1 The symbols

This section gives a list of some of the mathematical symbols that are available in LaTeX and examples of how to use them. It is not intended to be exhaustive, it is designed to be helpful though. At the same time it is not designed to teach you LaTeX or what all the bits of maths stuff in it do. The real place to go to learn is Leslie Lamport's book.

`\alpha`	α	`\beta`	β	`\gamma`	γ
`\delta`	δ	`\epsilon`	ϵ	`\zeta`	ζ
`\eta`	η	`\theta`	θ	`\iota`	ι
`\kappa`	κ	`\lambda`	λ	`\mu`	μ
`\nu`	ν	`\xi`	ξ	`\pi`	π
`\rho`	ρ	`\sigma`	σ	`\tau`	τ
`\upsilon`	υ	`\phi`	ϕ	`\chi`	χ
`\psi`	ψ	`\omega`	ω		
`\varepsilon`	ε	`\vartheta`	ϑ	`\varpi`	ϖ
`\varrho`	ϱ	`\varsigma`	ς	`\varphi`	φ
`\Gamma`	Γ	`\Delta`	Δ	`\Theta`	Θ
`\Lambda`	Λ	`\Xi`	Ξ	`\Pi`	Π
`\Sigma`	Σ	`\Upsilon`	Υ	`\Phi`	Φ
`\Psi`	Ψ	`\Omega`	Ω		

Table 1: The Greek letters

In addition to the Greek letters in table 1 there are various mathematical fonts. For example $\mathcal{C D I R P}$ is generated by

```
$\mathcal{C D I R P}$
```

If you use the document class `\documentclass{amsart}` or the command `\usepackage{amsfonts}` just after the `\documentclass{??}` command you can get the standard mathematical set font (the black board font). So you can write $\mathbb{N Q R C H}$ with

```
$\mathbb{N Q R C H}$
```

There are also $\mathbf{bold}\ and\ \mathrm{roman}\ typefaces\ in\ addition\ to\ the\ standard\ \mathit{italic}\ maths\ fonts$ and you get these like this:

```
$\mathbf{bold}\ and\ \mathrm{roman}\ typefaces\ in\ addition\ to\ the\
standard\ \mathit{italic}\ maths\ fonts$
```

Maths mode does not like putting in spaces, hence all the \ symbols in the above code if you leave them out you get then

```
$Something \mathrm{like} this $
```

gives you *Something*like*this*. To get a space of various width you can use various control codes. See table 2. The other option is to use an other AMS package, amstext (so include the command `\usepackage{amstext}`. This gives the verb—— command for fragments of text in equations. You can even embed more maths in it. So $f_{[i_{i-1},x_i]}$ is monotonic, $\quad i = 1,\dots,c+1$ is a gratuitous example generated by:

```
$f_{[i_{i-1},x_i]} \text{ is monotonic,}\quad i=1,\dots,c+1$
```

See example 2.4 for another. Beware, if using emacs which colour codes LaTeX then the colours may go funny if you embed maths in text which is in maths. If using an emacs that trys to type check it may try and stop you.

In general AMS-LaTeX is useful and well documented. Look for the `amsldoc.dvi` file among your systems standard LaTeX documentation.

<table>
<tr><td>\,</td><td>$\vert\,\vert$</td><td>\:</td><td>$\vert\:\vert$</td></tr>
<tr><td>\;</td><td>$\vert\;\vert$</td><td>\ </td><td>$\vert\ \vert$</td></tr>
<tr><td>\quad</td><td>$\vert\quad\vert$</td><td>\qquad</td><td>$\vert\qquad\vert$</td></tr>
</table>

Table 2: spaces

<table>
<tr><td>\aleph</td><td>$\aleph$</td><td>\hbar</td><td>$\hbar$</td><td>\imath</td><td>$\imath$</td></tr>
<tr><td>\jmath</td><td>$\jmath$</td><td>\ell</td><td>ℓ</td><td>\wp</td><td>$\wp$</td></tr>
<tr><td>\Re</td><td>$\Re$</td><td>\Im</td><td>$\Im$</td><td></td><td></td></tr>
</table>

Table 3: Other letters and symbols

<table>
<tr><td>\forall</td><td>$\forall$</td><td>\exists</td><td>$\exists$</td><td>\neg</td><td>$\neg$</td></tr>
<tr><td>\top</td><td>$\top$</td><td>\bot</td><td>$\bot$</td><td></td><td></td></tr>
<tr><td>vdash</td><td>$\vdash$</td><td>\dashv</td><td>$\dashv$</td><td>\models</td><td>$\models$</td></tr>
<tr><td>\wedge</td><td>$\wedge$</td><td>\vee</td><td>$\vee$</td><td></td><td></td></tr>
<tr><td>\triangle</td><td>$\triangle$</td><td>\bigtriangleup</td><td>$\bigtriangleup$</td><td>bigtriangledown</td><td>$\bigtriangledown$</td></tr>
<tr><td>\cdot</td><td>$\cdot$</td><td>\circ</td><td>$\circ$</td><td>\bullet</td><td>$\bullet$</td></tr>
<tr><td>\pm</td><td>$\pm$</td><td>\mp</td><td>$\mp$</td><td>\oplus</td><td>$\oplus$</td></tr>
<tr><td>\times</td><td>$\times$</td><td>\div</td><td>$\div$</td><td></td><td></td></tr>
<tr><td>\backslash</td><td>$\backslash$</td><td>\prime</td><td>$\prime$</td><td></td><td></td></tr>
<tr><td>\surd</td><td>$\surd$</td><td>\angle</td><td>$\angle$</td><td>\infty</td><td>∞</td></tr>
<tr><td>|</td><td>—</td><td>\|</td><td>$\|$</td><td></td><td></td></tr>
<tr><td>\partial</td><td>∂</td><td>\nabla</td><td>∇</td><td></td><td></td></tr>
</table>

Table 4: General symbols

=	$=$	neq	$\neq$	\approx	$\approx$
\propto	$\propto$	\cong	$\cong$	\equiv	$\equiv$
\sim	$\sim$	\simeq	$\simeq$	\parallel	$\parallel$
<	$<$	\leq	$\leq$	\ll	$\ll$
>	$>$	\geq	$\geq$	\gg	$\gg$

Table 5: Equalities

\Rightarrow	$\Rightarrow$	\Leftarrow	$\Leftarrow$	\Leftrightarrow	$\Leftrightarrow$
\rightarrow	$\rightarrow$	\leftarrow	$\leftarrow$	\leftrightarrow	$\leftrightarrow$
\longrightarrow	$\longrightarrow$	\longleftarrow	$\longleftarrow$	\longleftrightarrow	$\longleftrightarrow$
\Longrightarrow	$\Longrightarrow$	\Longleftarrow	$\Longleftarrow$	\Longleftrightarrow	$\Longleftrightarrow$
\hookrightarrow	$\hookrightarrow$	\hookleftarrow	$\hookleftarrow$	\mapsto	$\mapsto$
				\longmapsto	$\longmapsto$
\uparrow	$\uparrow$	\downarrow	$\downarrow$	\updownarrow	$\updownarrow$
\Uparrow	$\Uparrow$	\Downarrow	$\Downarrow$	\Updownarrow	$\Updownarrow$
\nearrow	$\nearrow$	\searrow	$\searrow$	\swarrow	$\swarrow$
\nwarrow	$\nwarrow$				

Table 6: Arrows

\{	$\{$	\}	$\}$	\emptyset	$\emptyset$
\in	$\in$	\ni	$\ni$	\notin	$\notin$
\cap	$\cap$	\supset	$\supset$	subset	$\subset$
\cup	$\cup$	\supseteq	$\supseteq$	subseteq	$\subseteq$
\bigcap	$\bigcap$	\bigcup	$\bigcup$		

Table 7: Sets

\arg	arg	\csc	csc	\det	det
\dim	dim	\exp	exp	\gcd	gcd
\hom	hom	\inf	inf	\ker	ker
\ln	ln	\lg	lg	\log	log
\max	max	\min	min	\sec	sec
\sup	sup				
\sin	sin	\cos	cos	\tan	tan
\sinh	sinh	\cosh	cosh	\cosh	cosh
\arcsin	arcsin	\arccos	arccos	\arctan	arctan
\lim	lim	\limsup	lim sup	\liminf	lim inf
\sum	$\sum$	\prod	$\prod$		
\int	$\int$	\oint	$\oint$		
\bigwedge	$\bigwedge$	\bigvee	$\bigvee$		
\frac{a}{b}	$\frac{a}{b}$	\sqrt{c}	$\sqrt{c}$	\sqrt[n]{d}	$\sqrt[n]{d}$

Table 8: Functions

\langle	$\langle$	\rangle	$\rangle$
\lceil	$\lceil$	\rceil	$\rceil$
\lfloor	$\lfloor$	\rfloor	$\rfloor$
\{	$\{$	\}	$\}$
(	$($	)	$)$
[	$[$	]	$]$

Table 9: brackets

\pounds	£	\copyright	©	\circledR	®
\dag	†	\ddag	‡	\S	§
\P	¶	\checkmark	✓		

Table 10: Symbols that don't need maths mode

2 Combining stuff

Some examples of how the symbols can be combined.

Each example consists of

```
Something like this which is now the stuff below was generated. So in this
case:
\begin{equation}
  \label{eq:exampleexample}
  Something\ like\ this\ that\ is\ generated\ by\ the\ above\ code.
\end{equation}
```

and

$$Something\ like\ this\ that\ is\ generated\ by\ the\ above\ code. \tag{1}$$

2.1 Example 1: Limits and sums

```
\begin{equation}
  \label{eq:limits}
  \lim_{N\rightarrow \infty}{\sum_{m=1}^{N}{\frac{1}{m^2}}}=2
\end{equation}
```

$$\lim_{N\rightarrow \infty}{\sum_{m=1}^{N}{\frac{1}{m^2}}}=2 \tag{2}$$

2.2 Example 2: Unions and intersections and set fonts

```
For events $A_{n},\ n \in \mathbb{N}$ we may ask for the probability that
infinitely many occur. Set
\begin{equation}
  \label{eq:limsup}
  \limsup{A_{n}}=\bigcap_{n}{\bigcup_{m\geq n}{A_{m}}}
\end{equation}
then
\begin{equation}
  \label{eq:infinitelyoften}
  \mathbb{P}(A_{n}\ i.o.)=\mathbb{P}(\limsup{A_{n}})
\end{equation}
```

For events $A_{n},\ n \in \mathbb{N}$ we may ask for the probability that infinitely many occur. Set

$$\limsup{A_{n}}=\bigcap_{n}{\bigcup_{m\geq n}{A_{m}}} \tag{3}$$

then

$$\mathbb{P}(A_{n}\ i.o.)=\mathbb{P}(\limsup{A_{n}}) \tag{4}$$

2.3 Example 3: Vectors, integrals and equation arrays

```
If x and y are vectors in a complex inner product space. then
\begin{eqnarray}
  \label{eq:polarization}
  \langle x,y \rangle & = & \frac{1}{4}(\|x+y\|^2 + i\|x+iy\|^2
  -\|x-y\|^2-i\|x-iy\|^2) \\
  \nonumber & = & \frac{1}{2\pi} \int_0^{2\pi}{e^{it}\| x+e^{it}y\|^2 dt}.
\end{eqnarray}
```

If x and y are vectors in a complex inner product space. then

$$\begin{aligned}\langle x,y \rangle &= \frac{1}{4}(\|x+y\|^2 + i\|x+iy\|^2 -\|x-y\|^2-i\|x-iy\|^2) \qquad (5)\\ &= \frac{1}{2\pi} \int_0^{2\pi}e^{it}\| x+e^{it}y\|^2 dt.\end{aligned}$$

2.4 Example 4: Silly integrals

LaTeX allows you to do some expectionally silly things with integrals and the like. If you want a challenge evaluate Ψ, you might even get a prize.

```
\begin{equation}
  \label{eq:complicatedintegration}
  \Psi=\lim_{N \rightarrow \infty}\frac{\partial}{\partial
  \phi}\int_{\oint_{\{ \omega=e^{i\theta}:\ 0\leq \theta < 2\pi \}
  }{\frac{1}{\omega} d\omega}}^{i\int_{\gamma }^{\phi}{e^{-\frac{x^2}{2}}
  dx}}{\frac{z}{\sum_{n=0}^N {1-z^{\prod_{\alpha=1}^{n}{\sin{z^\alpha}}}}}dz}
  \qquad \mathrm{for\ }-\infty < \gamma \leq \phi < \infty.
\end{equation}
```

$$\Psi=\lim_{N \rightarrow \infty}\frac{\partial}{\partial \phi}\int_{\oint_{\{ \omega=e^{i\theta}:\ 0\leq \theta < 2\pi \}}{\frac{1}{\omega} d\omega}}^{i\int_{\gamma }^{\phi}{e^{-\frac{x^2}{2}} dx}}{\frac{z}{\sum_{n=0}^N {1-z^{\prod_{\alpha=1}^{n}{\sin{z^\alpha}}}}}dz} \qquad \mathrm{for\ }-\infty < \gamma \leq \phi < \infty. \qquad (6)$$

A Manual Entry

The following comes from the LaTeX html manual

A.1 Math Formulae

There are three environments that put LaTeX in math mode:

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

Table 11: enviroments

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

`\(...\)` instead of `\begin{math}...\end{math}`

`\[...\]` instead of `\begin{displaymath}...\end{displaymath}`

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

`$ ... $` instead of `\(...\)`

A.2 Subscripts & Superscripts

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

A.3 Math Symbols

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

A.4 Spacing in Math Mode

In a math environment, LaTeX ignores the spaces you type and puts in the spacing that it thinks is best. LaTeX formats mathematics the way it's done in mathematics texts. If you want different spacing, LaTeX provides the following four commands for use in math mode:

`\;` - a thick space

`\:` - a medium space

`\,` - a thin space

`\!` - a negative thin space

subsectionMath Miscellany

`\cdots` Produces a horizontal ellipsis where the dots are raised to the centre of the line. eg. $\cdots$

`\ddots` Produces a diagonal ellipsis. eg. $\ddots$

`\frac{num}{den}` Produces the fraction num divided by den. eg. $\frac{num}{dec}$

`\ldots` Produces an ellipsis. This command works in any mode, not just math mode. eg. $\ldots$

`\overbrace{text}` Generates a brace over text. eg. $\overbrace{text}$

`\overline{text}` Causes the argument text to be overlined. eg. $\overline{text}$

`\sqrt[root]{arg}` Produces the square root of its argument. The optional argument, root, determines what root to produce, i.e., the cube root of x+y would be typed as `$\sqrt[3]{x+y}$`. eg. $\sqrt[3]{x+y}$

`\underbrace{text}` Generates text with a brace underneath. eg. $\underbrace{text}$

`\underline{text}` Causes the argument text to be underlined. This command can also be used in paragraph and LR modes. eg. $\underline{text}$

`\vdots` Produces a vertical ellipsis. eg. $\vdots$