to insert an italic correction, since those punctuation symbols have a very small height. However, with semicolons or colons, as well as normal letters, it can help. Compare \(f: f\) with \(f: f\).

Despite the name, roman characters can also have an italic correction. Compare pdfTEX with pdf\TeX.

20.7 \hrulefill

The \(\backslash \text{hrulefill}\) fill command produces a “rubber length” which can stretch or shrink horizontally. It will be filled with a horizontal rule.

20.8 \dotfill

The \(\backslash \text{dotfill}\) command produces a “rubber length” that fills with dots instead of just white space.

20.9 \addvspace

\addvspace{length}

The \(\backslash \text{addvspace}\) command normally adds a vertical space of height length. However, if vertical space has already been added to the same point in the output by a previous \(\backslash \text{addvspace}\) command, then this command will not add more space than needed to make the natural length of the total vertical space equal to \(\text{length}\).

20.10 \bigskip \medskip \smallskip

These commands produce a given amount of space.

\bigskip The same as \(\backslash \text{vspace} \{\text{bigskipamount}\}\), ordinarily about one line space (with stretch and shrink).

\medskip The same as \(\backslash \text{vspace} \{\text{medskipamount}\}\), ordinarily about half of a line space (with stretch and shrink).

\smallskip The same as \(\backslash \text{vspace} \{\text{smallskipamount}\}\), ordinarily about a quarter of a line space (with stretch and shrink).

The \(\ldots \text{amount}\) parameters are determined by the document class.

20.11 \vfill

The \(\backslash \text{vfill}\) fill command produces a rubber length (glue) which can stretch or shrink vertically as far as needed. It’s equivalent to \(\backslash \text{vspace} \{\text{fill}\}\) (see Section 20.2 [\hfill], page 65).
20.12 \texttt{\vspace[\star]{length}}

Synopsis:

\texttt{\vspace[\star]{length}}

The \texttt{\vspace} command adds the vertical space \textit{length}, i.e., a rubber length. \textit{length} can be negative or positive.

Ordinarily, \LaTeX{} removes vertical space added by \texttt{\vspace} at the top or bottom of a page. With the optional \star argument, the space is not removed.
21 Boxes

All the predefined length parameters (see Section 15.6 [Predefined lengths], page 47) can be used in the arguments of the box-making commands.

21.1 \mbox{text}

The \mbox command creates a box just wide enough to hold the text created by its argument. The text is not broken into lines, so it can be used to prevent hyphenation.

21.2 \fbox and \framebox

Synopses:
\fbox{text}
\framebox[width][position]{text}

The \fbox and \framebox commands are like \mbox, except that they put a frame around the outside of the box being created.

In addition, the \framebox command allows for explicit specification of the box width with the optional width argument (a dimension), and positioning with the optional position argument.

Both commands produce a rule of thickness \fboxrule (default ‘.4pt’), and leave a space of \fboxsep (default ‘3pt’) between the rule and the contents of the box.

See Section 9.19.3 [\framebox (picture)], page 27, for the \framebox command in the picture environment.

21.3 lrbox
\begin{lrbox}{cmd} text \end{lrbox}

This is the environment form of \sbox.

The text inside the environment is saved in the box cmd, which must have been declared with \newsavebox.

21.4 \makebox

Synopsis:
\makebox[width][position]{text}

The \makebox command creates a box just wide enough to contain the text specified. The width of the box is specified by the optional width argument. The position of the text within the box is determined by the optional position argument, which may take the following values:

- c Centered (default).
- l Flush left.
- r Flush right.
- s Stretch (justify) across entire width; text must contain stretchable space for this to work.
\makebox is also used within the picture environment see Section 9.19.2 [\makebox (picture)], page 26.

21.5 \parbox

Synopsis:
\parbox[position][height][inner-pos]{width}{text}

The \parbox command produces a box whose contents are created in paragraph mode. It should be used to make a box small pieces of text, with nothing fancy inside. In particular, you shouldn’t use any paragraph-making environments inside a \parbox argument. For larger pieces of text, including ones containing a paragraph-making environment, you should use a minipage environment (see Section 9.18 [minipage], page 25).

\parbox has two mandatory arguments:
width the width of the parbox;
text the text that goes inside the parbox.

The optional position argument allows you to align either the top or bottom line in the parbox with the baseline of the surrounding text (default is top).

The optional height argument overrides the natural height of the box.

The inner-pos argument controls the placement of the text inside the box, as follows; if it is not specified, position is used.
t text is placed at the top of the box.
text is centered in the box.
b text is placed at the bottom of the box.
s stretch vertically; the text must contain vertically stretchable space for this to work.

21.6 \raisebox

Synopsis:
\raisebox{distance}[height][depth]{text}

The \raisebox command raises or lowers text. The first mandatory argument specifies how high text is to be raised (or lowered if it is a negative amount). text itself is processed in LR mode.

The optional arguments height and depth are dimensions. If they are specified, \LaTeX treats text as extending a certain distance above the baseline (height) or below (depth), ignoring its natural height and depth.

21.7 \savebox

Synopsis:
\savebox{\boxcmd}{width}[pos]{text}

This command typeset text in a box just as with \makebox (see Section 21.4 [\makebox], page 68), except that instead of printing the resulting box, it saves it in the box labeled
\boxcmd, which must have been declared with \newsavebox (see Section 13.4 \newsavebox, page 43).

21.8 \sbox{\boxcmd}{text}

Synopsis:

\sbox{\boxcmd}{text}

\sbox types text in a box just as with \mbox (see Section 21.1 \mbox, page 68) except that instead of the resulting box being included in the normal output, it is saved in the box labeled \boxcmd. \boxcmd must have been previously declared with \newsavebox (see Section 13.4 \newsavebox, page 43).

21.9 \usebox{\boxcmd}

Synopsis:

\usebox{\boxcmd}

\usebox produces the box most recently saved in the bin \boxcmd by a \savebox command (see Section 21.7 \savebox, page 69).
22 Special insertions

\LaTeX provides commands for inserting characters that have a special meaning do not correspond to simple characters you can type.

22.1 Reserved characters

The following characters play a special role in \LaTeX and are called “reserved characters” or “special characters”:

\begin{verbatim}
# $ % & ~ _ ^ \ { } 
\end{verbatim}

Whenever you write one of these characters into your file, \LaTeX will do something special. If you simply want the character to be printed as itself, include a \ in front of the character. For example, \$ will produce $ in your output.

One exception to this rule is \ itself, because \ has its own special (context-dependent) meaning. A roman \ is produced by typing $\backslash$ in your file, and a typewriter \ is produced by using ‘\’ in a verbatim command (see Section 9.28 [verbatim], page 35).

Also, \ and \ place tilde and circumflex accents over the following letter, as in ô and ô (see Section 22.3 [Accents], page 74); to get a standalone “ or “, you can again use a verbatim command.

Finally, you can access any character of the current font once you know its number by using the \symbol command. For example, the visible space character used in the \verb* command has the code decimal 32, so it can be typed as \symbol{32}.

You can also specify octal numbers with ’ or hexadecimal numbers with “, so the previous example could also be written as \symbol{’40} or \symbol{"20}.

22.2 Text symbols

\LaTeX provides commands to generate a number of non-letter symbols in running text. Some of these, especially the more obscure ones, are not available in OT1; you may need to load the textcomp package.

\begin{verbatim}
\copyright
\textcopyright
\dag
\ddag
\LaTeX
\guillemotleft («)
\guillemotright (»)
\guilsinglleft (‹)
\guilsinglright (›)
\end{verbatim}

Double and single angle quotation marks, commonly used in French: «, », ‹, ›.
\ldots
\ldots
\textellipsis
An ellipsis (three dots at the baseline): ‘...’. \ldots and \ldots also work in math mode.
\lq
Left (opening) quote: ‘.
\p
\textparagraph
Paragraph sign (pilcrow).
\pounds
\textsterling
English pounds sterling: £.
\quotedblbase (,,)
\textquotesinglebase (,)
Double and single quotation marks on the baseline: ,, and ,.
\rq
Right (closing) quote: ‘.
\S
Section symbol.
\TeX
The \TeX logo.
\textasciicircum
ASCII circumflex: ^.
\textasciitilde
ASCII tilde: ~.
\textasteriskcentered
Centered asterisk: *.
\textbackslash
Backslash: \.
\textbar
Vertical bar: |.
\textbardbl
Double vertical bar.
\textbigcircle
Big circle symbol.
\textbraceleft
Left brace: {.
\textbraceright
Right brace: }.
\textbullet
Bullet: •.
\textcircled{letter}
letter in a circle, as in ®.
Composite word mark (invisible). The \textcapital... form has the cap height of the font, while the \textascender... form has the ascender height.

\textdagger
Dagger: †.

\textdaggerdbl
Double dagger: ‡.

\textdollar (or $)
Dollar sign: $.

\textemdash (or ---)
Em-dash: — (for punctuation).

\textendash (or --)
En-dash: — (for ranges).

\texteuro
The Euro symbol: €.

\textexclamdown (or !‘)
Upside down exclamation point: ¡.

\textgreater
Greater than: >.

\textless
Less than: <.

\textleftarrow
Left arrow.

\textordfeminine
\textordmasculine
Feminine and masculine ordinal symbols: ①, ②.

\textperiodcentered
Centered period: ·.

\textquestiondown (or ?‘)
Upside down questionation point: ¿.

\textquotedblleft (or ‘‘)
Double left quote: “.

\textquotedblright (or ‘)
Double right quote: ”.

\textquoteleft (or ‘)
Single left quote: ‘.

\textquoteright (or ’)
Single right quote: ’.
\textquotestraightbase
\textquotestraightdblbase
Single and double straight quotes on the baseline.
\textregistered
Registered symbol: ®.
\textrightarrow
Right arrow.
\textthreequartersemdash
“Three-quarters” em-dash, between en-dash and em-dash.
\texttrademark
Trademark symbol: TM.
\texttwelveudash
“Two-thirds” em-dash, between en-dash and em-dash.
\textunderscore
Underscore: _.
\textvisiblespace
Visible space symbol.

22.3 Accents
\LaTeX{} has wide support for many of the world’s scripts and languages, through the \texttt{babel} package and related support. This section does not attempt to cover all that support. It merely lists the core \LaTeX{} commands for creating accented characters.

The \texttt{\textbackslash capital...} commands produce alternative forms for use with capital letters. These are not available with OT1.

\texttt{\textbackslash "\textbackslash capitaldieresis}
Produces an umlaut (dieresis), as in ö.

\texttt{\textbackslash \textbackslash capitalacute}
Produces an acute accent, as in ó. In the \texttt{tabbing} environment, pushes current column to the right of the previous column (see Section 9.22 [tabbing], page 29).

\texttt{\textbackslash .
Produces a dot accent over the following, as in ó.

\texttt{\textbackslash \textbackslash capitalmacron
Produces a macron (overbar) accent over the following, as in ö.

\texttt{\textbackslash "
\texttt{\textbackslash capitalcircumflex
Produces a circumflex (hat) accent over the following, as in ó.

\texttt{\textbackslash \textbackslash capitalgrave
Produces a grave accent over the following, as in ö. In the \texttt{tabbing} environment, move following text to the right margin (see Section 9.22 [tabbing], page 29).
\~
\capitaltilde
  Produces a tilde accent over the following, as in ň.
\b
  Produces a bar accent under the following, as in ů.
\c
\capitalcedilla
  Produces a cedilla accent under the following, as in č.
\d
\capitaldotaccent
  Produces a dot accent under the following, as in ŵ.
\H
\capitalhungarumlaut
  Produces a long Hungarian umlaut accent over the following, as in ŏ.
\i
  Produces a dotless i, as in ‘ı’.
\j
  Produces a dotless j, as in ‘ȷ’.
\k
\capitalogonek
  Produces a letter with ogonek, as in ‘œ’. Not available in the OT1 encoding.
\r
\capitalring
  Produces a ring accent, as in ‘ő’.
\t
\capitaltie
\newtie
\capitalnewtie
  Produces a tie-after accent, as in ‘óó’. The \newtie form is centered in its box.
\u
\capitalbreve
  Produces a breve accent, as in ‘ő’.
\underbar
  Not exactly an accent, this produces a bar under the argument text. The argument is always processed in horizontal mode. The bar is always a fixed position under the baseline, thus crossing through descenders. See also \underline in Section 17.6 [Math miscellany], page 60.
\v
\capitalcaron
  Produces a háček (check, caron) accent, as in ‘ő’.

22.4 Non-English characters

Here are the basic LaTeX commands for inserting characters commonly used in languages other than English.
\aa \AA
å and Å.
\ae \AE
æ and Æ.
\dh \DH
Icelandic letter eth: ð and Ð.
\dj \DJ
xxxx
\ij \IJ
ij and IJ (except somewhat closer together than appears here).
\l \L
l and L.
\ng \NG
xxxx
\o \O
ø and Ø.
\oe \OE
œ and Œ.
\ss \SS
ß and SS.
\th \TH
Icelandic letter thorn: þ and Þ.

22.5 \rule

Synopsis:
\rule[raise]{width}{thickness}

The \rule command produces rules, that is, lines or rectangles. The arguments are:

- **raise** How high to raise the rule (optional).
- **width** The length of the rule (mandatory).
- **thickness** The thickness of the rule (mandatory).

22.6 \today

The \today command produces today’s date, in the format ‘month dd, yyyy’; for example, ‘July 4, 1976’. It uses the predefined counters \day, \month, and \year (see Section 14.8 [\day \month \year], page 46) to do this. It is not updated as the program runs.

The datetime package, among others, can produce a wide variety of other date formats.
Chapter 23: Splitting the input

23 Splitting the input

A large document requires a lot of input. Rather than putting the whole input in a single large file, it’s more efficient to split it into several smaller ones. Regardless of how many separate files you use, there is one that is the root file; it is the one whose name you type when you run \LaTeX.

See Section 9.11 \texttt{[filecontents]}, page 21, for an environment that allows bundling an external file to be created with the main document.

23.1 \texttt{include}

Synopsis:

\begin{verbatim}
\texttt{include\{file\}}
\end{verbatim}

If no \texttt{includeonly} command is present, the \texttt{include} command executes \texttt{clearpage} to start a new page (see Section 11.2 \texttt{[clearpage]}, page 39), then reads \texttt{file}, then does another \texttt{clearpage}.

Given an \texttt{includeonly} command, the \texttt{include} actions are only run if \texttt{file} is listed as an argument to \texttt{includeonly}. See the next section.

The \texttt{include} command may not appear in the preamble or in a file read by another \texttt{include} command.

23.2 \texttt{includeonly}

Synopsis:

\begin{verbatim}
\texttt{includeonly\{file1,file2,...\}}
\end{verbatim}

The \texttt{includeonly} command controls which files will be read by subsequent \texttt{include} commands. The list of filenames is comma-separated. Each \texttt{file} must exactly match a filename specified in a \texttt{include} command for the selection to be effective.

This command can only appear in the preamble.

23.3 \texttt{input}

Synopsis:

\begin{verbatim}
\texttt{input\{file\}}
\end{verbatim}

The \texttt{input} command causes the specified \texttt{file} to be read and processed, as if its contents had been inserted in the current file at that point.

If \texttt{file} does not end in \texttt{.tex} (e.g., \texttt{foo} or \texttt{foo.bar}), it is first tried with that extension (\texttt{foo.tex} or \texttt{foo.bar.tex}). If that is not found, the original \texttt{file} is tried (\texttt{foo} or \texttt{foo.bar}).
Chapter 24: Front/back matter

24 Front/back matter

24.1 Tables of contents

A table of contents is produced with the \tableofcontents command. You put the command right where you want the table of contents to go; LaTeX does the rest for you. A previous run must have generated a .toc file.

The \tableofcontents command produces a heading, but it does not automatically start a new page. If you want a new page after the table of contents, write a \newpage command after the \tableofcontents command.

The analogous commands \listoffigures and \listoftables produce a list of figures and a list of tables, respectively. Everything works exactly the same as for the table of contents.

The command \nofiles overrides these commands, and prevents any of these lists from being generated.

24.1.1 \addcontentsline

The \addcontentsline{ext}{unit}{text} command adds an entry to the specified list or table where:

- \texttt{ext} The extension of the file on which information is to be written, typically one of: toc (table of contents), lof (list of figures), or lot (list of tables).
- \texttt{unit} The name of the sectional unit being added, typically one of the following, matching the value of the ext argument:
  - toc The name of the sectional unit: part, chapter, section, subsection, subsubsection.
  - lof For the list of figures.
  - lot For the list of tables.
- \texttt{entry} The actual text of the entry.

What is written to the .ext file is the command \contentsline{unit}{name}.

24.1.2 \addtocontents

The \addtocontents{ext}{text} command adds text (or formatting commands) directly to the .ext file that generates the table of contents or lists of figures or tables.

- \texttt{ext} The extension of the file on which information is to be written: toc (table of contents), lof (list of figures), or lot (list of tables).
- \texttt{text} The text to be written.
24.2 Glossaries

The command \makeglossary enables creating glossaries.

The command \glossary{text} writes a glossary entry for text to an auxiliary file with the \texttt{.glo} extension.

Specifically, what gets written is the command \texttt{\glossaryentry{text}{pageno}}, where \texttt{pageno} is the current \texttt{\thepage} value.

The \texttt{glossary} package on CTAN provides support for fancier glossaries.

24.3 Indexes

The command \makeindex enables creating indexes. Put this in the preamble.

The command \index{text} writes an index entry for text to an auxiliary file with the \texttt{.idx} extension.

Specifically, what gets written is the command \texttt{\indexentry{text}{pageno}}, where \texttt{pageno} is the current \texttt{\thepage} value.

To generate a index entry for ‘bar’ that says ‘See foo’, use a vertical bar: \texttt{\index{bar|see{foo}}}. Use \texttt{seealso} instead of \texttt{see} to make a ‘See also’ entry.

The text ‘See’ is defined by the macro \texttt{\seename}, and ‘See also’ by the macro \texttt{\alsoname}. These can be redefined for other languages.

The generated \texttt{.idx} file is then sorted with an external command, usually either \texttt{makeindex} (\url{http://mirror.ctan.org/indexing/makeindex}) or (the multi-lingual) \texttt{xindy} (\url{http://xindy.sourceforge.net}). This results in a \texttt{.ind} file, which can then be read to typeset the index.

The index is usually generated with the \texttt{\printindex} command. This is defined in the \texttt{makeidx} package, so \texttt{\usepackage{makeidx}} needs to be in the preamble.

The rubber length \texttt{\indexspace} is inserted before each new letter in the printed index; its default value is ‘10pt plus5pt minus3pt’.

The \texttt{showidx} package causes each index entries to be shown in the margin on the page where the entry appears. This can help in preparing the index.

The \texttt{multind} package supports multiple indexes. See also the \TeX{} FAQ entry on this topic, \url{http://www.tex.ac.uk/cgi-bin/texfaq2html?label=multind}.
25 Letters

You can use \LaTeX to typeset letters, both personal and business. The \texttt{letter} document class is designed to make a number of letters at once, although you can make just one if you so desire.

Your .\texttt{tex} source file has the same minimum commands as the other document classes, i.e., you must have the following commands as a minimum:

\begin{verbatim}
\documentclass{letter}
\begin{document}
... letters ...
\end{document}
\end{verbatim}

Each letter is a \texttt{letter} environment, whose argument is the name and address of the recipient. For example, you might have:

\begin{verbatim}
\begin{letter}{Mr. Joe Smith
\hspace{1em}2345 Princess St.
\hspace{1em}Edinburgh, EH1 1AA}
... 
\end{letter}
\end{verbatim}

The letter itself begins with the \texttt{opening} command. The text of the letter follows. It is typed as ordinary \LaTeX input. Commands that make no sense in a letter, like \texttt{chapter}, do not work. The letter closes with a \texttt{closing} command.

After the \texttt{closing}, you can have additional material. The \texttt{cc} command produces the usual “cc: ...”. There’s also a similar \texttt{encl} command for a list of enclosures. With both these commands, use \texttt{\hspace{1em}} to separate the items.

These commands are used with the \texttt{letter} class.

25.1 \texttt{address\{return-address\}}

The \texttt{address} specifies the return address of a letter, as it should appear on the letter and the envelope. Separate lines of the address should be separated by \texttt{\hspace{1em}} commands.

If you do not make an \texttt{address} declaration, then the letter will be formatted for copying onto your organisation’s standard letterhead. (See Chapter 2 [Overview], page 3, for details on your local implementation). If you give an \texttt{address} declaration, then the letter will be formatted as a personal letter.

25.2 \texttt{cc}

Synopsis:

\begin{verbatim}
\cc{name1\hspace{1em}name2}
\end{verbatim}

Produce a list of \texttt{name}s the letter was copied to. Each name is printed on a separate line.

25.3 \texttt{closing}

Synopsis:

\begin{verbatim}
\closing{text}
\end{verbatim}

A letter closes with a \texttt{closing} command, for example,
\closing{Best Regards,}

25.4 \encl

Synopsis:
\encl{line1\line2}

Declare a list of one more enclosures.

25.5 \location

\location{address}

This modifies your organisation’s standard address. This only appears if the \firstpage pagestyle is selected.

25.6 \makelabels

\makelabels{number}

If you issue this command in the preamble, \LaTeX will create a sheet of address labels. This sheet will be output before the letters.

25.7 \name

\name{June Davenport}

Your name, used for printing on the envelope together with the return address.

25.8 \opening{text}

Synopsis:
\opening{text}

A letter begins with the \opening command. The mandatory argument, text, is whatever text you wish to start your letter. For instance:
\opening{Dear Joe,}

25.9 \ps

Use the \ps command to start a postscript in a letter, after \closing.

25.10 \signature{text}

Your name, as it should appear at the end of the letter underneath the space for your signature. \ starts a new line within text as usual.

25.11 \startbreaks

\startbreaks

Used after a \stopbreaks command to allow page breaks again.
25.12 \stopbreaks
\stopbreaks
Inhibit page breaks until a \startbreaks command occurs.

25.13 \telephone
\telephone{number}
This is your telephone number. This only appears if the firstpage pagestyle is selected.
26 Terminal input/output

26.1 `\texttt{\textbackslash typein[cmd]\{msg\}}`  
Synopsis:  
```
\texttt{\textbackslash typein[cmd]\{msg\}}
```
`\texttt{\textbackslash typein}` prints `msg` on the terminal and causes L\LaTeX{} to stop and wait for you to type a line of input, ending with return. If the optional `cmd` argument is omitted, the typed input is processed as if it had been included in the input file in place of the `\texttt{\textbackslash typein}` command. If the `cmd` argument is present, it must be a command name. This command name is then defined or redefined to be the typed input.

26.2 `\texttt{\textbackslash typeout\{msg\}}`  
Synopsis:  
```
\texttt{\textbackslash typeout\{msg\}}
```
Prints `msg` on the terminal and in the log file. Commands in `msg` that are defined with `\texttt{\textbackslash newcommand}` or `\texttt{\textbackslash renewcommand}` (among others) are replaced by their definitions before being printed.

L\LaTeX{}’s usual rules for treating multiple spaces as a single space and ignoring spaces after a command name apply to `msg`. A `\texttt{\textbackslash space}` command in `msg` causes a single space to be printed, independent of surrounding spaces. A `\texttt{\textbackslash ^\textbackslash J}` in `msg` prints a newline.
27 Command line

The input file specification indicates the file to be formatted; \TeX uses .tex as a default file extension. If you omit the input file entirely, \TeX accepts input from the terminal. You specify command options by supplying a string as a parameter to the command; e.g.

\begin{verbatim}
latex '\nonstopmode\input foo.tex'
\end{verbatim}

will process \textit{foo.tex} without pausing after every error.

If \TeX\ stops in the middle of the document and gives you a ‘*’ prompt, it is waiting for input. You can type \texttt{\textbackslash stop} (and return) and it will prematurely end the document.
Appendix A Document templates

Although not reference material, perhaps these document templates will be useful. Additional template resources are listed http://tug.org/interest.html#latextemplates.

A.1 book template
\documentclass{book}
\title{Book Class Template}
\author{Alex Author}
\begin{document}
\maketitle
\chapter{First}
Some text.
\chapter{Second}
Some other text.
\section{A subtopic}
The end.
\end{document}

A.2 beamer template
The beamer class creates slides presentations.
\documentclass{beamer}
\title{Beamer Class template}
\author{Alex Author}
\date{July 31, 2007}
\begin{document}
\maketitle
\begin{frame}[]
\frametitle{First Slide}
\begin{verbatim}
This is \verbatim!
\end{verbatim}
\end{frame}
\verbatim
This is \verbatim!
\verbatim\end{document}
A.3 tugboat template

TUGboat is the journal of the \TeX{} Users Group, http://tug.org/TUGboat.
\documentclass{ltugboat}
\usepackage{graphicx}
\usepackage{ifpdf}
\ifpdf
\usepackage[breaklinks,hidelinks]{hyperref}
\else
\usepackage{url}
\fi
\title{Example \TUB\ article}
% repeat info for each author.
\author{First Last}
\address{Street Address \ Town, Postal \ Country}
\netaddress{user (at) example dot org}
\personalURL{http://example.org/~user/}
\begin{document}
\maketitle
\begin{abstract}
This is an example article for \TUB{}.
\end{abstract}
\section{Introduction}
This is an example article for \TUB{}, from
\url{http://tug.org/TUGboat/location.html}.

We recommend the graphicx package for image inclusions, and the
hyperref package for active url's (in the \acro{PDF} output).
Nowadays \TUB\ is produced using \acro{PDF} files exclusively.

The \texttt{ltugboat} class provides these abbreviations and many more:

% verbatim blocks are often better in \small
\begin{verbatim}\small
\AllTeX \AMS \AmS \AmSLaTeX \AmSTeX \aw \AW
\BibTeX \CTAN \DTD \HTML
\ISBN \ISSN \LaTeXe
\end{verbatim}
\acro{FRED} -> {\small[er] fred} \% please use!
\cs{fred} -> \fred
\env{fred} -> \begin{fred}
\meta{fred} -> <fred>
\nth{n} -> 1st, 2nd, ...
\sfrac{3/4} -> 3/4
\booktitle{Book of Fred}
\end{verbatim}

For more information, see the ltuguid document at:
\url{http://mirror.ctan.org/macros/latex/contrib/tugboat}
(we recommend using \verb|mirror.ctan.org| for \CTAN\ references).

Email \verb|tugboat@tug.org| if problems or questions.

\bibliographystyle{plain} \% we recommend the plain bibliography style
\nocite{book-minimal} \% just making the bibliography non-empty
\bibliography{xampl} \% xampl.bib comes with BibTeX

\makesignature
\end{document}
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