Math in \LaTeX

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1 General Information

Special Characters: # $ \% \& \{ \} \_ \^ \_ \. The first seven can be generated with \ followed by the character.

Quotation marks: ‘‘\ldots’’ yields “…”.

Dashes: – (hyphen -), — (range –), and --- (dash —).

Spaces between words don’t matter a bit. Forced hyphenation can be done this way: hy\-phen\-a\-tion.

\textbf{Emphasized Text} = Emphasized Text
\{\textbf{Bold Text}\} = Bold Text
\{\texttt{Typewriter Text}\} = Typewriter Text

To prevent line breaks between certain words, use a ~ in place of a space: Mr. Johns, Figure 7 (Mr.~Johns, Figure~7).

To print long text on a single line, surround it by an \mbox: \mbox{This text will appear on one line}.

Footnotes\footnote{This is a footnote} can be printed using \footnote{This is a footnote}.

Comments are done by % characters.

Vertical space can be specified by \vspace{0.25in}

Verbatim text can be done with \verb+Text!+ or the verbatim environment \begin{verbatim} ... \end{verbatim}.

\footnote{This is a footnote.}
Lists types: itemize, enumerate, and description.

\begin{itemize}
  \item \begin{description}
    \item[Name1] Description of the Name1 object.
    \item[Name2] Description of the Name2 object.
  \end{description}
  \item \begin{enumerate}
    \item item1
    \item item2
  \end{enumerate}
\end{itemize}

- **Name1** Description of the Name1 object.

**Name2** Description of the Name2 object.

- 1. item1
  2. item2

## 2 Types of Math Environments

Formulas in the middle of text: \(2x=4\) or \$2x=4\$. This appears as follows: \(2x = 4\) or \(2x = 4\). \begin{math} \end{math} also works the same.

The displaymath environment offsets equations for emphasis:

\begin{displaymath}
  2x=4
\end{displaymath}

\[2x = 4\]

The commands \[ \] are shortcuts to the displaymath environment.

The equation environment does the same, but numbers the equation:

\begin{equation}
  2x=4
  \label{simpleequation}
\end{equation}

\[2x = 4 \quad (1)\]

To refer to Equation 1 (Equation\ref{simpleequation}), use a cross-reference. Note that this takes multiple passes of \LaTeX. In figures, the label command must go after the caption command.
3 Typical Math Constructs

Exponentiation: $x^{-2} = x^2$, $x^{2y} = x^{4y}$, $x^{-4y} = x^{4y}$.

Subscripts: $x_2 = x_2$, $x^{-2} = x^{2y}$.

Fractions: $n/(2+m) = n/(2 + m)$, $\frac{y+z/2}{y^2+1} = \frac{y + z/2}{y^2 + 1}$

Ellipses: \ldots = ... 

Roots: $\sqrt{x+y} = \sqrt{x + y}$, $\sqrt[n]{x+y} = \sqrt[n]{x + y}$

Greek letters: $\alpha = \alpha$, $\beta = \beta$, $\delta = \delta$, $\Delta = \Delta$, $\theta = \theta$, $\pi = \pi$, ...

Common operators:

\times \div \pm \bullet \\
\cap \cup \subset \supset \\
\lor \land \lnot \in \\
\leq \geq \neq \equiv \\
\infty \forall \exists \emptyset \\
← ⇐ ↔ ⇔

3.1 Functions

\sum \prod \int \\
\bigcup \bigcap \oint \\
\sum \bigcap \bigcup \oint \\
These functions all work similar to the following example: $\sum_{i=0}^n x_i = \int_0^1 f$. This expression will look this way $\sum_{i=0}^n x_i = \int_0^1 f$ when in the text but this way 

$\sum_{i=0}^n x_i = \int_0^1 f$
when in displaymath mode.

Common math functions:

\log \cos \sin \tan
\arccos \arcsin \cosh \sinh
\lim \ln \max \min

\log \cos \sin \tan
\arccos \arcsin \cosh \sinh
\lim \ln \max \min

Example with limits:

\lim_{n \rightarrow \infty} x = 0

\lim_{n \rightarrow \infty} x = 0 and in displaymath mode:

\lim_{n \rightarrow \infty} x = 0

Picky things about functions:

- To typeset \{a \mid a > 0\}, try \{a \mid a > 0\}. The point is to use \mid instead of \}. The latter has spacing problems.

- To typeset f: X \rightarrow Y, try f:X \rightarrow Y. Use \colon instead of : to get the correct spacing.

- To typeset multi-character names in math mode, use \mathit. For example, doesn’t difference = 1 look better than difference = 1? The commands \textstyle (for in-text math) and \displaystyle (for displaymath mode) can be used to make plain text in an equation: \[\textstyle{\text{Let,} \, x=1.}\]

Let x = 1.

Notice the extra space by \,.! You can also use \textbf{mbox} to make plain text.

You can define your own function in the following manner:

\newcommand{\SumToX}[2]{\ensuremath{\sum_{#1=1}^{#2}}}
\newcommand{\QuadraticFormula}[3]{\ensuremath{\frac{-#2 \pm \sqrt{#2^2 - 4 \times #1 \times #3}}{2 \times #1}}}

Then we can use the new commands in our document: $\SumToX{i}{N}x_i$ = $\sum_{i=1}^{N} x_i$.

$\text{QuadraticFormula\{a\}{b\}{c\}}$ =

\[\frac{-b \pm \sqrt{b^2 - 4 \times a \times c}}{2 \times a}\]
3.2 Arrays

Note that the \texttt{tabular} environment is very similar to the \texttt{array} environment, except it is for regular text.

\[
\begin{array}{cl|r}
\hline
Name1 & Name2 & Name3 \\
\hline
a & xy & 12 \\
a+b & x+y & 5 \\
a+b+c & x/y & 100 \\
\end{array}
\]

Delimiters are often used in combination with arrays. The delimiters automatically scale to encompass the arrays. Use the commands \texttt{left} or \texttt{right} before a delimiter to specify the left or right side. Common delimiters:

( ) [ ] \lfloor \rfloor \lceil \rceil

\[
\begin{bmatrix}
\begin{array}{cc}
x_1 & x_2 \\
x_3 & x_4
\end{array}
\end{bmatrix}
\]

An example:

\[
X = \left[ \begin{array}{c}
a_1 \\
\ldots \\
a_n
\end{array} \right] - \left[ \begin{array}{cc}
x-y & x+y \\
xy & x/y
\end{array} \right]
\]

The argument \texttt{t} aligns the top line of the second array with the center of the first. The argument \texttt{b} would align the bottom line with the center.
You can make an invisible delimiter with a “.” as follows:

\[ x = \left\{ \begin{array}{ll} 
  y & \text{if } y > 0 \\
  0 & \text{otherwise} 
\end{array} \right. \]

3.3 Equation Arrays

Equation arrays allow you to create an aligned series of equations. Each equation can either be numbered (using \texttt{eqnarray}) or unnumbered (using \texttt{eqnarray*}). A \texttt{\nonumber} command on a line tells \LaTeX to not number that line. Here are two examples:

\begin{eqnarray}
  x & = & 5y + 6z \\
  y & > & a + b + c + d + e + f + g \nonumber
\end{eqnarray}

\begin{eqnarray*}
  10 & = & 5x \\
  x & = & 10/5 \\
  x & = & 2
\end{eqnarray*}

\begin{align*}
  x & = 5y + 6z \quad (2) \\
  y & > a + b + c + d + e + f + g \quad (3)
\end{align*}

\begin{align*}
  10 & = 2x + 3x \\
  10 & = x(2 + 3) \\
  x & = 2
\end{align*}
3.4 Stacking

You can overline with the \overline command and underline with the \underline command. For example, $\overline{\overline{y^3 + 1}} = \underline{3x}$ yields $\overline{\overline{y^3 + 1}} = \underline{3x}$.

Overbracing and underbracing works similarly: $\overbrace{w + \underbrace{x + y}_{12}}^{24}$ yields $\overbrace{w + \underbrace{x + y}_{12}}^{24}$.

Some common math accents:
\begin{array}{cccc}
\hat{x} & \bar{x} & \vec{x} & \dot{x}
\end{array}
\begin{array}{cccc}
\hat{x} & \bar{x} & \vec{x} & \dot{x}
\end{array}

The letters \textit{i} and \textit{j} should not have dots when accented, so use \texttt{\imath} and \texttt{\jmath} to produce these: \textit{i} + \textit{j}.

The \texttt{\stackrel} command allows us to stack arbitrary symbols:
$\vec{X}\stackrel{\textit{def}}{=} (x_1, \ldots, x_n)$ yields $\vec{X}\stackrel{\textit{def}}{=} (x_1, \ldots, x_n)$.

3.5 Theorems and Such

We can define and automatically number theorems as shown in the following examples:
\begin{verbatim}
\newtheorem{theorem}{Theorem}
\newtheorem{axiom}{Axiom}

\begin{theorem}
This is a theorem.
\label{TheoremThis}
\end{theorem}

\begin{axiom}
All theorems are dull.
\label{AxiomDullTheorems}
\end{axiom}
\end{verbatim}

\textbf{Theorem 1} \textit{This is a theorem.}

\textbf{Axiom 1} \textit{All theorems are dull.}

By Axiom\ref{AxiomDullTheorems}, we can state that Theorem\ref{TheoremThis} is dull.

By Axiom 1, we can state that Theorem 1 is dull.