



LATEX

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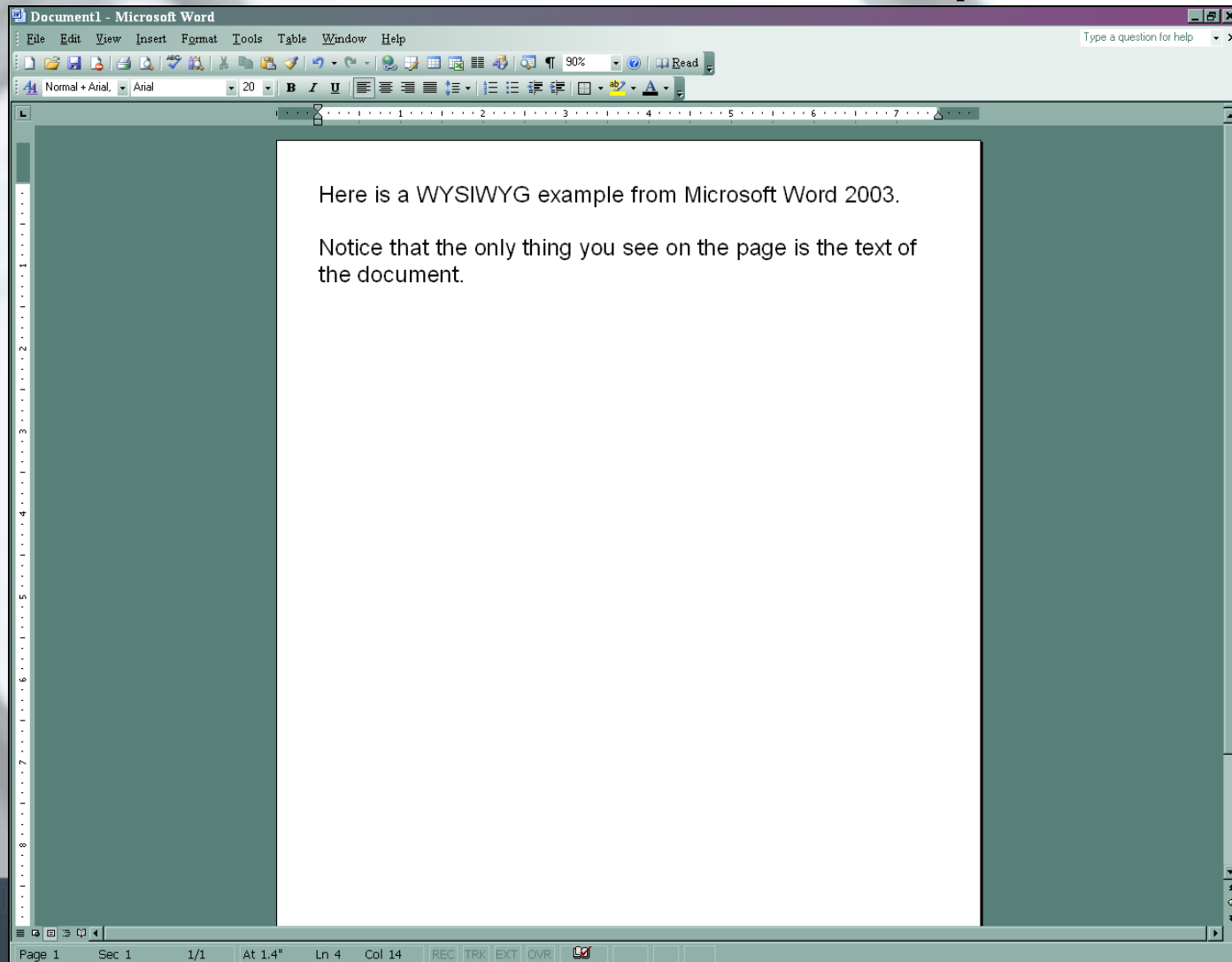
A Brief History of TeX

- Pronounced “Tech” because it’s supposed to be the Greek letters Tau, Epsilon, and Chi.
- TeX is a typesetting program used to produce documents. It has the same goal as Microsoft Word, but the method to achieve the end document is different.
- Word is a WYSIWYG (What You See Is What You Get) system. This means that what you see on the screen is approximately what prints out on paper
- TeX is a markup language, similar to HTML, where the user enters the format for the document as commands, as well as entering the text of the document.

A Brief History of LaTeX

- Pronounced “Lay-Tech” or “Lah-Tech”
- A supplement to TeX designed by Leslie Lamport (hence the “La” in LaTeX)
- In LaTeX itself, the word is written L^AT_EX
- In ASCII we use LaTeX

WYSIWYG versus Markup



WYSIWYG versus Markup

Below is a sample of a LaTeX .tex file, which shows the commands in blue.

```
\documentclass[12pt]{article}

\setlength{\textwidth}{5.0 in}
\setlength{\oddsidemargin}{0.5 in}
\setlength{\evensidemargin}{0.5 in}
\topmargin-0.9in
\textheight=7in

\begin{document}
%Page 1

\Huge
\newpage
Here is an example from LaTeX, an extension on TeX.\\
Notice that you see both this text and the commands to format the page.\\

\end{document}
```

[LaTeX Example.tex](#)

WYSIWYG versus Markup

- To the right is the PDF output from running LaTeX on the .tex file from the previous slide.
- Note that the PDF does not show the page formatting details.

Here is an example from LaTeX, an extension on TeX.
Notice that you see both this text and the commands to format the page.

LaTeX Commands

- LaTeX commands are CASE SENSITIVE!
- They always start with a `\` and are followed by either a name with only letters, or by a single non-letter (see [Special Characters](#))

LaTeX File Structure

preamble { `\documentclass[options]{class}`
`\usepackage[options]{class}`

body { `\begin{document}`
lines of text
`\end{document}`

`\documentclass[options]{class}`

- **class** – specifies the type of document to be created
 - Ex. `article`, `proc`, `minimal`, `report`, `book`, `slides`
- **options** – parameters which allow the settings for the document class to be changed
 - Ex. `10 pt`, `11 pt`, `12 pt` `onecolumn`, `twocolumn`
`a4paper`, `letterpaper` `twoside`, `oneside`
`fleqn`, `leqno` `landscape`
`titlepage`, `notitlepage` `openright`, `openany`

Common Packages

- Any of the below can be used as the *class* argument of `\usepackage[options]{class}`
- `doc` - documentation
- `exscale` – scaled versions of the math font
- `fontenc` – LaTeX font encoding
- `ifthen` – allows logical commands
- `latexsym` – symbol font
- `makeidx` – produces indexes
- `syntonly` – processes a document without generating the output; saves time
- `inputenc` – allows specification of an input encoding (ASCII, Apple, etc...)
- `amsmath` – special math commands

More Document Commands

- Setting the Page Style
 - `\pagestyle{style}`
 - *style* – sets the type of header or footer
 - ex. plain, headings, empty...
 - `\thispagestyle{style}` – applies the style to only the current page.

Page Style Examples

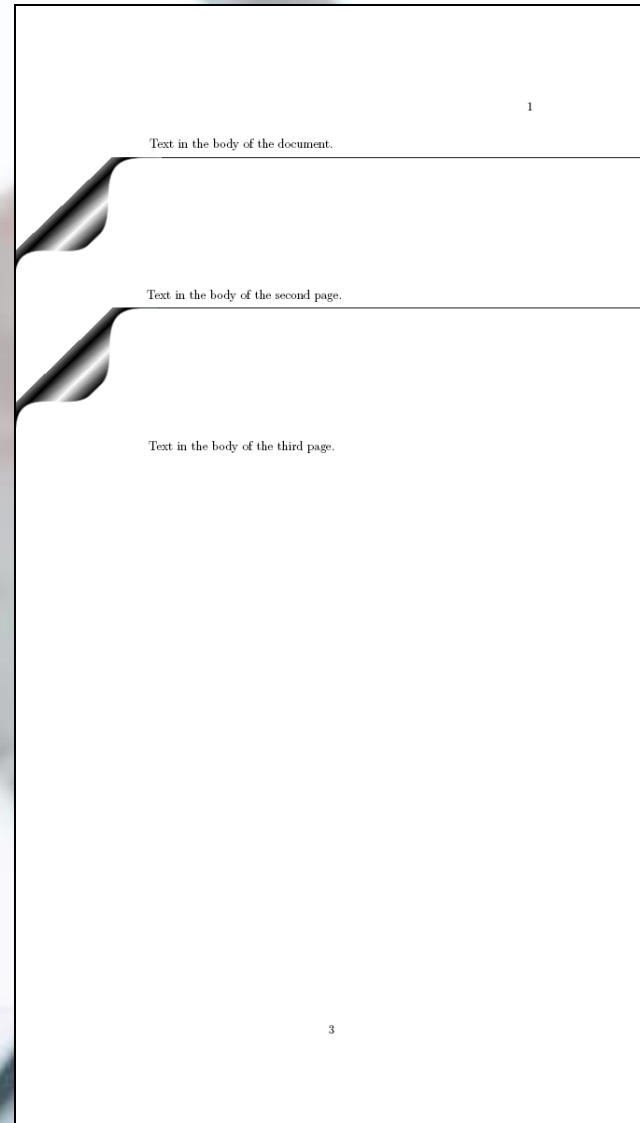
L^AT_EX

Code:

```
\documentclass[12pt]{article}
\pagestyle{headings}

\begin{document}
Text in the body of the document.
\newpage
\thispagestyle{empty}
Text in the body of the second page.
\newpage
\thispagestyle{plain}
Text in the body of the third page.
\end{document}
```

PDF File:



More Document Commands

- Including Files
 - `\include{filename}`
 - *filename* – name of another document that you want to include somewhere in this document.
 - NOTE: a new page is started where the document is inserted
 - `\includeonly{filename1, filename2, ...}`
 - `\include` commands in the body will only work for filenames given as arguments to this command.
 - This command goes in the preamble, the other commands listed here go in the body.
 - `\input{filename}`
 - works the same as the `\include` command, but LaTeX reorganizes the page breaks after including the new document.

Include Example Code

```
\documentclass[12pt]{article}

\includeonly{fileex1}

\begin{document}

Here is some text before the other file is inserted.

\include{fileex1}

Here is some text after the other file is inserted.

\include{fileex3}

Here is some text after a file is included that wasn't in the includeonly statement.

\end{document}
```

Include Example PDF File

Here is some text before the other file is inserted.

This is the text in fileex1.tex

Here is some text after the other file is inserted.

Here is some text after a file is included that wasn't in the includeonly statement.

Comments

- Use `% comment text` to add a single line of comments
- To add multiple lines of comments, use:

```
\begin{comment}  
  comment text  
\end{comment}
```

**need to use package verbatim*

Whitespace

- Whitespace is any empty space on the page
- A single “” space and multiple spaces “” are all handled as a single space by LaTeX
 - The symbol “” denotes a single space.
- A single line break is also handled as a single space by LaTeX
- A double line break signals the end of a paragraph
- A period “`.`” after a lowercase letter is taken by LaTeX to be the end of a sentence and therefore it automatically inserts a double space
- A period after an uppercase letter is taken as an abbreviation so no extra space is added

Whitespace, cont...

- To indicate that a period after a lowercase letter is part of an abbreviation, use `.~`
- Use `\@.` to indicate a period after an uppercase letter is the end of a sentence and not an abbreviation
- To remove the extra space after all periods, use the command `\frenchspacing`
- `V` is called the “Italic Correction.” It inserts a small space after an italic letter to compensate for the slant. (`V` is `\` and `/` not the letter `V`)
- Any whitespace after a command is ignored; put `{_}` to get a space after a command

Whitespace, cont...

- To insert horizontal blank space within a paragraph, use: `\hspace{n}` or `\hspace*{n}`
- Similarly, you can insert vertical space by using `\vspace{n}` or `\vspace*{n}`

`\hspace{n}` or
`\hspace*{n}`

the `*` tells LaTeX that even if there is a line break, don't ignore the horizontal space

`n` is the length of the blank space given in the units shown to the right.

pt	point	1 in = 72.27 pt
pc	pica	1 pc = 12 pt
in	inch	1 in = 2.54 cm
bp	big pt	1 in = 72 bp
cm	centimeter	1 cm = 10 mm
mm	millimeter	
dd	didot	1157 dd = 1238 pt
cc	cicero	1 cc = 12 dd
sp	scaled pt	65536 sp = 1 pt

Whitespace Example Code

```

\documentclass[10pt]{article}

\setlength{\oddsidemargin}{0in}
\setlength{\evensidemargin}{0in}
\setlength{\textwidth}{8in}

\begin{document}
\noindent Various examples of whitespace: \ \ \

\noindent \begin{tabular}{l|l}
( ) & a single space \ \
(  ) & several spaces \ \
A sentence. And a second sentence. & period at the end of a sentence \ \
An abbreviation S.C.U.B.A. all in one sentence. & period after a capital letter \ \
An abbreviation S.C.U.B.A\@. And a second sentence. & capital letter at the end of a sentence with correction\ \
This is High St. and this is the same sentence. & period after a lowercase and not the end of a sentence \ \
This is High St.~and this is the same sentence. & with the correction \ \
\ frenchspacing{With french spacing. Sentence two. Sentence three} & using frenchspacing\ \
\em Important words \em in italic & without the Italic Correction\ \
\em Important words\ / \em in italic & with the Italic Correction\ \
Command here \emph without two spaces & command with one space\ \
Command here \emph{ } with an extra space & command with two spaces\ \
\end{tabular}
\ \ \ \ \ Two inches of horizontal whitespace has been \hspace{2in} added to this paragraph.
\vspace*{2in}\ \
Two inches of vertical whitespace has been added before this paragraph.
\end{document}

```

Whitespace Example PDF File

Various examples of whitespace:

()

()

A sentence. And a second sentence.

An abbreviation S.C.U.B.A. all in one sentence.

An abbreviation S.C.U.B.A. And a second sentence.

This is High St. and this is the same sentence.

This is High St. and this is the same sentence.

With french spacing. Sentence two. Sentence three

Important words in italic

Important words in italic

Command here *without* two spaces

Command here *with* an extra space

a single space

several spaces

period at the end of a sentence

period after a capital letter

capital letter at the end of a sentence with correction

period after a lowercase and not the end of a sentence

with the correction

using frenchspacing

without the Italic Correction

with the Italic Correction

command with one space

command with two spaces

Two inches of horizontal whitespace has been

added to this paragraph.

Two inches of vertical whitespace has been added before this paragraph.

Special Strings

- Strings
 - `\TeX`, `\LaTeX`, `\LaTeX2e` display the formatted text. For example `\LaTeX` shows L^AT_EX
 - `\today` displays the current date

Special Symbols

Symbols	Code
$1 + 2 + 3 + \cdots + n$	<code>\cdots</code>
$1, 2, \dots, n$	<code>\ldots</code>
©	<code>\copyright</code>
“	<code>``</code> (two grave accents)
”	<code>“</code> (two single quotes)
hyphenated-name	-
pages 10–15	--
sentence—interruption!	---
$1 - 5 = 4$	<code>-\$-\$</code>
\tilde{n}	<code>\~n</code>
$\sim \text{text}$	<code>\$\$\sim\$</code>
$^{\circ} \text{F}$	<code>\$\$\text{,}^{\circ}\{\text{circ}\}\$</code>

Common Body Typesetting Commands

- Line Breaks
 - `\\` or `\newline` – starts a new line but not a new paragraph.
 - `*` starts a new line but prohibits a page break at that location.
 - With `\linebreak[n]` and `\nolinebreak[n]` LaTeX tries to position a line break (or not position one) that looks good based on the value of *n*
 - *n* can be an integer from 0-4; the higher the number the stronger the recommendation to LaTeX to perform the line break.
 - In general, LaTeX tries to position new lines so that the text is evenly spaced.

Common Body Typesetting Commands

- Page Breaks
 - `\newpage` – starts a new page
 - Similar to `\linebreak[n]`, with `\pagebreak[n]` and `\nopagebreak[n]` LaTeX tries to even out the right border of the page based on the value of n (0-4)
- `\sloppy` loosens LaTeX's even positioning; `\fussy` restores LaTeX back to it's normal positioning

Hyphenation

- LaTeX automatically hyphenates words as necessary to even out the right border.
- `\hyphenation{wordlist}` – this command goes in the preamble; it allows the default hyphenating of LaTeX to be overridden; the words given in *wordlist* are hyphenated as specified by the `\-` in the words; a lack of `\-` in a word tells LaTeX not to hyphenate that word at all.
- In the body of the text, `\-` can also be used to suggest where a hyphen should go.

Hyphenation cont...

- Words with special characters are not automatically hyphenated. The hyphenation must be specified.
- To prevent hyphenation of words, use `\mbox{text}` or `\fbox{text}`
 - Any words in *text* are kept together under all circumstances. To show just the text, use `\mbox`, to draw a box around the text, use `\fbox`.

Hyphenation Example Code

```
\documentclass[10pt]{article}

\hyphenation{fan-cy good-bye
sup-er-cal-i-frag-il-is-tic-ex-pi-al-i-do-ci-ous)

\begin{document}

I like to have lots of long and short words that I
hyphenate.  You can specify the hyphenation in more than
one location, which can be important if you want to
specify the hyphenation of many words and have a default
and a special case. This word was hyphenated in the
preamble of the document
supercalifragilisticexpialidocious.  \ \ On the other
hand, the name of the official state fish of Hawaii,
\mbox{Humuhumunukunukuapua'a}, was set to never
hyphenate!\ \ \ \

The hyphenation can also be specified in line, such as
here: flocci\ -nauci\ -ni\ -hili\ -pili\ -fi\ -ca\ -tion.  But
for one of the longest Spanish words,
superextraordinar\acute{\mbox{i}}\simamente, you must
tell \LaTeX{ } where to hyphenate because of the special
character.

\end{document}
```

Hyphenation Example PDF File

I like to have lots of long and short words that I hyphenate. You can specify the hyphenation in more than one location, which can be important if you want to specify the hyphenation of many words and have a default and a special case. This word was hyphenated in the preamble of the document supercalifragilisticexpialidocious.

On the other hand, the name of the official state fish of Hawaii, Humuhumunukunukuapua'a, was set to never hyphenate!

The hyphenation can also be specified in line, such as here: floccinaucinihilipilification. But for one of the longest Spanish words, superextraordinarísimamente, you must tell L^AT_EX where to hyphenate because of the special character.

Font Types

- `\rm` – roman
- `\sl` – slanted roman
- `\it` – italic
- `\tt` – typewriter
- `\bf` – boldface
- `\em` – emphasis
- `\emph{text}` – same as above, but this doesn't change the font and will work to emphasize any font
- `\underline{text}` – also doesn't change the font, just underlines it

Examples:

Roman
<i>Slanted Roman</i>
<i>Italic</i>
Typewriter
Boldface
<i>Emphasis</i>
<i>Emphasized Roman</i> <i>Emphasized Typewriter</i>
<u>Underlined Roman</u> <u>Underlined Typewriter</u>

Running LaTeX from Command Line

- LaTeX input files must end in `.tex` and be stored as a plain ASCII text file, not RTF or any other format
- To run LaTeX on a file, enter
`latex blah.tex`
If no errors are found, this will generate a `.dvi` file
- If there is an error, LaTeX will give some indication and stop processing the file; Ctrl-D will return you to the command line (exits LaTeX)
- To convert to PS, you can use
`dvips -Pcmz blah.dvi -o blah.ps`

Mathematical Expressions

- To insert a mathematical expression directly into a line of text, surround the expression with $\$expression\$$.
- To insert an expression in its own line, surround it by $\left[expression\right]$.

Code:

```
\documentclass{article}

\begin{document}
An expression in a line of text  $a^2 + b^2 = c^2$  can be like
this.\\
A longer equation can be placed in it's own line, like this:
\left[2x + 3xy + x^2y + 2xy^3 = 14\right]
\end{document}
```

PDF File:

An expression in a line of text $a^2 + b^2 = c^2$ can be like this.

A longer equation can be placed in it's own line, like this:

$$2x + 3xy + x^2y + 2xy^3 = 14$$

Mathematical Expressions, cont...

- To insert numbered or multiline expressions, use the following:

<code>\begin{equation}</code> <i>expressions</i> <code>\end{equation}</code>	numbered
<code>\begin{align}</code> [†] <i>expressions</i> <code>\end{align}</code>	numbered, multiline, can align equations using “&” symbol
<code>\begin{align*}</code> [†] <i>expressions</i> <code>\end{align*}</code>	unnumbered, multiline, can align equations using “&” symbol
<code>\begin{array}</code> <i>expressions</i> <code>\end{array}</code> \$	an array or matrix

[†] requires amsmath package

Mathematical Expressions Examples

<pre>\begin{equation} u=abcba{\diamond} \end{equation}</pre>	$u = abcba\diamond \quad (1)$
<pre>\begin{align} w &= bcaa{\diamond}abb \\ x &= abc \end{align}</pre>	$w = bcaa\diamond abb \quad (2)$ $x = abc \quad (3)$
<pre>\begin{align*} y &= 101{\diamond}010 \\ t &= 00100100{\diamond} \end{align*}</pre>	$y = 101\diamond 010$ $t = 00100100\diamond$
<pre>\begin{center} \$\begin{array}{cccccc} & a & \diamond & b & b & b \\ & a & \diamond & b & b & b \\ & a & a & \diamond & b & \\ b & \diamond & \diamond & b & b & \\ b & b & b & b & b & \end{array}\$ \end{center}</pre>	$ \begin{array}{cccccc} & a & \diamond & b & b & b \\ & a & \diamond & b & b & b \\ & a & a & \diamond & b & \\ b & \diamond & \diamond & b & b & \\ b & b & b & b & b & \end{array} $

Mathematical Font Types

- `\mathnormal` - default
- `\mathit` – math italic
- `\boldmath... \unboldmath` – math bold
- `\mathbf` – boldface
- `\mathrm` – roman
- `\mathsl` – slanted roman
- `\mathtt` – typewriter
- `\mathcal` – calligraphic (symbols)
- `\mathbb` – blackboard bold

Mathematical Font Examples

Code:

```
\documentclass{article}

\begin{document}
  \noindent
    $\mathnormal{Normal}$ \\
    $\mathit{Italic}$ \\
    $\mathbf{Boldface}$ \\
    \boldmath $Math Bold$ \rm \\
    $\mathrm{Roman}$ \\
    $\mathsf{San Serif}$ \\
    $\mathtt{Typewriter}$ \\
    $\mathcal{CALLIGRAPHIC}$ \\
\end{document}
```

PDF File:

```
Normal
Italic
Boldface
MathBold
Roman
SanSerif
Typewriter
CALLIGRAPHIC
```

Whitespace in Mathematical Expressions

- `\quad` – inserts a blank space the size of the letter “M”
- `\qquad` – inserts a blank space twice the size of `\quad`
- `\,` - inserts a thin blank space
- `\!` – removes a thin blank space

Code:

```
\documentclass{article}

\begin{document}
\noindent
A quad whitespace  $\|\quad\|$ . \\
A thin blank space  $\|\,\|$ . \\
Removing a thin blank space  $\|\!\!\|$ .

\end{document}
```

PDF File:

```
A quad whitespace | |.
A thin blank space ||.
Removing a thin blank space ||.
```

Mathematical Expression Syntax

- Prime:
 - $\$n'\$ - n'$
- Superscripts and Subscripts:
 - $\$a^b\$ - a^b$
 - $\$a_b\$ - a_b$
 - $\$a^{\{bc\}}\$ - a^{bc}$
 - $\$a_{\{bc\}}\$ - a_{bc}$
 - They can be nested as well, like $\$a_{\{b_c\}}\$ - a_{b_c}$
- Fractions:
 - $\$\frac{\textit{numerator}}{\textit{denominator}}\$ - \textit{numerator}$ and $\frac{1+2}{b-c}$
 $\textit{denominator}$ can be mathematical expressions

Mathematical Expression Syntax, cont...

- Square Roots:
 - `\sqrt[n]{expression}`, where n is the degree of the root
- Large Delimiters:
 - `\left(expression \right)`, where (and) are the delimiters (these could also be [], { }, or || also)
 - `\overline{expression}` and `\underline{expression}` create a line over or under an expression
- Text in an Expression:
 - to insert text so its not in math italic, use `\mbox{text}`

Mathematical Expression Syntax Examples

Code:

```
\documentclass{article}
\usepackage{amssymb}

\begin{document}


$$\sqrt[3]{b^3} = b$$


\begin{center}\[d = \left\{
\begin{array}{ll}
\overline{\text{Bin}'(vw_iv)(h'-p'(vw_iv))} & \text{if } \alpha \neq \square \text{ and } b = \alpha \text{ and } a = \beta \\
\text{Bin}'(vw_iv)(h'-p'(vw_iv)) & \text{if } \alpha \neq \square \text{ and } (b \neq \alpha \text{ or } a \neq \beta) \\
\text{Bin}'(vw_iv)(h'+p'(vw_iv)) & \text{if } \alpha = \square \text{ and } \beta \neq \square \text{ and } a = \beta \\
\overline{\text{Bin}'(vw_iv)(h'+p'(vw_iv))} & \text{if } \alpha = \square \text{ and } \beta \neq \square \text{ and } a \neq \beta \\
0 & \text{otherwise}
\end{array}
\right.\]
\end{center}

\end{document}
```

PDF File:

$$\sqrt[3]{b^3} = b$$

$$d = \begin{cases} \overline{\text{Bin}'(vw_iv)(h' - p'(vw_iv))} & \text{if } \alpha \neq \square \text{ and } b = \alpha \text{ and } a = \beta \\ \text{Bin}'(vw_iv)(h' - p'(vw_iv)) & \text{if } \alpha \neq \square \text{ and } (b \neq \alpha \text{ or } a \neq \beta) \\ \text{Bin}'(vw_iv)(h' + p'(vw_iv)) & \text{if } \alpha = \square \text{ and } \beta \neq \square \text{ and } a = \beta \\ \overline{\text{Bin}'(vw_iv)(h' + p'(vw_iv))} & \text{if } \alpha = \square \text{ and } \beta \neq \square \text{ and } a \neq \beta \\ 0 & \text{otherwise} \end{cases}$$

Mathematical Expression Symbols:

Lowercase Greek

Display	Code	Display	Code	Display	Code
α	<code>\alpha</code>	ι	<code>\iota</code>	σ	<code>\sigma</code>
β	<code>\beta</code>	κ	<code>\kappa</code>	ς	<code>\varsigma</code>
γ	<code>\gamma</code>	λ	<code>\lambda</code>	τ	<code>\tau</code>
δ	<code>\delta</code>	μ	<code>\mu</code>	υ	<code>\upsilon</code>
ϵ	<code>\epsilon</code>	ν	<code>\nu</code>	ϕ	<code>\phi</code>
ε	<code>\varepsilon</code>	ξ	<code>\xi</code>	φ	<code>\varphi</code>
ζ	<code>\zeta</code>	π	<code>\pi</code>	χ	<code>\chi</code>
η	<code>\eta</code>	ϖ	<code>\varpi</code>	ψ	<code>\psi</code>
θ	<code>\theta</code>	ρ	<code>\rho</code>	ω	<code>\omega</code>
ϑ	<code>\vartheta</code>	ϱ	<code>\varrho</code>		

Mathematical Expression Symbols:

Uppercase Greek

Display	Code	Display	Code
Γ	<code>\Gamma</code>	Σ	<code>\Sigma</code>
Δ	<code>\Delta</code>	Υ	<code>\Upsilon</code>
Θ	<code>\Theta</code>	Φ	<code>\Phi</code>
Λ	<code>\Lambda</code>	Ψ	<code>\Psi</code>
Ξ	<code>\Xi</code>	Ω	<code>\Omega</code>
Π	<code>\Pi</code>		

Mathematical Expression Symbols:

Miscellaneous

Display	Code	Display	Code	Display	Code
\aleph	<code>\aleph</code>	$'$	<code>\prime</code>	\forall	<code>\forall</code>
\hbar	<code>\hbar</code>	\emptyset	<code>\emptyset</code>	\exists	<code>\exists</code>
\imath	<code>\imath</code>	∇	<code>\nabla</code>	\neg	<code>\neg</code>
\jmath	<code>\jmath</code>	\surd	<code>\surd</code>	\flat	<code>\flat</code>
ℓ	<code>\ell</code>	\top	<code>\top</code>	\natural	<code>\natural</code>
\wp	<code>\wp</code>	\perp	<code>\perp</code>	\sharp	<code>\sharp</code>
\Re	<code>\Re</code>	\parallel	<code>\parallel</code>	\clubsuit	<code>\clubsuit</code>
\Im	<code>\Im</code>	\angle	<code>\angle</code>	\diamondsuit	<code>\diamondsuit</code>
∂	<code>\partial</code>	\triangle	<code>\triangle</code>	\heartsuit	<code>\heartsuit</code>
∞	<code>\infty</code>	\backslash	<code>\backslash</code>	\spadesuit	<code>\spadesuit</code>

Mathematical Expression Operators:

Binary

Display	Code	Display	Code	Display	Code
\pm	<code>\pm</code>	\cap	<code>\cap</code>	\vee	<code>\vee</code>
\mp	<code>\mp</code>	\cup	<code>\cup</code>	\wedge	<code>\wedge</code>
\setminus	<code>\setminus</code>	\oplus	<code>\oplus</code>	\oplus	<code>\oplus</code>
\cdot	<code>\cdot</code>	\sqcap	<code>\sqcap</code>	\ominus	<code>\ominus</code>
\times	<code>\times</code>	\sqcup	<code>\sqcup</code>	\otimes	<code>\otimes</code>
$*$	<code>*</code>	\triangleleft	<code>\triangleleft</code>	\oslash	<code>\oslash</code>
\star	<code>\star</code>	\triangleright	<code>\triangleright</code>	\odot	<code>\odot</code>
\diamond	<code>\diamond</code>	\wr	<code>\wr</code>	\dagger	<code>\dagger</code>
\circ	<code>\circ</code>	\bigcirc	<code>\bigcirc</code>	\ddagger	<code>\ddagger</code>
\bullet	<code>\bullet</code>	\triangleup	<code>\triangleup</code>	\amalg	<code>\amalg</code>
\div	<code>\div</code>	\triangledown	<code>\triangledown</code>		

Mathematical Expression Operators:

Large

Display	Code	Display	Code
Σ	<code>\sum</code>	\sqcup	<code>\bigsqcup</code>
\prod	<code>\prod</code>	\vee	<code>\bigvee</code>
\coprod	<code>\coprod</code>	\wedge	<code>\bigwedge</code>
\int	<code>\int</code>	\odot	<code>\bigodot</code>
\oint	<code>\oint</code>	\otimes	<code>\bigotimes</code>
\bigcap	<code>\bigcap</code>	\oplus	<code>\bigoplus</code>
\bigcup	<code>\bigcup</code>	\bigoplus	<code>\biguplus</code>

Mathematical Expression Operators:

Relations

Display	Code	Display	Code	Display	Code
\leq	<code>\leq *</code>	\geq	<code>\geq *</code>	\equiv	<code>\equiv *</code>
\prec	<code>\prec *</code>	\succ	<code>\succ *</code>	\sim	<code>\sim *</code>
\preceq	<code>\preceq *</code>	\succeq	<code>\succeq *</code>	\simeq	<code>\simeq *</code>
\ll	<code>\ll</code>	\gg	<code>\gg</code>	\asymp	<code>\asymp *</code>
\subset	<code>\subset *</code>	\supset	<code>\supset *</code>	\approx	<code>\approx *</code>
\subseteq	<code>\subseteq *</code>	\supseteq	<code>\supseteq *</code>	\cong	<code>\cong *</code>
\sqsubset	<code>\sqsubseteq *</code>	\sqsupset	<code>\sqsupseteq *</code>	\bowtie	<code>\bowtie</code>
\in	<code>\in</code>	\ni	<code>\ni</code>	\propto	<code>\propto</code>
\vdash	<code>\vdash</code>	\dashv	<code>\dashv</code>	\models	<code>\models</code>
\smile	<code>\smile</code>	\mid	<code>\mid</code>	\doteq	<code>\doteq</code>
\frown	<code>\frown</code>	\parallel	<code>\parallel</code>	\perp	<code>\perp</code>

* Can be negated with a `\not` in front of the command; this also works with `\not<`, `\not>`, and `\not=`

Mathematical Expression Operators:

Arrows

Display	Code	Display	Code	Display	Code
\leftarrow	<code>\leftarrow</code>	\longleftarrow	<code>\longleftarrow</code>	\uparrow	<code>\uparrow</code> *
\Lleftarrow	<code>\Lleftarrow</code>	\Llongleftarrow	<code>\Llongleftarrow</code>	\Uparrow	<code>\Uparrow</code>
\rightarrow	<code>\rightarrow</code>	\longrightarrow	<code>\longrightarrow</code>	\downarrow	<code>\downarrow</code> *
\Rightarrow	<code>\Rightarrow</code>	\Longrightarrow	<code>\Longrightarrow</code>	\Downarrow	<code>\Downarrow</code>
\leftrightarrow	<code>\leftrightarrow</code>	\longleftrightarrow	<code>\longleftrightarrow</code>	\updownarrow	<code>\updownarrow</code>
\Leftrightarrow	<code>\Leftrightarrow</code>	\Llongleftrightarrow	<code>\Llongleftrightarrow</code>	\Updownarrow	<code>\Updownarrow</code>
\mapsto	<code>\mapsto</code>	\longmapsto	<code>\longmapsto</code>	\nearrow	<code>\nearrow</code>
\hookleftarrow	<code>\hookleftarrow</code>	\hookrightarrow	<code>\hookrightarrow</code>	\searrow	<code>\searrow</code>
\leftharpoonup	<code>\leftharpoonup</code>	\rightharpoonup	<code>\rightharpoonup</code>	\swarrow	<code>\swarrow</code>
\leftharpoondown	<code>\leftharpoondown</code>	\rightharpoondown	<code>\rightharpoondown</code>	\nwarrow	<code>\nwarrow</code>
\rightleftharpoons	<code>\rightleftharpoons</code>				

* A command to negate this symbol can be created as follows: `\newcommand{\notdownarrow}{\not\downarrow}`
`\newcommand{\notuparrow}{\not\uparrow}`

Mathematical Expression Openings and Closings

Openings		Closings	
Display	Code	Display	Code
[<code>\lbrack</code>]	<code>\rbrack</code>
{	<code>\lbrace</code>	}	<code>\rbrace</code>
⌊	<code>\lfloor</code>	⌋	<code>\rfloor</code>
⟨	<code>\langle</code>	⟩	<code>\rangle</code>
⌈	<code>\lceil</code>	⌋	<code>\rceil</code>

Functions in Mathematical Expressions

- Conventionally functions are not given in italics, so LaTeX presents the following standard functions automatically in Roman; any functions not on this list require a `\mbox{}` to convert the font.
 - `\arccos`, `\arcsin`, `\arctan`, `\arg`, `\cos`, `\cosh`, `\cot`, `\coth`, `\csc`, `\deg`, `\det`, `\dim`, `\exp`, `\gcd`, `\hom`, `\inf`, `\ker`, `\lg`, `\lim`, `\liminf`, `\limsup`, `\ln`, `\log`, `\max`, `\min`, `\Pr`, `\sec`, `\sin`, `\sinh`, `\sup`, `\tan`, `\tanh`
 - Example Code: `\gcd(15,10)=5` `\mbox{avg}(15,10)=12.5` Example PDF File: $\gcd(15, 10) = 5$
 $\mbox{avg}(15, 10) = 12.5$

Mathematical Accents

Display	Code
\underline{a}	<code>\underline{a}</code>
\overline{a}	<code>\overline{a}</code>
\hat{a}	<code>\hat{a}</code>
\check{a}	<code>\check{a}</code>
\tilde{a}	<code>\tilde{a}</code>
\acute{a}	<code>\acute{a}</code>
\grave{a}	<code>\grave{a}</code>
\dot{a}	<code>\dot{a}</code>
\ddot{a}	<code>\ddot{a}</code>
\breve{a}	<code>\breve{a}</code>
\bar{a}	<code>\bar{a}</code>
\vec{a}	<code>\vec{a}</code>

Cross References

- To point the user to other locations in the document in a dynamic way, such as figures, sections, etc...
- `\label{marker}` – labels this location with the label *marker*
- `\ref{marker}` – generates the number of the section, subsection, figure, table, or theorem where the label *marker* is
- `\pageref{marker}` – generates the page number where the label *marker* is

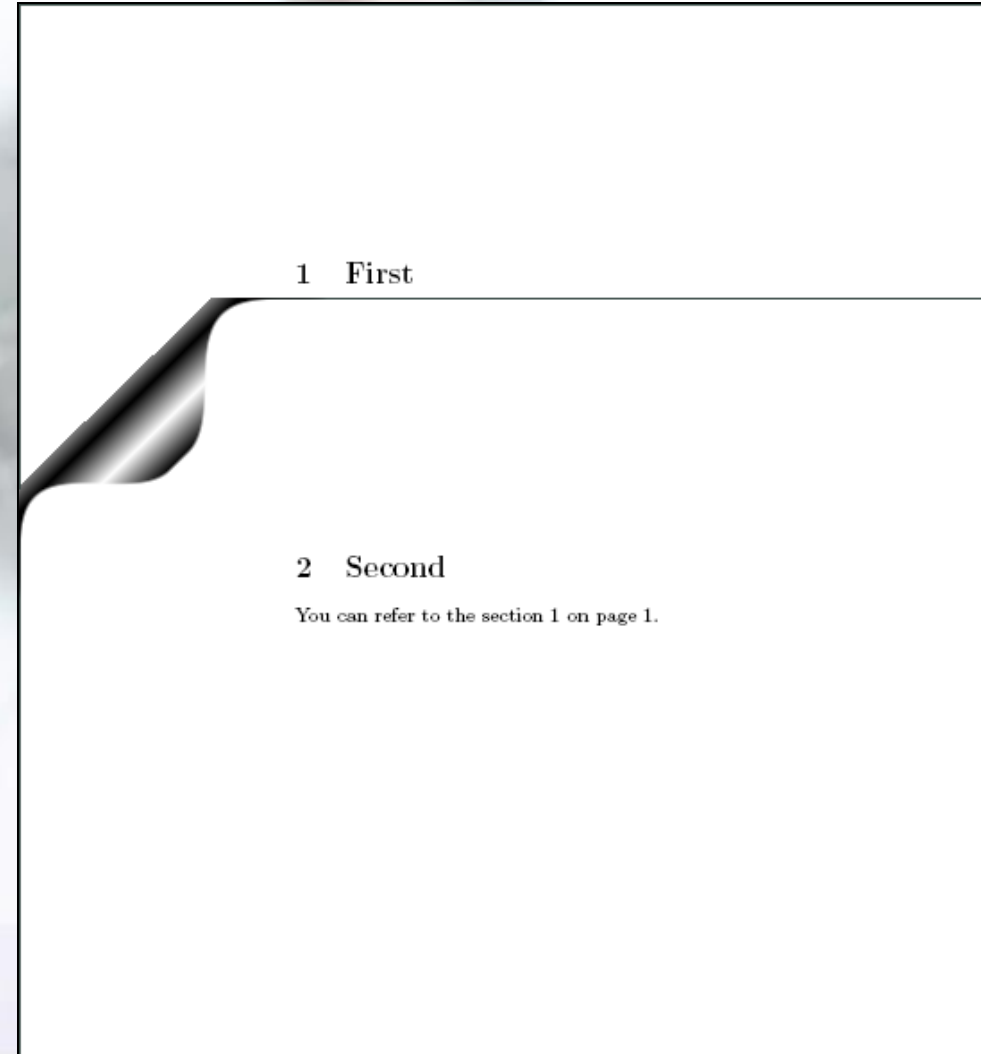
Cross References Example

Code:

```
\documentclass{article}

\begin{document}
  \section{First}
  \label{first}
  \newpage
  \section{Second}
  You can refer to the section
  \ref{first} on page
  \pageref{first}.
\end{document}
```

PDF File:



Citations/BibTeX

- The easiest way to handle creating citations and a bibliography in LaTeX is through the companion program BibTeX.
- BibTeX will automatically number references which are given in a .bib file and create a bibliography according to a .bst (bibliography style) file.
- Each entry in the .bib file has a label which can be called by the `\cite{label}` command to insert a reference.

Citations/BibTeX example

Code:

```
\documentclass{article}
\begin{document}
An introduction to partial words is given by Blanchet-Sadri in \cite{BSbook}.
\bibliographystyle{splncs03}
\bibliography{bibliography}
\end{document}
```

bibliography.bib entry:

```
@book{BSbook,
author = {Blanchet-Sadri, F.},
title = {Algorithmic Combinatorics on Partial Words},
year = {2008},
publisher = {Chapman & Hall/CRC Press},
address = {Boca Raton, FL},
}
```

An introduction to partial words is given by Blanchet-Sadri in [1].

References

- [1] Blanchet-Sadri, F.: Algorithmic Combinatorics on Partial Words. Chapman & Hall/CRC Press, Boca Raton, FL (2008)

Citations/BibTeX notes

- The .bib file and .bst file must be in the same folder as the .tex file.
- First compile the .tex file using LaTeX, then BibTeX, then LaTeX two more times.
- MathSciNet is a searchable database of publications provided by AMS which can save citations in the proper format for a .bib file.
 - www.ams.org/mathscinet

Footnotes

- Automatically inserts the superscript number and the footnote at the bottom of the page
 - `\footnote{footnotetext}`

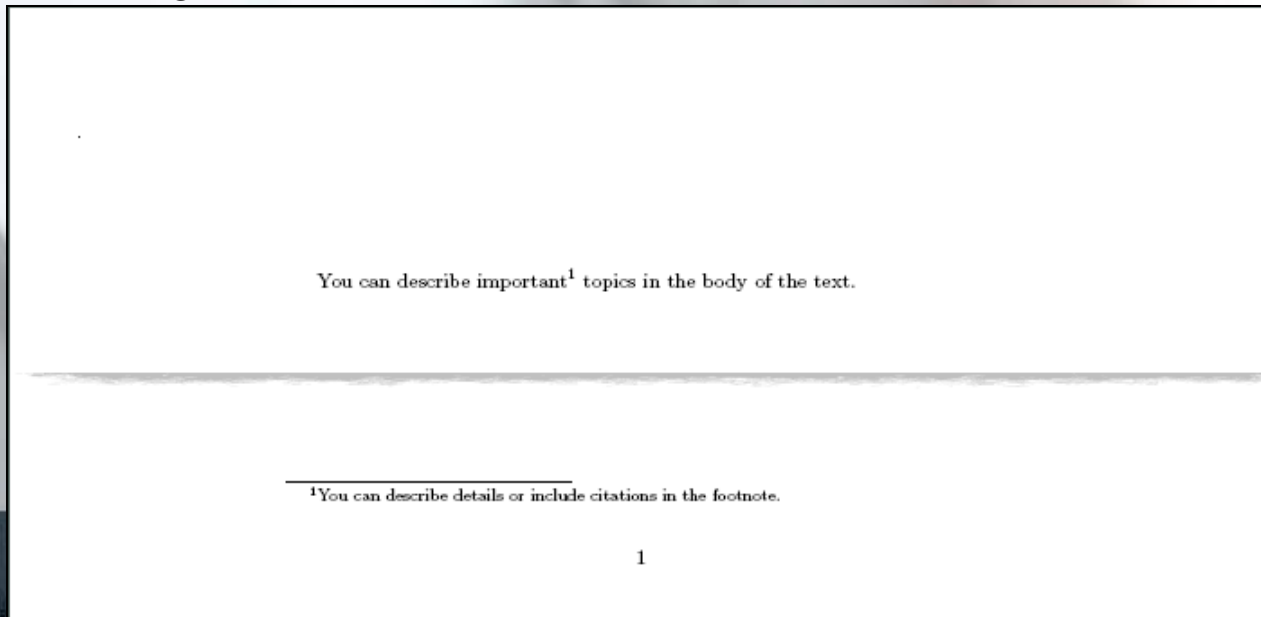
Footnotes Example

Code:

```
\documentclass{article}

\begin{document}
  You can describe
  important\footnote{You can
  describe details or include
  citations in the footnote.}
  topics in the body of the text.
\end{document}
```

PDF File:



Environments

- Used to set various properties for several lines of text
- In general the format is:
 - `\begin{environment}` text `\end{environment}`
where *environment* is the name of the environment

Environments, cont ...

- List Environments:
 - `enumerate` – creates enumerated lists
 - `itemize` – creates simple bulleted lists
 - `description` – format for terms and definitions
- Justification Environments:
 - `flushleft`, `center`, `flushright` – justifies text like the name implies
- `abstract` – special environment for adding an abstract to a scientific publication

Listing Environment Examples

Code:

```
\documentclass{article}

\begin{document}
  \noindent Enumerate:
  \begin{enumerate}
    \item first item \item second item \item
third item
  \end{enumerate}
  Itemize:
  \begin{itemize}
    \item first bullet \item second bullet
\item third bullet
  \end{itemize}
  Description:
  \begin{description}
    \item[term] The text of the definition.
  \end{description}
\end{document}
```

PDF File:

Enumerate:

1. first item
2. second item
3. third item

Itemize:

- first bullet
- second bullet
- third bullet

Description:

term The text of the definition.

Quotation Environments

- **quote** – indents quotes up to one paragraph in length
- **quotation** – indents multiparagraph quotes, further indenting the first line of each paragraph
- **verse** – for quoting poems because it doubly indents wrapped lines so each line of the poem is easy to identify

Quotation Example Code

```

\documentclass{article}

\begin{document}
  \noindent Quote:
  \begin{quote}
    The minute anything---science, feminism, Buddhism, holism, whatever---starts to take on the characteristics of a cosmology, it should be
    discarded. \emph{How} things are held in the mind is infinitely more important than \emph{what} is in the mind, including this statement
    itself. \\\
    $\sim{}$ Morris Berman \\\
  \end{quote}
  Quotation:
  \begin{quotation}
    In the fifteenth century, everything changed. \\\

    The human mind discovered a means of perpetuating itself which was not only more lasting and resistant than architecture but also simpler
    and easier. Architecture was dethroned. The lead characters of Gutenberg succeeded the stone characters of Orpheus. \\\

    \emph{The book was to kill the building.} \\\

    The invention of the printing-press is the greatest event in history. It was the mother of revolutions. It was the total renewal of man's
    mode of expression, the human mind sloughing off one form to put on another, a complete and definitive change of skin by that symbolic
    serpent which, ever since Adam, has represented the intelligence. \\\

    In its printed form, thought is more imperishable than ever; it is volatile, elusive, indestructible. It mingles with the air. In the
    days of architecture, thought had turned into a mountain and taken powerful hold of a century and of a place. Now it turned into a flock of
    birds and was scattered on the four winds occupying every point of air and space simultaneously. \\\

    We repeat: who cannot see that in this guise it is far more indelible? Before, it was solid, now it is alive. It has passed from duration
    to immortality. You can demolish a great building, but how do you root out ubiquity? Come a flood and the mountain will long ago have
    vanished beneath the waters while the birds are still flying; let a single ark be floating on the surface of the cataclysm and they will
    alight on it, will survive on it, and, like it, will be present at the receding of the waters; and as it awakes, the new world which emerges
    from the chaos will see the ideas of the drowned world soaring above it, winged and full of life. \\\

    $\sim{}$ From Book Five, Chapter Two of \emph{Notre-Dame de Paris}, translated by John Sturrock.
  \end{quotation}
  Verse:
  \begin{verse}
    Humpty-Dumpty sat on a wall.\\
    Humpty-Dumpty had a great fall.\\
    All the King's horses and all the King's men couldn't put Humpty together again.
  \end{verse}
\end{document}

```


Quotation Example PDF File

Quote:

The minute anything—science, feminism, Buddhism, holism, whatever—starts to take on the characteristics of a cosmology, it should be discarded. *How* things are held in the mind is infinitely more important than *what* is in the mind, including this statement itself.
~ Morris Berman

Verse:

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

Quotation:

In the fifteenth century, everything changed.

The human mind discovered a means of perpetuating itself which was not only more lasting and resistant than architecture but also simpler and easier. Architecture was dethroned. The lead characters of Gutenberg succeeded the stone characters of Orpheus.

The book was to kill the building.

The invention of the printing-press is the greatest event in history. It was the mother of revolutions. It was the total renewal of man's mode of expression, the human mind sloughing off one form to put on another, a complete and definitive change of skin by that symbolic serpent which, ever since Adam, has represented the intelligence.

In its printed form, thought is more imperishable than ever; it is volatile, elusive, indestructible. It mingles with the air. In the days of architecture, thought had turned into a mountain and taken powerful hold of a century and of a place. Now it turned into a flock of birds and was scattered on the four winds occupying every point of air and space simultaneously.

We repeat: who cannot see that in this guise it is far more indelible? Before, it was solid, now it is alive. It has passed from duration to immortality. You can demolish a great building, but how do you root out ubiquity? Come a flood and the mountain will long ago have vanished beneath the waters while the birds are still flying; let a single ark be floating on the surface of the cataclysm and they will alight on it, will survive on it, and, like it, will be present at the receding of the waters; and as it awakes, the new world which emerges from the chaos will see the ideas of the drowned world soaring above it, winged and full of life.

~ From Book Five, Chapter Two of *Notre-Dame de Paris*, translated by John Sturrock.

Verbatim Environment

- Generates text just as it is entered, without any LaTeX commands being executed; this is useful for showing LaTeX commands in the text
- Using `\begin{verbatim}`* shows a `_` for each space in the text

Verbatim Example

Code:

```
\documentclass{article}

\begin{document}
  \noindent You can use the verbatim
environment to show \LaTeX{} code, for example:
  \begin{verbatim}
    \documentclass{article}
    \begin{document}
      See how the code shows?
    \end{document}
  \end{verbatim}
\end{document}
```

PDF File:

```
You can use the verbatim environment to show LATEX code, for example:

\documentclass{article}
\begin{document}
See how the code shows?
\end{document}
```

minimal – Document class

- The bare minimum (3 lines) that is needed in the LaTeX class file.
- Sets only text width and height and defines `\normalsize`
- Intended for debugging and testing.
- Base used for designing a new class that is radically different from the structure supplied by the article class.

proc – Proceedings class

A document class for conference proceedings, based on article.

- Provides two column output.
- `\copyrightspace` makes the blank space for a copyright notice (can be used after first `\footnote` command).
- LaTeX automatically numbers the output pages.
- It is a good idea to identify the paper.

report – Document class

It is a less complicated version of the book class, often used for theses and other short multi-chapter documents.

Parts available in report:

`\chapter{chapter title}`

`\section{section title}`

`\subsection{subsection title}`

`\paragraph{paragraph title}`

`\subparagraph{subparagraph title}`

slides – Document class

Uses a bigger based font size, suitable for transparency presentations, and provides an easy way to make overlays.

```
\documentclass{slides}  
\begin{document}  
\begin{slide}  
\begin{itemize}  
\item Item 1  
\item My item 2  
\end{itemize}  
\end{slide}  
\begin{slide}  
....  
\end{slide}  
\end{document}
```

Sectioning a Document

- It depends on the class what types of sections are available.
- Article:
 - `\section{...}`, `\subsection{...}`, `\subsubsection{...}`
 - `\paragraph{...}`, `\subparagraph{...}`
 - `\part{...}`
- Report or Book:
 - `\chapter{...}`
 - `\appendix`
- To leave a section out of the Table of Contents, use a `*` after the command, for example `\chapter*{...}`

Sectioning a Document, cont...

- `\tableofcontents` – automatically generates the TOC at the location this command is issued; the document must be compiled 2-3 times to get the TOC to be generated properly.
- To specify a short version of a section title for the TOC, place it in `[]` after the section command:
 - `\chapter[shorttitle]{longtitle}`
- `\maketitle` – generates the title of the document at the location it is issued; the contents of the title are set using the following:
 - `\title{title}`, `\author{author}`, and `\date{data}`
 - NOTE: for several authors, separate the names with an `\and`

Index Environment

- Create index entries using the `theindex` environment

```
\begin{theindex}
```

```
indexentries
```

```
\end{theindex}
```

- This environment is 2-column with the header INDEX
- Entries are made using `\item`, `\subitem`, `\subsubitem`, and `\indexspace` (leaves a blank line in the index)

MakeIndex

- MakeIndex is a program that can be run on a LaTeX file that contains MakeIndex commands
- To use MakeIndex on a LaTeX file, include `\usepackage{makeidx}` in the preamble
- To supply the words for the index, use `\index{keyword}`
- Commands may be used as keywords
- To create subitems use `\index{main_keyword!sub_keyword}`
`\index{main_keyword!sub_keyword!sub_sub_keyword}`
- When LaTeX runs with the `\makeindex` command, it creates a `.idx` file
- This file contains `\indexentry{keyword}{pagenumber}` entries for each keyword in the index

Running MakeIndex

- The input to MakeIndex is the .idx file
`makeindex filename.idx`
- The output is a .ind file that contains the index
- To include the index in the document include `\printindex` at the location you want the index inserted
- After the .ind file has been created, run LaTeX on the document again to insert the index

MakeIndex Options

- The MakeIndex program has several options you can set when it is run from the command line

<i>-l</i>	Ignores blanks when sorting alphabetically
<i>-c</i>	Multiple and leading blanks are removed like in LaTeX
<i>-g</i>	German sorting order is used; symbols precede letters, lowercase precedes uppercase, and letters precede numbers
<i>-s</i>	The name of an index formatting file can be included to redefine the functioning of MakeIndex

Special Book Class Commands

- `\frontmatter` – goes immediately after the `\begin{document}` command; page numbering in this section is in Roman numerals and sections aren't enumerated, but they will be included in the TOC
- `\mainmatter` – contains the body of the text (chapters), uses Arabic page numbering, and the counter is reset (doesn't continue from the frontmatter)
- `\appendix` – comes after the main body of the text, each chapter in the appendix is enumerated by letters.
- `\backmatter` – contains the bibliography, index, etc...

Book Class Example Code

```
\documentclass{book}
\usepackage{makeidx}
\makeindex
\title{My Book}
\author{By: Me!}
\begin{document}
  \maketitle
  \frontmatter
  \tableofcontents
  \mainmatter
  \chapter[Short Title]{The Long Long Title}
  The contents of Chapter 1. \index{contents}
\appendix
  \chapter{Appendix Title}
\backmatter
  \printindex
\end{document}
```

Book Example PDF File

My Book

By: Me!

April 29, 2006

2

Contents

1	Short Title	1
A	Appendix Title	3

ii

CONTENTS

Chapter 1

The Long Long Title

The contents of Chapter 1.

2

CHAPTER 1. SHORT TITLE

Appendix A

Appendix Title

4

APPENDIX A. APPENDIX TITLE

Index

contents, 1

Tables and Columns

The easiest way to align text in columns can be accomplished by using **tabbing**

```
\begin{tabbing}
column 1 \= column 2 \= column 3 \\
txt in col1 \> txt in col2 \> txt in col 3\\
Ttxt in col1 \> \> txt in col3\\
.....
.....
\end{tabbing}
```

tabbing commands

Following commands can be used inside of tabbing environment

- `\=` (set tab)
- `\>` (advance to next tab stop)
- `\<` (the left of the local margin)
- `\+` (indent; move margin right)
- `\-` (unindent; move margin left)
- `\'` (flush against the current column's tab stop)
- `\`` (flushed right against any tab stop)
- `\\` (end of line; newline)
- `\kill` (ignore preceding text; use only for spacing)
- `\hspace[*]{len}` adds horizontal space

The accents inside tabbing are created by using `\a=`, `\a'`, `\a``

tabbing

- tabbing environment can be used only in paragraph mode.
- tabbing starts new paragraph.
- tabbing can be split across multiple pages.
- The width of the columns is determined by setting tab stops.

tabbing example

```
\begin{tabbing}
\bf Type\quad=\ \bf Quality\quad=\ \bf Color\quad=\ \bf
Price\\[2ex]
paper \> med. \> white \> low\\
letter \>good\>brown\>high\\
\> \>red
\end{tabbing}
```

Type	Quality	Color	Price
paper	med.	white	low
letter	good	brown	high
		red	

Making Tables with **tabular**

- Creates tables with optional horizontal and vertical lines.
- `tabular` environment can be used in any mode not only in paragraph.
- Table is treated as one letter that cannot be split across pages.
- The width of the columns is determined automatically by LaTeX.

tabular syntax

```
\begin{tabular}[pos]{cols}
```

Or

```
\begin{tabular*}{width}[pos]{cols}
```

The * makes the width argument mandatory (specifies the width of the tabular environment)

tabular pos

pos Specifies the vertical position of the whole tabular environment (recall that it is a box). The default is to align the box on the center of the environment.

t - align on top row

b - align on bottom row

tabular cols

cols Specifies the column formatting. It consists of a sequence of the following specifies, at least one for each of the columns.

- **l** - A column of left-aligned items.
- **r** - A column of right-aligned items.
- **c** - A column of centered items.
- **p{wd}** - Produces a column which can be multiple lines.
- **|** - A vertical line the full height and depth of the environment.
- **@{text}** - This inserts text in every row.
- ***{num}{cols}** - Equivalent to num copies of cols, where num is any positive integer and cols is any list of column-specifiers, which may contain another *-expression.

tabular example

```
\begin{tabular}{|l|c|c|r|} \hline
Type & Quality & Color & Price \\ \hline \hline
paper & med. & white & low \\
letter & good & brown & high \\
& & red & \\ \hline
\end{tabular}
```

Type	Quality	Color	Price
paper	med.	white	low
letter	good	brown	high
		red	

tabular example1

```

\begin{figure}
  \centering
  \caption{\$G_{(4,7)}(u)\$}
  \begin{tabular}{c c c c c }
    & & & \$a\$ & \$a\$ \\\
    & & & \$a\$ & \$a\$ \\\
    & & \$b\$ & & \$\diamond\$ & \\\
    & \$b\$ & \$b\$ & \$b\$ & \\\
    \$a\$ & \$\diamond\$ & \$b\$ & \\\
    & \$\diamond\$ & \\\
  \end{tabular}
\end{figure}

```

Figure 1: $G_{(4,7)}(u)$

		a	a
		a	a
		b	\diamond
	b	b	b
a	\diamond	b	
	\diamond		

tabular example2

```

\begin{figure}[h]
  \centering
  \caption{Ordering of  $w$ }
  \begin{tabular}{|c|c|l|l|c|c|} \hline
     $k_0$  &  $p_{0,k_0}$  &  $v_{0,k_0}$  &  $v'_{0,k_0}$  &  $p_{0,l_0}$  &  $l_0$  \\ \hline
    5 & &  $\diamond cbba$  &  $\diamond cbba$  & & 5 \\
    4 & &  $a$  &  $cbba$  & & 4 \\
    3 & &  $a\diamond cbba$  &  $bba$  & & 3 \\
    2 & &  $ba$  &  $ba$  & & 2 \\
    1 & &  $bba$  &  $a$  & & 1 \\
    0 & 1 &  $cbba$  &  $a\diamond cbba$  & & 0 \\ \hline
  \end{tabular}
\end{figure}

```

Figure 2: Ordering of w

k_0	p_{0,k_0}	v_{0,k_0}	v'_{0,k_0}	p_{0,l_0}	l_0
5		$\diamond cbba$	$\diamond cbba$		5
4		a	$cbba$		4
3		$a\diamond cbba$	bba		3
2		ba	ba		2
1		bba	a		1
0	1	$cbba$	$a\diamond cbba$		0

tabular example3

Advanced options of tabular:

```
\begin{figure}[h]
```

```
\centering
```

```
\caption{Ordering of  $w$ }
```

```
\begin{tabular}{|c|c|l|l|c|@{\hspace{0.2in}}c| \hline
```

```
 $k_0$  &  $p_{0,k_0}$  &  $v_{0,k_0}$  &  $v'_{0,k_0}$  &  $p_{0,l_0}$  &  $l_0$  \\ \hline
```

```
 $5$  & &  $\diamond cbba$  &  $\diamond cbba$  & &  $5$  \\
```

```
 $4$  & &  $a$  &  $cbba$  & &  $4$  \\
```

```
 $3$  & &  $a\diamond cbba$  &  $bba$  & &  $3$  \\
```

```
 $2$  & &  $ba$  &  $ba$  & &  $2$  \\
```

```
 $1$  & &  $bba$  &  $a$  & &  $1$  \\
```

```
 $0$  &  $1$  &  $cbba$  &  $a\diamond cbba$  & &  $0$  \\ \hline
```

```
\end{tabular}
```

```
\end{figure}
```

The @ parameter can be used to insert text or commands in every field of specified column.

Figure 3: Ordering of w

k_0	p_{0,k_0}	v_{0,k_0}	v'_{0,k_0}	p_{0,l_0}	l_0
5		$\diamond cbba$	$\diamond cbba$		5
4		a	$cbba$		4
3		$a\diamond cbba$	bba		3
2		ba	ba		2
1		bba	a		1
0	1	$cbba$	$a\diamond cbba$		0

array example

```
\begin{figure}[h]
  \centering
  \caption{Ordering of $w$}
  $
```

```
\begin{array}{|c|c|||c|c|} \hline
k_{0} & p_{0,k_{0}} & v_{0,k_{0}} & v'_{0,k_{0}} & p_{0,l_{0}} & l_{0} \\ \hline
5 & & \diamond cbba & \diamond cbba & & 5 \\
4 & & a & cbba & & 4 \\
3 & & a\diamond cbba & bba & & 3 \\
2 & & ba & ba & & 2 \\
1 & & bba & a & & 1 \\
0 & 1 & cbba & a\diamond cbba & & 0 \\ \hline
\end{array}
$
\end{figure}
```

Figure 4: Ordering of w

k_0	p_{0,k_0}	v_{0,k_0}	v'_{0,k_0}	p_{0,l_0}	l_0
5		$\diamond cbba$	$\diamond cbba$		5
4		a	$cbba$		4
3		$a\diamond cbba$	bba		3
2		ba	ba		2
1		bba	a		1
0	1	$cbba$	$a\diamond cbba$		0

Array syntax resembles tabular.

Floating Bodies

The idea behind floating bodies is to solve a problem of figures or tables that are too big to fit on a current page while also filling current page with body text.

Latex offers two environments for floating bodies one for **tables** and one for **figures**.

figure

```
\begin{figure}[placement]  
body of the figure  
\caption{figure title}  
\end{figure}
```

table

`\begin{table}[placement]`

body of the table

`\caption{table title}`

`\end{table}`

(optional form of table exists **table***, puts table in a single column when in two column mode)

table figure [placement]

Optional parameter for table and figure determines where LaTeX will try to place your floating body

- **h** Here - at the position in the text where the table environment appears.
- **t** Top - at the top of a text page.
- **b** Bottom - at the bottom of a text page.
- **p** Page of floats - on a separate float page, which is a page containing no text, only floats.
- **!** without considering most of the internal parameters which could stop this float from being placed.

minipage - environment

the `minipage` environment can be used to put one or more paragraphs inside of a `picture environment` or as a `table item`

```
\begin{minipage}[pos]{width}  
  text  
\end{minipage}
```

- `width` - Mandatory specifies the width of the minipage.
- `pos` - `t` -for top or `b` for bottom.

minipage example

```
\begin{minipage}[b]{0.5\linewidth}
  \setlength{\unitlength}{1mm}
  \begin{picture}(50,40)
    \put(30,30){\circle{30}}
    \put(30,30){\circle*{5}}
  \end{picture}
  Drawing with LaTeX example circle.
\end{minipage}
```

Side-by-Side Figures

`Tabular` can be combined with `minipage` to place figures side by side. It can also be used to create one figure out of two or more figures.

Side-by-side Figures Example a)

```

\begin{figure}[t]
\begin{tabular}{|c|c|} \hline
\bf{Normal:} & \bf{Reverse:} \\ \hline
\begin{minipage}[b]{0.5\linewidth}
  \centering
  \caption{Ordering of $w$}
\begin{tabular}{|c|c|||c|c|} \hline
$k_{0}$ & $p_{0,k_{0}}$ & $v_{0,k_{0}}$ & $v'_{0,k_{0}}$ &
  $p_{0,l_{0}}$ & $l_{0}$ \\ \hline
$5$ & $$ & $\{\diamond\}cbba$ & $\{\diamond\}cbba$ & $$ & $5$ \\
$4$ & $$ & $a$ & $cbba$ & $$ & $4$ \\
$3$ & $$ & $a\{\diamond\}cbba$ & $bba$ & $$ & $3$ \\
$2$ & $$ & $ba$ & $ba$ & $$ & $2$ \\
$1$ & $$ & $bba$ & $a$ & $$ & $1$ \\
$0$ & $1$ & $cbba$ & $a\{\diamond\}cbba$ & $$ & $0$ \\ \hline
\end{tabular}
\end{minipage} &

```

Side-by-side Figures Example b)

```

\begin{minipage}[b]{0.5\linewidth}
  \centering
  \caption{Reverse ordering of $w$}
\begin{tabular}{|c|c|||c|c|} \hline
$k_{1}$ & $p_{1,k_{1}}$ & $v_{1,k_{1}}$ & $v'_{1,k_{1}}$ & $p_{1,l_{1}}$ \\
& $l_{1}$ & \\\hline
$5$ & $$ & $\{\diamond\}a$ & $\{\diamond\}a$ & $$ & $5$ \\\
$4$ & $$ & $a$ & $c\{\diamond\}a$ & $$ & $4$ \\\
$3$ & $$ & $abbc\{\diamond\}a$ & $bc\{\diamond\}a$ & $$ & $3$ \\\
$2$ & $$ & $bbc\{\diamond\}a$ & $bbc\{\diamond\}a$ & $$ & $2$ \\\
$1$ & $$ & $bc\{\diamond\}a$ & $a$ & $$ & $1$ \\\
$0$ & $5$ & $c\{\diamond\}a$ & $abbc\{\diamond\}a$ & $$ & $0$ \\\hline
\end{tabular}
\end{minipage} \\\
& \\\hline % extra space
\end{tabular}
\end{figure}

```

Side-by-side Figures Results

Normal:						Reverse:					
Figure 5: Ordering of w						Figure 6: Reverse ordering of w					
k_0	p_{0,k_0}	v_{0,k_0}	v'_{0,k_0}	p_{0,l_0}	l_0	k_1	p_{1,k_1}	v_{1,k_1}	v'_{1,k_1}	p_{1,l_1}	l_1
5		$\diamond cbba$	$\diamond cbba$		5	5		$\diamond a$	$\diamond a$		5
4		a	$cbba$		4	4		a	$c \diamond a$		4
3		$a \diamond cbba$	bba		3	3		$abb \diamond a$	$bc \diamond a$		3
2		ba	ba		2	2		$bbc \diamond a$	$bbc \diamond a$		2
1		bba	a		1	1		$bc \diamond a$	a		1
0	1	$cbba$	$a \diamond cbba$		0	0	5	$c \diamond a$	$abb \diamond a$		0

Graphics in LaTeX

The 3 steps required to import images:

1. Export picture in EPS format.
2. Load the **graphicx** package:

```
\usepackage[driver]{graphicx}
```

3. Include your graphics file:

```
\includegraphics[key=value,key=value,...]{file}
```

(*driver* usually **dvips**)

Possible keys; **width**, **height**, **angle**, **scale**, **angle**, [more options ...](#)

Floating Bodies and Graphics

Using floating bodies and Graphics together:

```
\begin{figure}  
\centering  
\includegraphics[angle=90,width=0.75\textwidth]{pic.eps}  
\caption{A picture, included from pic.eps file.}  
\end{figure}
```

Making graphics with LaTeX

The **picture** environment allows creating graphics using latex commands.

(circles, eclipses, lines, vectors,...)

TikZ is a package for creating graphics within LaTeX as well, which defines the **tikzpicture** environment.

picture environment

Some commands available in picture environment:

```
\setlength{\unitlength}{1.5in}
```

```
\put(x,y){object}
```

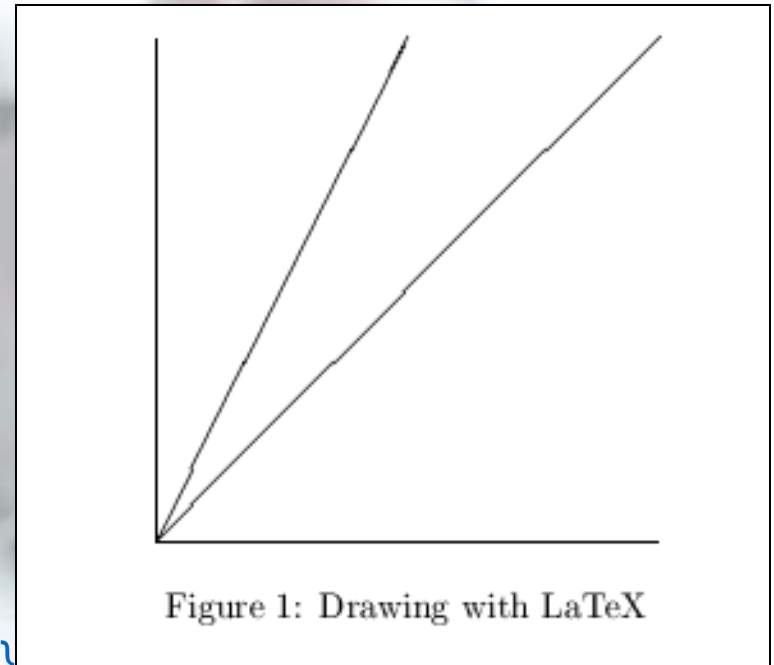
```
\multiput(x,y)( $\Delta x$ ,  $\Delta y$ ){n}{object}
```

Bezier curves :

```
\qbezier(x1,y1)(x2,y2)(x3,y3)
```

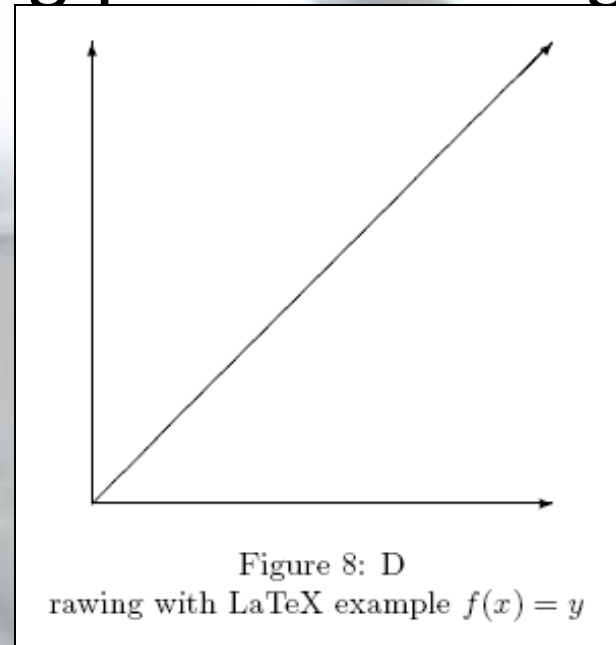
Examples of using `picture`

```
\begin{figure}  
\centering  
\setlength{\unitlength}{5cm}  
\begin{picture}(1,1)  
\put(0,0){\line(0,1){1}}  
\put(0,0){\line(1,1){1}}  
\put(0,0){\line(1,0){1}}  
\put(0,0){\line(1,2){.5}}  
\end{picture}  
\caption{Drawing with LaTeX}  
\end{figure}
```



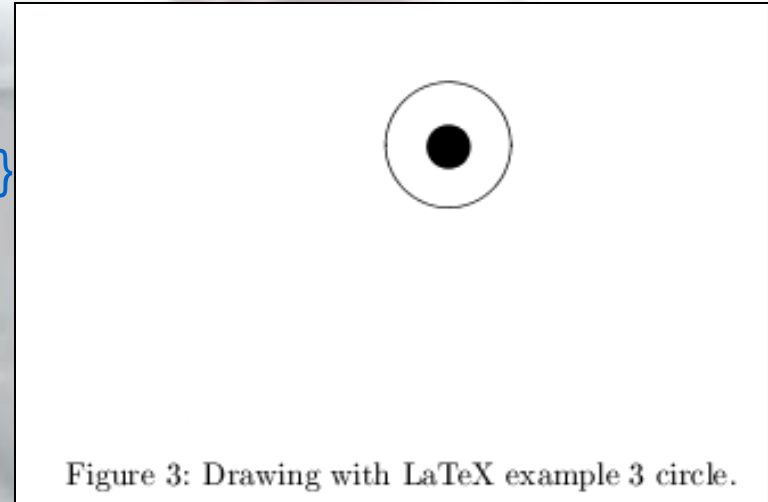
Example 2 of using picture and figure

```
\begin{figure}
\centering
\setlength{\unitlength}{5cm}
\begin{picture}(1,1)
\put(0,0){\vector(0,1){1}}
\put(0,0){\vector(1,1){1}}
\put(0,0){\vector(1,0){1}}
\end{picture}
\begin{caption}
Drawing with LaTeX example  $f(x) = y$ 
\end{caption}
\end{figure}
```



Drawing circles using `picture`

```
\begin{figure}  
\centering  
\setlength{\unittlength}{1mm}  
\begin{picture}(50,40)  
\put(30,30){\circle{30}}  
\put(30,30){\circle*{5}}  
\end{picture}  
\caption{Drawing with LaTeX example 3 circle.}  
\end{figure}
```



Adding new commands

Existing LaTeX commands are sufficient for most situations. But if there is something that you think is missing you can always add or modify using following commands:

`\newcommand`

`\renewcommand`

`\providecommand`

`\DeclareMathOperator`

newcommand command

```
\newcommand{name}[num][opt]{def}
```

name – the name of your new command.

num – is an optional parameter specifying number of arguments the new command requires if not present the default is 0.

opt – number of arguments that are required if **num** is used.

def – definition what your new command should do.

newcommand example

```
\documentclass{article}
\newcommand{\uncg}{University of North
  Carolina at Greensboro}
\begin{document}
I'm a graduate student at the \uncg.
\end{document}
```

I'm a graduate student at the University of North Carolina at Greensboro.

renewcommand & providecommand

The **renewcommand** and **providecommand** have the same syntax as the **newcommand** except:

renewcommand is used to override already existing command.

providecommand is used if the command is already defined latex will ignore your command.

renewcommand example

```
\documentclass{article}
```

```
\renewcommand{\^} {\diamond}
```

$$u = abaab\circ ba$$

```
\begin{document}
```

```
$u=abaab\^ ba$
```

```
\end{document}
```

Did that break \wedge ? NO!

```
\documentclass{article}
\renewcommand{\wedge} {\diamond}
\begin{document}
```

```
$u=abaab\wedge ba$ \\  
$a^u$ and $u^\wedge$ \\  
Still works !
```

$u = abaab\diamond ba$ a^u and u^\diamond Still works !

```
\end{document}
```

DeclareMathOperator

- `\DeclareMathOperator{name1}{name2}` will create the new command `name1` which will typeset the text “name2” like a mathematical operator (like sin or lim)
- Requires amsmath package.

```
\documentclass{article}
```

```
\usepackage{amsmath}
```

```
\DeclareMathOperator{\re}{Re}
```

```
\begin{document}
```

If $z = a + bi$, then $\re z = \re(a + bi) = a$.

```
\end{document}
```

$\text{If } z = a + bi, \text{ then } \operatorname{Re} z = \operatorname{Re}(a + bi) = a.$

Creating your own **newenvironment**

Just as allowing you to create a new commands LaTeX also provides you ability to create your own environment using **newenvironment** and **renewenvironment** commands.

(the syntax for **newenvironment** and **renewenvironment** is the same the only difference is that **renewenvironment** redefines already existing environment)

newenvironment and renewenvironment

```
\newenvironment{name}[args][opt]{begdef}{enddef}
```

```
\renewenvironment{name}[args][opt]{begdef}{enddef}
```

name – the name of your environment.

args – optional the number of arguments.

opt – optional the number of arguments required that are listed in args.

begdef The text substituted for every occurrence of `\begin{name}`; a parameter of the form `#n` in `begdef` is replaced by the text of the `n`th argument when this substitution takes place.

enddef The text substituted for every occurrence of `\end{name}`. It may not contain any argument parameters.

Creating your own package

If you created a large number of **newcommands** and **newenvironments** the preamble of your document can become quite large, to avoid this it is recommended to place your new commands and environments in a separate file and include it using the **\usepackage**.

Creating your package file

To create your package file place all of your new commands and environments in a separate file and save it with file extension **.sty** at the top of the file add `\ProvidesPackage` command.

`\ProvidesPackage{name}` command

`name` – specifies the name of your package it has to match the name you use with `\usepackage` command.

Useful websites

- Detexify: allows you to draw a symbol and it will give you the LaTeX command for it:
 - <http://detexify.kirelabs.org/classify.html>
- Art of Problem Solving: good introduction to LaTeX and quick reference for symbols and basic formatting:
 - <http://www.artofproblemsolving.com/Wiki/index.php/LaTeX>
- MathSciNet:
 - www.ams.org/mathscinet

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