Introduction to LaTex 2ε

Based on “The Not So Short Introduction to LaTeX 2ε” by
Tobias Oetiker et al., April 2001

Contents

- Things you need to know
- Typesetting text
- Typesetting Mathematical Formulae
- Specialties
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What is Latex

- LaTeX is a typesetting system which is very suitable for producing scientific and mathematical documents of high typographical quality. The system is also suitable for producing all sorts of other documents, from simple letters to complete books. LaTeX uses TeX as its formatting language.

- The scope of this presentation is not to tell you how to install and set up a LaTex system, but to teach you how to write your documents so that they can be processed by LaTeX.

- LaTeX installation is already available on all of the Apple eMac systems in the Economics Department at Boston College. You can use TeXShop editor to write your documents which you will later compile into pdf files.

- For you personal computer you can consider downloading WinEdt™ (shareware) which is a powerful and versatile ASCII editor and shell for MS Windows with a strong predisposition towards the creation of [La]TeX documents. You will also need to download and install MiKTex (www.miktex.org). MiKTeX is an up-to-date TeX implementation for the Windows operating system . It offers a complete set of utilities, macro packages and fonts.

Things you need to know

- LaTeX is quite different from the WYSISYG (what you see is what you get) approach which most modern processors such at MS Word and Corel WordPerfect take. With these applications authors specify the document layout interactively while typing text into the computer. When using LaTex it is normally not possible to see the final output while typing the text. But the final output can be previewed on the screen after processing the file with LaTeX. Then corrections can be made before actually sending the document to the printer.

- Layout design- LaTeX forces the author to declare the logical structure of the document. LaTeX then chooses the most suitable layout.

- The input for LaTeX is a plain ASCII text file, which you can create with any text editor. It contains the text of the document as well as the commands which tell LaTeX how to typeset the text.

Things you need to know

- **Spaces-** “whitespace” characters such as blank or tab are treated uniformly as “space” by LaTeX. Several consecutive whitespace characters are treated as one “space”. Whitespace at the start of a line is generally ignored, and a single linebreak is treated as “whitespace”.An empty line between two lines of text defines the end of a paragraph. Several empty lines are treated the same as one empty line.

- **Special Characters-** The following symbols are reserved characters that either have a special meaning under LaTeX or are not available in all the fonts. If you enter them directly in your text, they will normally not print, but rather coerce LaTeX to do things you did not intend.
- $ & % # _ {} ~ ^ \
- These characters can be used in your documents all the same by adding a prefix backslash.
- \ $ \&   \%   \#   _   \{ \ } \~   \^
- **Note** that (\\) is used for linebreaking.
- The other symbols can be printed with special commands.

Things you need to know

- **LaTeX commands** take one of the following two formats

  1. They start with a backslash \ and then have a name consisting of letters only. Command names are terminated by space, a number or any other ‘non-letter’.

  2. They consist of backslash and exactly one special character.

- LaTeX ignores whitespaces after commands. If you want to get a space after a command, you have to put either {} and a blank or a special spacing command after the command name.
- Some commands need a parameter which has to be given between curly braces {} after the command name. Some commands support optional parameters which are added after the command name in square brackets [ ].

Things you need to know

- **Comments**
- When LaTex encounters a % character while processing an input file, it ignores the rest of the present line, the linebreak, and all whitespace at the beginning of the next line. This can be used to write notes in the input file, which will not show up in the printed version. The % character can also be used to split long input lines where no whitespace or linebreaks are allowed.

- For longer comments you should use the comment environment.

  \begin{comment}

  …

  \end{comment}

Things you need to know

- **Input File Structure**

  Every input file must start with the command

  \documentclass{…}

  This specifies what sort of document you intend to write. After that you can include commands which influence the style of the whole document, or you can load packages which add new features to the LaTeX system. To load such a package, you use the command

  \usepackage{…}

  When all setup is done, you start the body of text with the command

  \begin{document}

  At the end of the document you add the

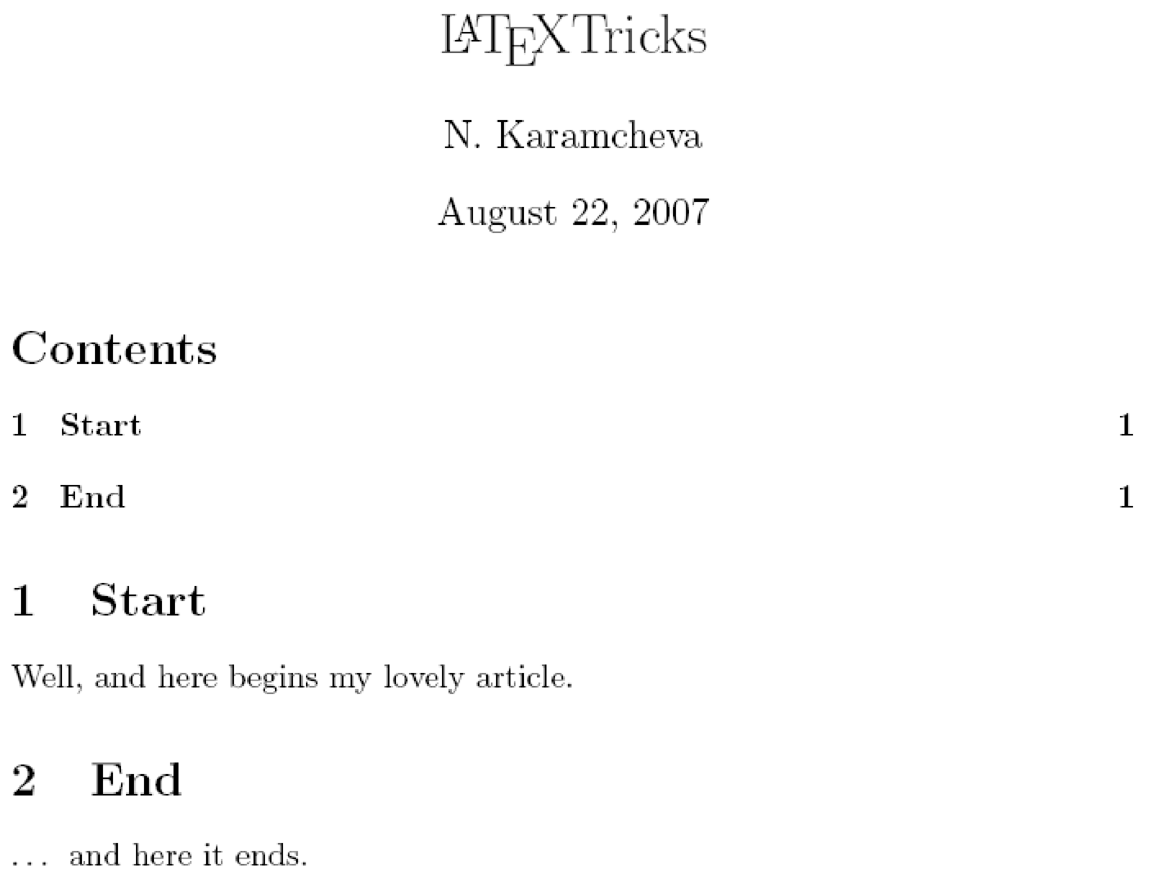
  \end{document}. Anything which follows this command will be ignored by LaTeX.

Things you need to know

- **Example of a journal article**

```
\documentclass[a4paper,11p]{article}
\author{H.~Partl}
\title{Minimalism}
\begin{document}
% generates the title
\maketitle
% insert the table of contents
\tableofcontents
\section{Start}
Well, and here begins my lovely article.
\section{End}
\ldots{} and here it ends.
\end{document}
```

And this is how our document would look like



LaTeXTricks

N. Karamcheva

August 22, 2007

Contents

1 Start

Well, and here begins my lovely article.

2 End

. . . and here it ends.

Things you need to know

- **Document classes**
- The first information LaTeX needs to know when processing an input file is the type of document the author wants to create.

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

  Here *class* specifies the type of document to be created (i.e. article, report, book , slides). The *options* parameter customizes the behavior of the document class.

  Example:

  \documentclass[11pt, twoside,a4paper]{article}
- **Packages**
- There are some areas where basic LaTeX cannot solve your problem. If you want to include graphics, colored text or source code from a file into your document, you need to enhance the capabilities of LaTeX. Such enhancements are called *packages*.

  \usepackage[*options*]{*package*}

Things you need to know

Files that you might encounter

.tex LaTeX or TeX input file. Can be compiled with LaTeX.

.sty LaTeX macro package. This is a file you can load into your LaTeX document using the \usepackage command

.dtx Documented TeX. This is the main distribution format for LaTeX style files. If you process a .dtx file you get documented macro code of the LaTeX package contained in the .dtx file.

.ins Is the installer for the files contained in the matching .dtx file. If you download a LaTeX package from the net, you will normally get a .dtx and a .ins file. Run LaTeX on the .ins file to unpack the .dtx file.

.cls Class files define what your document looks like. They are selected with the \documentclass command

The following files are generated when you run LaTeX on your input file.

.dvi Device Independent File. This is the main result of LaTeX compile run. You can look at its content with DVI previewer program or you can send it to a printer with dvips or a similar application.

.log Gives a detailed account of what happened during the last compiler run.

Typesetting Text

- **The Structure of Text and Language**

  The most important text unit in LaTeX is the paragraph. You can force linebreaks with e.g. \\ and paragraph breaks with e.g. leaving an empty line in the source code. If a new thought begins, a new paragraph should begin, and if not, only linebreaks should be used.

- **Linebreaking and Pagebreaking**

  Often books are typeset with each line having the same length. LaTeX inserts the necessary linebreaks and spaces between words by optimizing the contents of a whole paragraph. How the paragraphs are typeset depends on the document class. Normally the first line of a paragraph is indented, and there is no additional space between two paragraphs.

  In special cases it might be necessary to order LaTeX to break a line:

  \\ or **\newline** starts a new line without starting a new paragraph.

  \\***** additionally prohibits a pagebreak after the forced linebreak.

  \newpage starts a new page.

  \linebreak[n], \nolinebreak[n], \pagebreak[n] and \nopagebreak[n] do what their names say. n can be set to a number between 0 and 4.

Typesetting Text

- **Hyphenation**

  LaTeX hyphenates words whenever necessary. If the hyphenation algorithm does not find the correct hyphenation points, you can remedy the situation by using the following commands

  e.g. \hyphenation{FORTRAN Hy-phen-a-tion}

  Several words can be kept together on one line with the command \mbox{*text*}

- **Special Characters and Symbols**

  Quotation marks: In LaTeX use the ‘s (grace accent) for opening quotation marks and two ’s (apostrophe) for closing quotation marks.

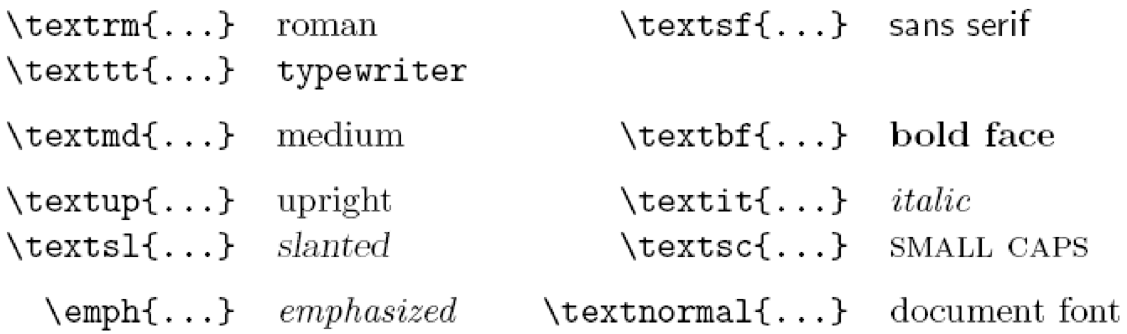
  ***Tilde* (~):** e.g. http://www.clever.edu/ $\sim$demo will be typeset as http://www.clever.edu/~demo

  ***Ellipsis* (…):** use \ldots

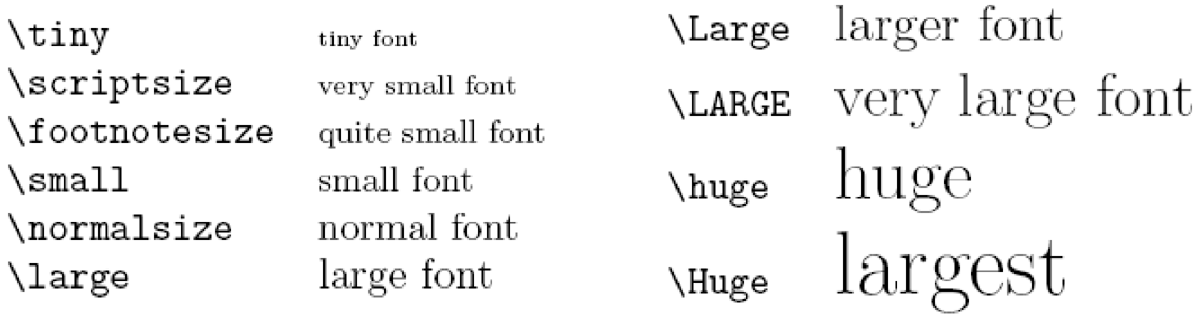
Typesetting Text

Fonts and Sizes

- LaTeX chooses the appropriate font and size based on the logical structure of the document(sections, footnotes,…) In some cases one might like to change them by hand. To do this, you can use commands like:



`\textrm{...}`	roman	`\textsf{...}`	sans serif
`\texttt{...}`	`typewriter`		
`\textmd{...}`	medium	`\textbf{...}`	**bold face**
`\textup{...}`	upright	`\textit{...}`	*italic*
`\textsl{...}`	*slanted*	`\textsc{...}`	SMALL CAPS
`\emph{...}`	*emphasized*	`\textnormal{...}`	document font



`\tiny`	tiny font	`\Large`	larger font
`\scriptsize`	very small font	`\LARGE`	very large font
`\footnotesize`	quite small font	`\huge`	huge
`\small`	small font	`\Huge`	largest
`\normalsize`	normal font		
`\large`	large font		

- If you want to activate a size changing command for a whole paragraph of text, you might want to use the environment syntax for font changing command.
- \begin{Large} …. \end{Large}

Typesetting Text

- **Titles, Chapters , and Sections**

  The following sectioning commands are available for the article class.

  \section{…}
  \subsection{…}
  \subsubsection{…}
  \paragraph{…}
  \subparagraph{…}

  You can use two additional commands for the report and the book class:

  \part{…}
  \chapter{…}

  The spacing between sections, the numbering and the font size of the titles will be set automatically by LaTeX.

  LaTeX creates table of contents by taking the section headings and page numbers from the last compile cycle of the document. The command \tableofcontents expands to a table of contents at the place where it is issued.

Typesetting Text

- **Titles, Chapters , and Sections (cont'd)**

  By adding a star * after the command, you can generate a section heading which does not show up in the table of contents and is not numbered.

  The title of the whole document is generated by issuing a **\maketitle** command. The contents of the title have to be defined by the commands **\title{…}, \author{…}** and optionally **\date{…}** before calling **\maketitle**.

- **Cross References**

  LaTeX provides the following commands for cross referencing

  \label{*marker*}, \ref{*marker*} and \pageref{*marker*}

Typesetting Text

- **Footnotes**

  With the command **\footnote**{*footnote text*}

- **Emphasized Words**

  \underline{*text***}** underlines the word

  \emph{*text***}** typesets the word in an italic form

- **Environments**

  Itemize, Enumerate, and Description: The *itemize* environment is suitable for simple lists, the *enumerate* environment for enumerated lists and the *description* environment for descriptions.

e.g.

```
\begin{enumerate}
\item Here is my first enumerated sentence.
\item Here is my second enumerated sentence.
\end{enumerate}
```

Typesetting Text

- **Environments (cont'd)**

  Flushleft, Flushright, and Center

  Flushleft and *flushright* generate environments which are either left- or right-aligned. The *center* environment generates centered text. If you do not issue \\ to specify linebreaks, LaTeX will automatically determine linebreaks.

  e.g.
  ```
  \begin{flashleft}
  Here you type your text.
  \end{flashleft}
  ```

  Tabular

  The tabular environment can be used to typeset tables with horizontal and vertical lines. LaTeX determines the width of the columns automatically.

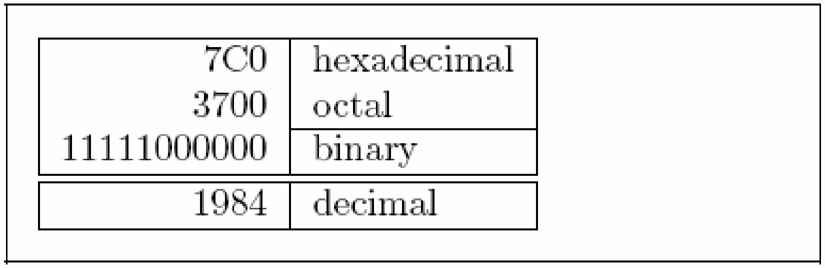
  \begin{tabular}{*table spec*}.

  The *table spec* argument defines the format of the table. Use l for a column or left-aligned text, r for right-aligned text, and c for centered; p{*width*} for a column containing justified text with linebreaks, and | for a vertical line.

Typesetting Text

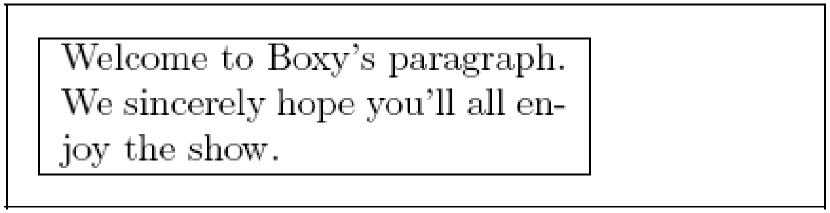
- Note: & jumps to the next column, \\ starts a new line and \hline inserts a horizontal line. You can add partial Line by using the \cline{j-l} whereby j and i are the column numbers the line should extend over.
- Examples:

```
\begin{tabular}{|r|l|}
\hline
7C0 & hexadecimal \\
3700 & octal \\ \cline{2-2}
11111000000 & binary \\
\hline \hline
1984 & decimal \\
\hline
\end{tabular}
```



7C0	hexadecimal
3700	octal
11111000000	binary
1984	decimal

```
\begin{tabular}{|p{4.7cm}|}
\hline
Welcome to Boxy's paragraph.
We sincerely hope you'll
all enjoy the show.\\
\hline
\end{tabular}
```

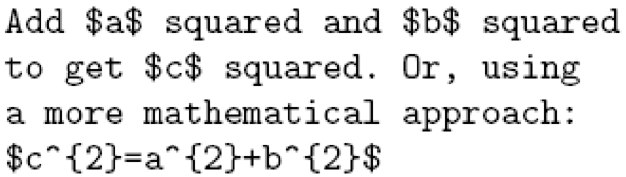


Welcome to Boxy's paragraph.
We sincerely hope you'll all en-
joy the show.

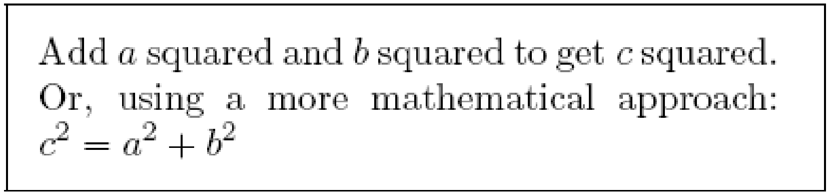
Typesetting Mathematical Formulae

General

LaTeX has a special mode for typesetting mathematics. Mathematical text within a paragraph is entered between \(and\), between $ and $ or between \begin{math} and \end{math}.



```
Add $a$ squared and $b$ squared
to get $c$ squared. Or, using
a more mathematical approach:
$c^{2}=a^{2}+b^{2}$
```

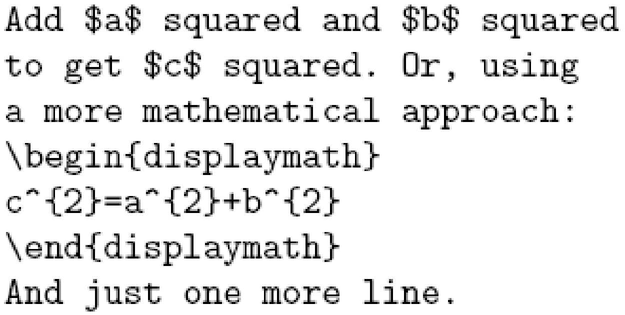


Add a squared and b squared to get c squared. Or, using a more mathematical approach: $c^2 = a^2 + b^2$

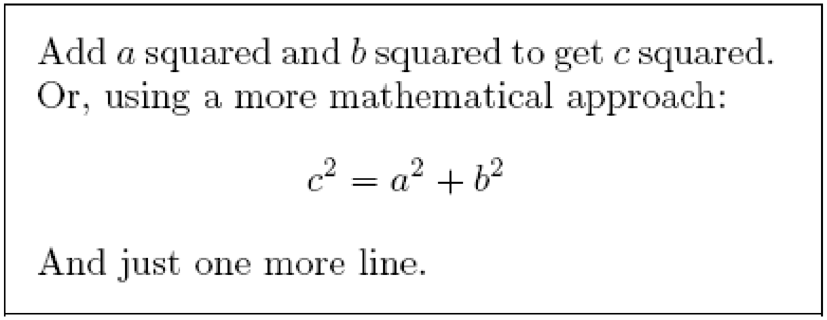
It is preferable to *display* larger mathematical equations or formulae, rather than to typeset them on separate lines. This means you enclose them in \[and \] or between **\begin{displaymath}** and **\end{displaymath}.** This produces formulae that are not numbered. If you want LaTeX to number them, you can use the **equation** environment.

Typesetting Mathematical Formulae

General (cont’d)



```
Add $a$ squared and $b$ squared
to get $c$ squared. Or, using
a more mathematical approach:
\begin{displaymath}
c^{2}=a^{2}+b^{2}
\end{displaymath}
And just one more line.
```

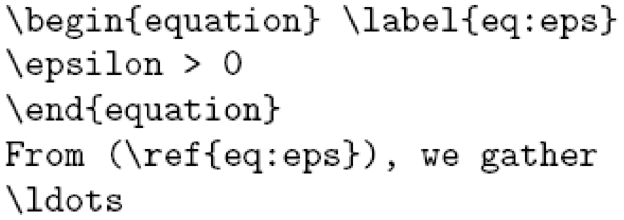


Add a squared and b squared to get c squared. Or, using a more mathematical approach:

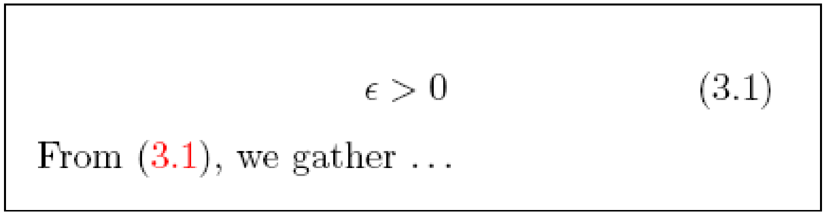
$$c^2 = a^2 + b^2$$

And just one more line.

You can reference an equation with \label and \ref



```
\begin{equation} \label{eq:eps}
\epsilon > 0
\end{equation}
From (\ref{eq:eps}), we gather
\ldots
```



$$\epsilon > 0 \tag{3.1}$$

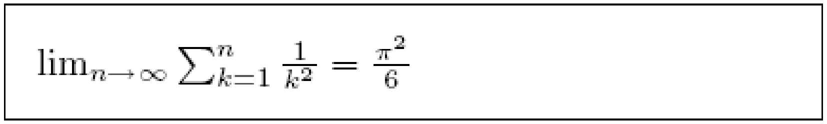
From (3.1), we gather …

Typesetting Mathematical Formulae

General (cont'd)

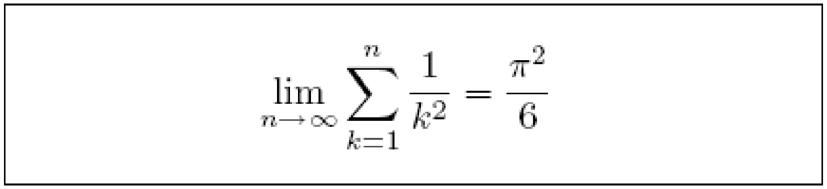
Note that the equation will be typeset in a different style if displayed.

```
$\lim_{n \to \infty}
\sum_{k=1}^n \frac{1}{k^2}
= \frac{\pi^2}{6}$
```



$\lim_{n \to \infty} \sum_{k=1}^n \frac{1}{k^2} = \frac{\pi^2}{6}$

```
\begin{displaymath}
\lim_{n \to \infty}
\sum_{k=1}^n \frac{1}{k^2}
= \frac{\pi^2}{6}
\end{displaymath}
```



$$\lim_{n \to \infty} \sum_{k=1}^n \frac{1}{k^2} = \frac{\pi^2}{6}$$

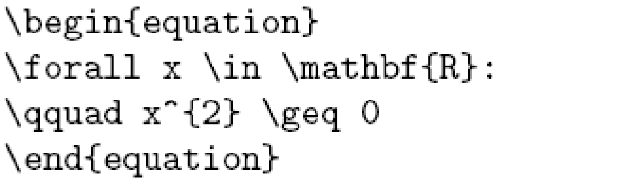
Typesetting Mathematical Formulae

General (cont’d)

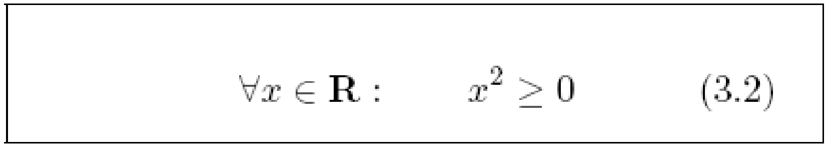
Differences between math mode and text mode.

In math mode:

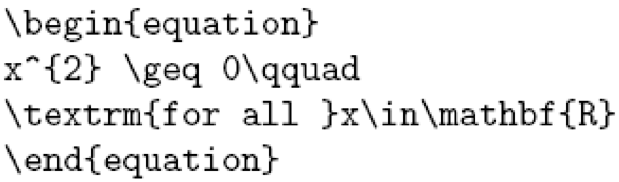
1. Most spaces and linebreaks do not have any significance. Spaces are either derived logically or have to be specified using commands such as \, \quad or \\qquad.
2. Empty lines are not allowed. Only one paragraph per formula.
3. Each letter is considered to be the name of a variable and will be typeset as such. If you want to typeset normal text within a formula, then you have to enter the text using the **\textrm{…}** command.



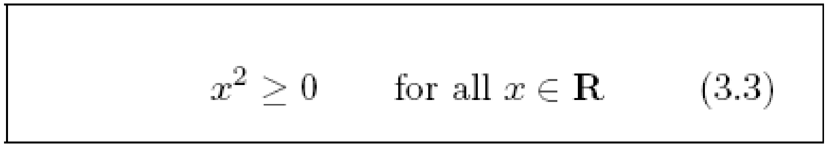
```
\begin{equation}
\forall x \in \mathbf{R}:
\qquad x^{2} \geq 0
\end{equation}
```



$$\forall x \in \mathbf{R}: \qquad x^{2} \geq 0 \qquad (3.2)$$



```
\begin{equation}
x^{2} \geq 0\qquad
\textrm{for all }x\in\mathbf{R}
\end{equation}
```

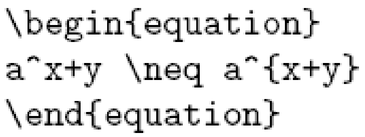


$$x^{2} \geq 0 \qquad \textrm{for all } x \in \mathbf{R} \qquad (3.3)$$

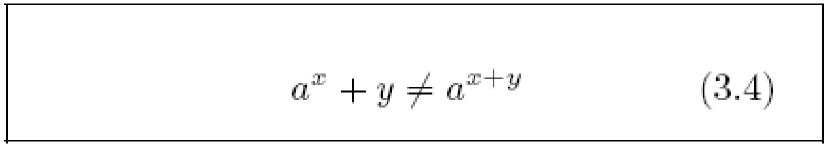
Typesetting Mathematical Formulae

Grouping in Math Mode

Most math mode commands act only on the next character. So if you want a command to affect several characters, you have to group them together using curly braces {…}



```
\begin{equation}
a^x+y \neq a^{x+y}
\end{equation}
```

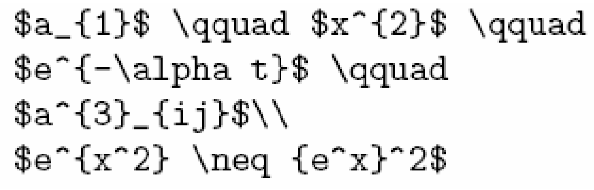


$$a^x + y \neq a^{x+y} \qquad (3.4)$$

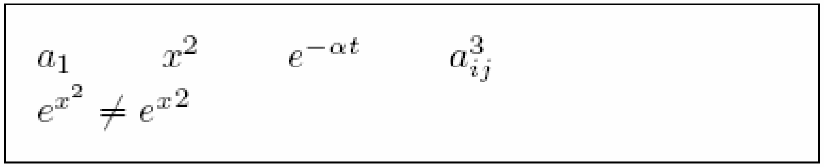
Building Blocks of a Mathematical Formula

Lower case Greek letters are entered as \alpha, \beta, \gamma,…uppercase letters are entered as \Gamma, \Delta,…

Exponents and Subscripts can be specified using the ^ and _ character.



```
$a_{1}$ \qquad $x^{2}$ \qquad
$e^{-\alpha t}$ \qquad
$a^{3}_{ij}$\\
$e^{x^2} \neq {e^x}^2$
```



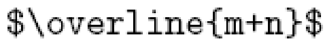
$a_1 \qquad x^2 \qquad e^{-\alpha t} \qquad a^3_{ij}$

${e^{x^2}} \neq {e^x}^2$

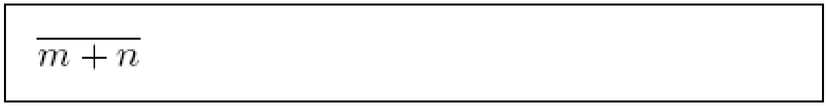
Typesetting Mathematical Formulae

The **square root** is entered as \sqrt, the nth root is entered as \sqrt[n].

The commands **\overline** and **\underline** create horizontal lines directly over or under an expression.

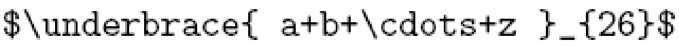


```
$\overline{m+n}$
```

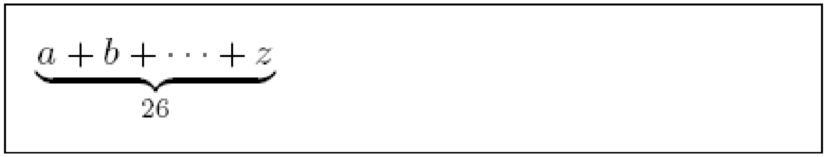


$\overline{m+n}$

The commands **\overbrace** and **\underbrace** create long horizontal braces over or under an expression.

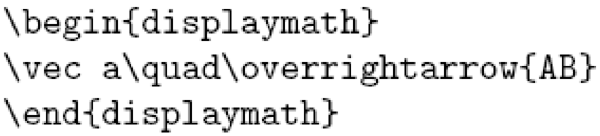


```
$\underbrace{ a+b+\cdots+z }_{26}$
```

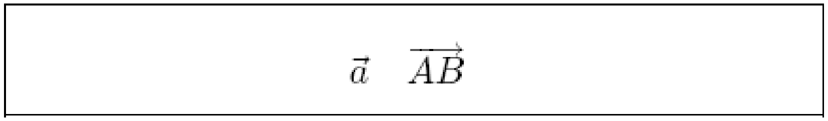


$\underbrace{a+b+\cdots+z}_{26}$

Vectors are often specified by adding small arrow symbols on top of a variable. This is done with the \vec command. The two commands \overrightarrow and \overleftarrow are useful to denote the vector from A to B.



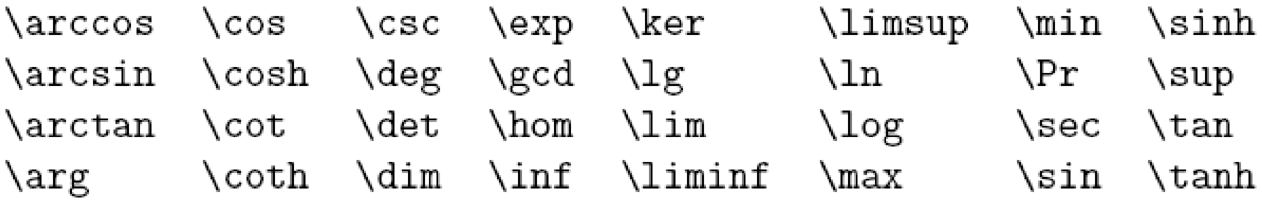
```
\begin{displaymath}
\vec a\quad\overrightarrow{AB}
\end{displaymath}
```



$$\vec a\quad\overrightarrow{AB}$$

Typesetting Mathematical Formulae

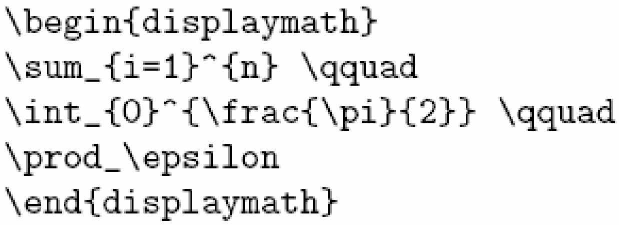
Names of log-like functions are often typeset in an upright font and not in italic like variables. Here are the commands to typeset the most important function names:



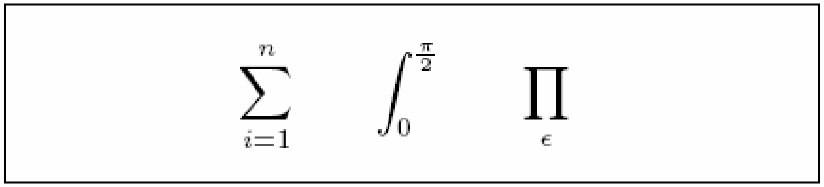
```
\arccos   \cos    \csc   \exp   \ker      \limsup   \min   \sinh
\arcsin   \cosh   \deg   \gcd   \lg       \ln       \Pr    \sup
\arctan   \cot    \det   \hom   \lim      \log      \sec   \tan
\arg      \coth   \dim   \inf   \liminf   \max      \sin   \tanh
```

The built-up fraction is typeset with the \frac{…}{…} command.

The **integral operator** is generated with \int, the **sum operator** with \sum and the **product operator** with \prod. The upper and lower limits are specified with ^ and _ like subscripts and superscripts.



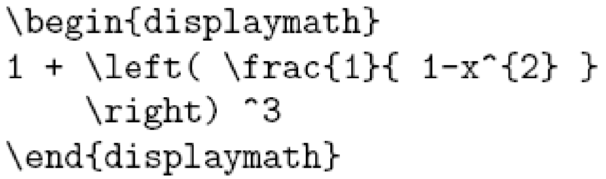
```
\begin{displaymath}
\sum_{i=1}^{n} \qquad
\int_{0}^{\frac{\pi}{2}} \qquad
\prod_\epsilon
\end{displaymath}
```



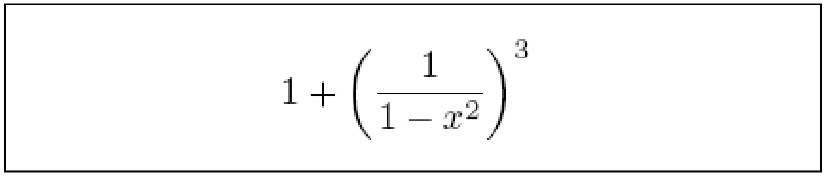
$$\sum_{i=1}^{n} \qquad \int_{0}^{\frac{\pi}{2}} \qquad \prod_\epsilon$$

Typesetting Mathematical Formulae

If you put the command \left in front of an opening delimiter or \right in front of a closing delimiter, TeX will automatically determine the correct size of the delimiter.

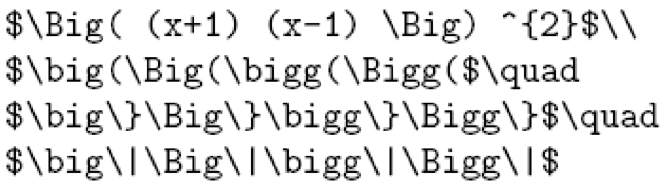


```
\begin{displaymath}
1 + \left( \frac{1}{ 1-x^{2} }
    \right) ^3
\end{displaymath}
```

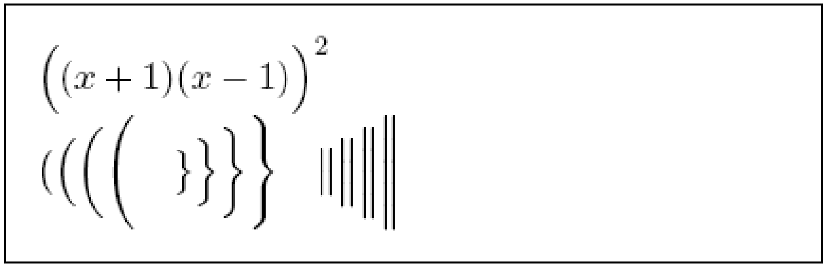


$$1+\left(\frac{1}{1-x^{2}}\right)^{3}$$

In some cases it is necessary to specify the correct size of a mathematical delimiter by hand, which can be done using the commands \big, \Big, \bigg, and \Bigg as prefixes to most delimiter commands.



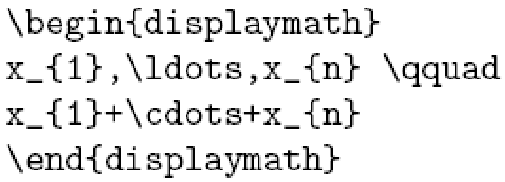
```
$\Big( (x+1) (x-1) \Big) ^{2}$\\
$\big(\Big(\bigg(\Bigg($\quad
$\big\}\Big\}\bigg\}\Bigg\}$\quad
$\big\|\Big\|\bigg\|\Bigg\|$
```



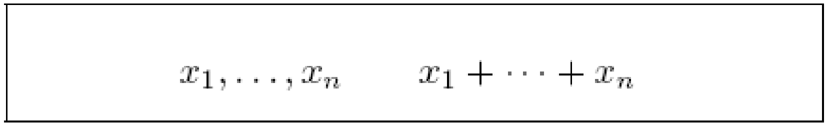
$\Big((x+1)(x-1)\Big)^{2}$
$\big(\Big(\bigg(\Bigg($ $\big\}\Big\}\bigg\}\Bigg\}$ $\big\|\Big\|\bigg\|\Bigg\|$

Typesetting Mathematical Formulae

To enter three dots into a formula, you can use several commands. **\ldots** typesets the dots on the baseline, **\cdots** sets them centered. Besides that, there are commands **\vdots** for vertical and **\ddots** for diagonal dots.



```
\begin{displaymath}
x_{1},\ldots,x_{n} \qquad
x_{1}+\cdots+x_{n}
\end{displaymath}
```



$$x_1, \ldots, x_n \qquad x_1 + \cdots + x_n$$

Math Spacing

If the spaces within formulae chosen by TeX are not satisfactory, they can be adjusted by inserting special spacing commands:

\, for 3/18 quad

\: for 4/18 quad

\; for 5/18 quad

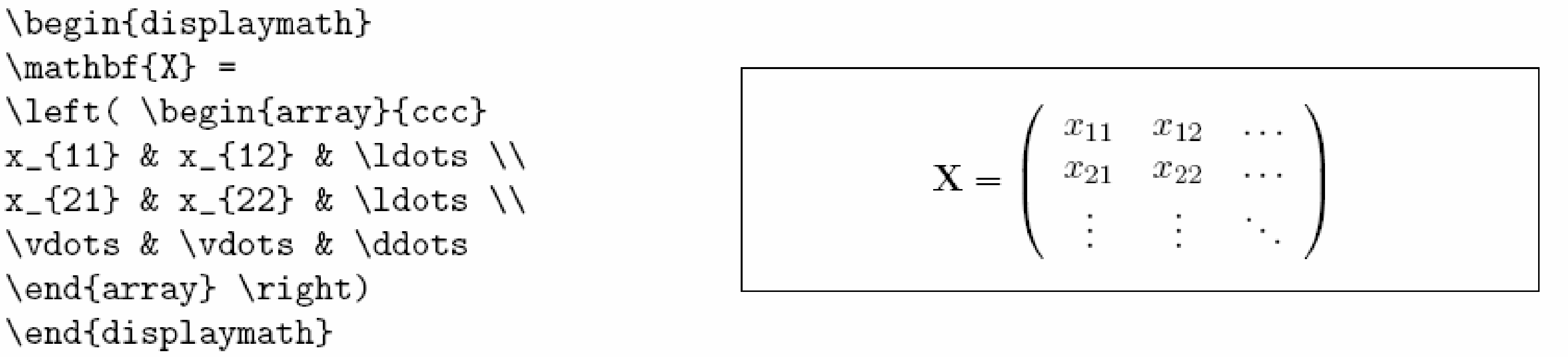
\! For negative -3/18 quad

\quad and \\qquad produce large spaces , where \quad corresponds to the width of the character ‘M’ of the current font.

Typesetting Mathematical Formulae

Vertically Aligned Material

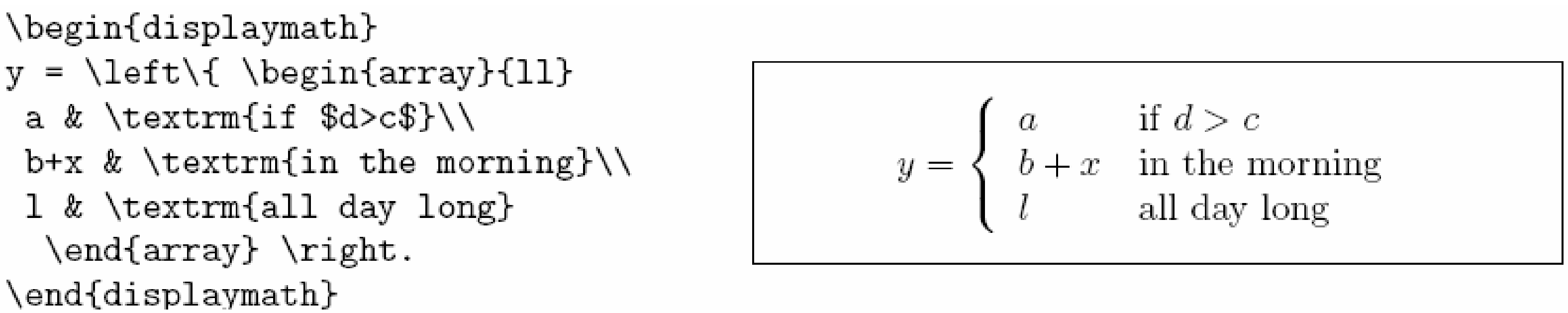
To typeset **arrays**, use the **array** environment. It works similar to the tabular environment. The \\ command is used to break the lines.



```
\begin{displaymath}
\mathbf{X} =
\left( \begin{array}{ccc}
x_{11} & x_{12} & \ldots \\
x_{21} & x_{22} & \ldots \\
\vdots & \vdots & \ddots
\end{array} \right)
\end{displaymath}
```

$$\mathbf{X} = \left(\begin{array}{ccc} x_{11} & x_{12} & \ldots \\ x_{21} & x_{22} & \ldots \\ \vdots & \vdots & \ddots \end{array} \right)$$

The array environment can also be used to typeset expressions which have on big delimiter by using a "." as an invisible **\right** delimiter.



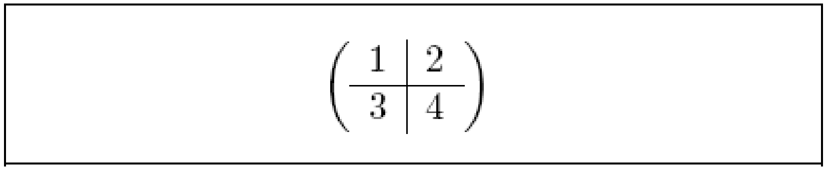
```
\begin{displaymath}
y = \left\{ \begin{array}{ll}
 a & \textrm{if $d>c$}\\
 b+x & \textrm{in the morning}\\
 l & \textrm{all day long}
  \end{array} \right.
\end{displaymath}
```

$$y = \left\{ \begin{array}{ll} a & \textrm{if $d>c$}\\ b+x & \textrm{in the morning}\\ l & \textrm{all day long} \end{array} \right.$$

Typesetting Mathematical Formulae

As with the tabular environment you can also draw lines in the array environment, e.g. separating the entries of a matrix.

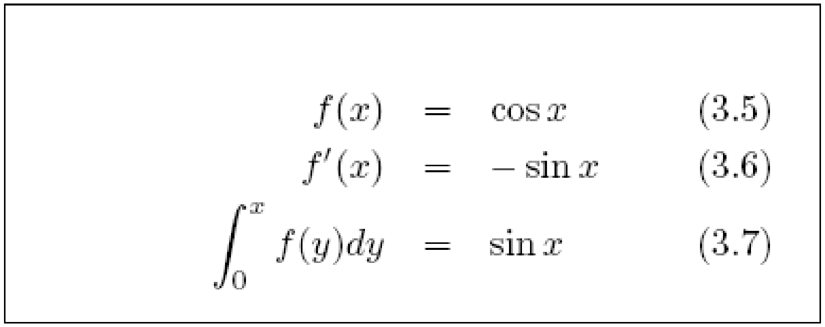
```
\begin{displaymath}
\left(\begin{array}{c|c}
 1 & 2 \\
\hline
3 & 4
\end{array}\right)
\end{displaymath}
```



$$\left(\begin{array}{c|c} 1 & 2 \\ \hline 3 & 4 \end{array}\right)$$

For formulae running over several lines or for equation systems, you can use the environment **eqnarray**, and **eqnarray*** instead of **equation**. In **eqnarray** each line gets an equation number. The **eqnarray*** does not number anything.

```
\begin{eqnarray}
f(x) & = & \cos x      \\
f'(x) & = & -\sin x   \\
\int_{0}^{x} f(y)dy &
 = & \sin x
\end{eqnarray}
```



$$\begin{array}{rcll} f(x) & = & \cos x & (3.5) \\ f'(x) & = & -\sin x & (3.6) \\ \int_0^x f(y)dy & = & \sin x & (3.7) \end{array}$$

Typesetting Mathematical Formulae

Long equations will not automatically be divided into neat bits. The author has to decide where to break them. The **\nonumber** command causes LaTeX to not generate a number for this equation.

Math Font Size

In math mode, TeX select the font size according to the context. Nevertheless, sometimes you need to tell LaTeX the correct font size. In math mode, the font size is set with the four commands:

\displaystyle, \textstyle, \scriptstyle and \scriptscriptstyle

Bold Symbols

It is quite difficult to get bold symbols in LaTeX. The font change command **\mathbf** gives bold letters, but these are roman (upright) whereas mathematical symbols are normally italic. There is a **\boldmath** command, but this can only be used outside mathematics mode.

Specialties

Including graphics

LaTeX provides the basic facilities to work with floating bodies such as images or graphics, with the **figure** and the table **environment**. There are also several possibilities to generate the actual graphics with basic LaTeX or a LaTeX extension package. A much easier way to get graphics into a document, however is to generate them with a specialized software package and then include the finished graphics into the document.

Bibliography

You can produce a bibliography with **thebibliography** environment. For larger projects, you might want to check out the BibTeX program. BibTex is included with most TeX distributions. It allows you to maintain a bibliographic database and then extract the references relevant to things you cited in your paper. BibTex allows you to create bibliographies following a wide range of established designs.

LaTeX also allows you to make indexes, to write you own commands, environments and packages. For more complete information on these and other topics in relation to LaTeX, you can visit the Economic's Department website at http://fmwww.bc.edu/ec/res.info.php#tex

Let’s Practice