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 Ω. Once in math mode, you'll notice that mathematical symbols look fine but spacing and normal text work differently. To add a space, use `\` 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

- `$\text{` *text here* `}$`
  eg. $\alpha\ =\ \text{size of array}$
- `${\mbox{\scriptsize` *text here* `}$`
  eg. $\beta\ =\ \text{size of array}$
- 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

\alpha (α)	\beta (β)	\gamma (γ)
\delta (δ)	\epsilon (ϵ)	\eta (η)
\theta (θ)	\lambda (λ)	\pi (π)
\sigma (σ)	\psi (ψ)	\omega (ω)

   You can also capitalize certain Greek characters eg.

\Gamma (Γ)	\Delta (Δ)	\Theta (Θ)
\Lambda (Λ)	\Pi (Π)	\Sigma (Σ)
\Phi (Φ)	\Psi (Ψ)	\Omega (Ω)

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

2. Operators

\leq ($\leq$)	\geq ($\geq$)	\equiv ($\equiv$)	\neq ($\neq$)
\subset ($\subset$)	\supset ($\supset$)	\subseteq ($\subseteq$)	\supseteq ($\supseteq$)

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.

\leftarrow ($\leftarrow$)	\longleftarrow ($\longleftarrow$)
\Leftarrow ($\Leftarrow$)	\Longleftarrow ($\Longleftarrow$)
\rightarrow ($\rightarrow$)	\longrightarrow ($\longrightarrow$)
\Rightarrow ($\Rightarrow$)	\Longrightarrow ($\Longrightarrow$)
\leftrightarrow ($\leftrightarrow$)	\longleftrightarrow ($\longleftrightarrow$)
\Leftrightarrow ($\Leftrightarrow$)	\Longleftrightarrow ($\Longleftrightarrow$)

4. Misc Symbols

\ldots ($\ldots$)	\cdots ($\cdots$)	\vdots ($\vdots$)	\ddots ($\ddots$)
\forall ($\forall$)	\infty (∞)	\emptyset ($\emptyset$)	\exists ($\exists$)
\sum ($\sum$)	\prod ($\prod$)	\bigcap ($\bigcap$)	\bigcup ($\bigcup$).

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:

\overset{n}{\sum}	$\overset{n}{\sum}$
\underset{i=0}{\prod}	$\underset{i=0}{\prod}$
\overset{n}{\underset{i=0}{\sum}}	$\overset{n}{\underset{i=0}{\sum}}$

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:

$$T(n) = 2T(\frac{n}{2}) + cn \tag{1}$$

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:

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

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:

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

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:

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

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.giss.nasa.gov/latex/
http://coulomb.ecn.purdue.edu/~bulsara/LaTeX/latex.html