

# 15-451: Sample Latex Math File

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## 1 Math mode

To enter Latex's math mode, use the  $\$$  character to delimit the beginning and end of math mode. For example,  $\$\Omega\$$  gives you  $\Omega$ . Once in math mode, you'll notice that mathematical symbols look fine but spacing and normal text work differently. To add a space, use  $\backslash$  followed by a space.

For instance,  $\$\epsilon\$ \ \$\epsilon\$$  gives:  $\epsilon \epsilon$  (note the space).

On the other hand,  $\$\epsilon\$ \$\epsilon\$$  gives you  $\epsilon\epsilon$ .

To add text, use either

- $\$\text{\textit{text here}}\$$   
eg.  $\alpha =$  size of array
- $\$\{\mbox{\scriptsize text here}\}$$   
eg.  $\beta =$  size of array
- Or just make sure your math delimiters end before you start adding the text  
eg.  $\$\theta\ =\ \$$  size of array, which gives you  $\theta =$  size of array

## 2 Basic Mathematical Symbols

Once in math mode, you can use all sorts of mathematical symbols. Characters that you'll probably need in your assignments include:

1. Greek alphabet letters like

$\backslash$ alpha ( $\alpha$ )	$\backslash$ beta ( $\beta$ )	$\backslash$ gamma ( $\gamma$ )
$\backslash$ delta ( $\delta$ )	$\backslash$ epsilon ( $\epsilon$ )	$\backslash$ eta ( $\eta$ )
$\backslash$ theta ( $\theta$ )	$\backslash$ lambda ( $\lambda$ )	$\backslash$ pi ( $\pi$ )
$\backslash$ sigma ( $\sigma$ )	$\backslash$ psi ( $\psi$ )	$\backslash$ omega ( $\omega$ )

You can also capitalize certain Greek characters eg.

<code>\Gamma</code> ( $\Gamma$ )	<code>\Delta</code> ( $\Delta$ )	<code>\Theta</code> ( $\Theta$ )
<code>\Lambda</code> ( $\Lambda$ )	<code>\Pi</code> ( $\Pi$ )	<code>\Sigma</code> ( $\Sigma$ )
<code>\Phi</code> ( $\Phi$ )	<code>\Psi</code> ( $\Psi$ )	<code>\Omega</code> ( $\Omega$ )

There are many more Greek letters available and this is not an exhaustive list.

## 2. Operators

<code>\leq</code> ( $\leq$ )	<code>\geq</code> ( $\geq$ )	<code>\equiv</code> ( $\equiv$ )	<code>\neq</code> ( $\neq$ )
<code>\subset</code> ( $\subset$ )	<code>\supset</code> ( $\supset$ )	<code>\subseteq</code> ( $\subseteq$ )	<code>\supseteq</code> ( $\supseteq$ )

Note that  $<$  and  $>$  can be typed in directly but you need to use it in math mode.

## 3. Arrows

Latex has tons of arrows to use with your equations. The list below is just a sample of what is available.

<code>\leftarrow</code> ( $\leftarrow$ )	<code>\longleftarrow</code> ( $\longleftarrow$ )
<code>\Leftrightarrow</code> ( $\Leftrightarrow$ )	<code>\Leftrightarrow</code> ( $\Leftrightarrow$ )
<code>\rightarrow</code> ( $\rightarrow$ )	<code>\longrightarrow</code> ( $\longrightarrow$ )
<code>\Rightarrow</code> ( $\Rightarrow$ )	<code>\Rightarrow</code> ( $\Rightarrow$ )
<code>\leftrightarrow</code> ( $\leftrightarrow$ )	<code>\longleftrightarrow</code> ( $\longleftrightarrow$ )
<code>\Leftrightarrow</code> ( $\Leftrightarrow$ )	<code>\Leftrightarrow</code> ( $\Leftrightarrow$ )

## 4. Misc Symbols

<code>\ldots</code> ( $\dots$ )	<code>\cdots</code> ( $\cdots$ )	<code>\vdots</code> ( $\vdots$ )	<code>\ddots</code> ( $\ddots$ )
<code>\forall</code> ( $\forall$ )	<code>\infty</code> ( $\infty$ )	<code>\emptyset</code> ( $\emptyset$ )	<code>\exists</code> ( $\exists$ )
<code>\sum</code> ( $\sum$ )	<code>\prod</code> ( $\prod$ )	<code>\bigcap</code> ( $\bigcap$ )	<code>\bigcup</code> ( $\bigcup$ )

# 3 Subscripts and Superscripts

Subscripts are indicated by the `_` symbol. For instance, `a_{sub}` looks like  $a_{sub}$ . Similarly, superscripts are indicated by the `^` symbol eg. `a^{super}` looks like  $a^{super}$ . You can combine subscripts and superscripts as in `T_{i}^{2}`, which generates  $T_i^2$ .

## 4 Overset and Underset

Subscripts and superscripts can be used for summation or product formulas. For instance, `\sum_{n=0}^{10}` looks like  $\sum_{n=0}^{10}$ . However, the `\overset` and `\underset` commands can also be used. The table below illustrates the use of these commands:

<code>\overset{n}{\sum}</code>	$\sum^n$
<code>\underset{i=0}{\prod}</code>	$\prod_{i=0}^n$
<code>\overset{n}{\underset{i=0}{\sum}}</code>	$\sum_{i=0}^n$

## 5 Fractions, Combinatorics, and Roots

Fractions such as  $\frac{11}{20}$  are created using the `\frac{numerator}{denominator}` construct. You can make the numerator and denominator as complicated as you want eg.  $\frac{\alpha*\beta}{\delta_n^2}$

For the choose expression like  $\binom{k}{2}$ , use `\binom{top}{bottom}`.

For roots, use `\sqrt{abc}` for  $\sqrt{abc}$  and `\sqrt[n]{abc}` for  $\sqrt[n]{abc}$ .

## 6 Formatting Equations

You can place equations in sections using Latex commands like `equation`, `gather`, and `align`. The sections are indicated using `\begin{...}` and `\end{...}` tags eg. `\begin{equation}` and `\end{equation}`. Anything between these begin and end tags will be in math mode. You will not need the `$` delimiters. If you put a `*` after the command eg. `\begin{equation*}`, it will not label the section with a number.

### 6.1 The Equation Command

The equation command puts an equation on a separate line eg.

```
\begin{equation}
T(n) = 2T(\frac{n}{2}) + cn
\end{equation}
```

Looks like:

$$T(n) = 2T\left(\frac{n}{2}\right) + cn \quad (1)$$

Notice that it is numbered. If I wanted the equation not to have a number, I would have used Latex instructions like this:

```
\begin{equation*}
T(n) = 2T(\frac{n}{2}) + cn
\end{equation*}
```

Which looks like:

$$T(n) = 2T\left(\frac{n}{2}\right) + cn$$

## 6.2 The Gather Command

If you wanted to put multiple lines of an equation in a section with no alignment, use the gather command eg.

```
\begin{gather}
x^2 + y^2 = 1\\
x = \sqrt{1-y^2}
\end{gather}
```

Which yields:

$$\begin{aligned} x^2 + y^2 &= 1 \\ x &= \sqrt{1 - y^2} \end{aligned}$$

## 6.3 The Align Command

The align command lets you use vertical alignment on multiple lines of equations. For example, the code below:

```
\begin{align*}
x^2 + y^2 &= 1\\
x &= \sqrt{1-y^2}
\end{align*}
```

Gives you:

$$x^2 + y^2 = 1$$
$$x = \sqrt{1 - y^2}$$

Note that the & indicates where you want the alignment. In this case, I wanted the alignment on the = signs. You also need a \\ at the end of every equation in order to indicate that a new line is about to start.

## 7 Online Latex Help

Places on the web that can help you with Latex:

<http://www.latex-project.org/>

[http://www.emerson.emory.edu/services/latex/latex\\_toc.html](http://www.emerson.emory.edu/services/latex/latex_toc.html)

<http://www.giss.nasa.gov/latex/>

<http://coulomb.ecn.purdue.edu/~bulsara/LaTeX/latex.html>