

## 1 Introduction

The purpose of this tutorial is to teach beginners the bare minimum basics of L<sup>A</sup>T<sub>E</sub>X by inspecting this TeX file while observing its compiled output.

L<sup>A</sup>T<sub>E</sub>X is a compiled typesetting language - you write plain text and shorthand commands in a .tex file, which is then compiled into a readable format. We request that you submit your work in pdf format using the pdflatex compiler (this is the default on most non-\*nix systems). Your text editor on windows or macs will probably automate all of this for you, you just need to hit compile.

Much of the tutorial will actually be in the comments of the .tex file for this document, so you will not see everything displayed on the pdf. It will help to compare the .tex file and the .pdf file side by side to see how the short hand becomes rendered. This tutorial will *only cover the bare basics* needed to help you write up your homework. Much of the power of L<sup>A</sup>T<sub>E</sub>X is in the complete control you have over the general formatting of macros, theorems, references, graphics, etc. but that won't be covered here. A MUCH more comprehensive tutorial can be found at the [Not So Short Guide to L<sup>A</sup>T<sub>E</sub>X](#). The Wiki at [Wikibooks/Latex](#) will be helpful as a reference source as well.

For details about installation, see [Wikibooks/Latex/Installation](#). For Windows users, I highly recommend MikTeX, with whatever text editor you prefer. The MikTeX default editor, TeXWorks, isn't too bad. Same goes with MacTeX for Macs and the default editor TexShop.

If you happen to use Vim, I highly recommend learning [Vim-Latex](#). I believe there are similar excellent packages for Emacs, but I don't know them.

Along with the power of L<sup>A</sup>T<sub>E</sub>X, I've also added a special header file that contains a lot of useful macros that I've written over the years. Feel free to modify this header file as you wish.

## 2 Basics

You may often want to list things. The itemize and enumerate environments make this easy

- First thing
- Second thing
  - Second thing point 1
  - Second thing point 2

To write Math, you generally need to enter “Math Mode”, by putting dollar signs (\$) around your code. You typically want math mode whenever you're writing fractions, subscripts, superscripts, integrals, etc. For example,

`$x = \frac{3}{2}$` becomes rendered as  $x = \frac{3}{2}$ .

If you want an equation to get its own line, then use `\[` and `\]` to mark the beginning and end of your code. Regular math mode looks like:  $\min_{l,r \in A} \int_{x=l}^r x^2 dx$ , and displaymath looks like:

$$\min_{l,r \in A} \int_{x=l}^r x^2 dx$$

Here is a table of many common math symbols and shorthand. Special commands and macros that are NOT standard L<sup>A</sup>T<sub>E</sub>X but ARE included in the custom header file are marked with a \*.

Use	Command	Rendered
Greek Letters	<code>\alpha, \beta, \epsilon, \delta ...</code>	$\alpha, \beta, \epsilon, \delta \dots$
Math Symbols	<code>\leq, \geq, \neq, \approx, \xor, \infty, \to, \implies, \iff</code>	$\leq, \geq, \neq, \approx, \oplus, \infty, \rightarrow, \implies, \iff$
Fractions	<code>\frac{NUM}{DEN}, \frac{3+4}{1+2}</code>	$\frac{NUM}{DEN}, \frac{3+4}{1+2}$
Sub/Super Scripts	<code>a_1, b_{x=3}, e^{\frac{x^2}{2}}</code>	$a_1, b_{x=3}, e^{-\frac{x^2}{2}}$
Sums/Integrals/Mins/etc	<code>\sum_{x=5}^7 x, \int_s \in S</code>	$\sum_{x=5}^7 x, \int_{s \in S}$
*Fancy Sets/Vectors/etc*	<code>\mathbb{F}, \vec{x}, \mathcal{F}</code>	$\mathbb{F}, \mathbf{x}, \mathcal{F}$
*paired sets, brackets, etc.*	<code>\set{...}, \bracks{...}</code>	$\{x_1, \dots x_n\}, [\frac{1}{2}]$
*Conditionals*	<code>f(x) = \multi{ 1 &amp; \text{if...}</code>	$f(x) = \begin{cases} 1 & \text{if x is even} \\ 2 & \text{if x is odd} \end{cases}$

### 3 Equations

The align environment helps you format systems of equations very cleanly. Every line ends with the newline symbol, `\`, and contains one or more `&` symbols to indicate where in each line you want to align. Using “align\*” instead of “align” will suppress individual numbering of each equation.

Also, align environments are automatically in displaymath mode, so you must use the command `\text` to write normally within an align. If you want right justified text on the end of a line, use the command `\tag` before the newline.

Here’s a simple example

$$\begin{aligned}
 \sum_{x=1}^n x &= \frac{1}{2} \left[ \sum_{x=1}^n x + \sum_{x=1}^n x \right] \\
 &= \frac{1}{2} \left[ \sum_{x=1}^n x + \sum_{x=1}^n (n+1-x) \right] && \text{(counting backwards)} \\
 &= \frac{1}{2} \left[ \sum_{x=1}^n x + (n+1-x) \right] && \text{(combining the sums)} \\
 &= \frac{1}{2} \left[ \sum_{x=1}^n (n+1) \right] \\
 &= \frac{n(n+1)}{2}
 \end{aligned}$$

Here’s a longer example, taken from some of my old math homework.

$$\begin{aligned}
 P[X_{1,h} + X_{2,h} \leq 1] &= \int_{x=0}^1 \int_{y=0}^{1-x} \lambda h e^{-\lambda h x} \mu h e^{-\mu h y} dx dy \\
 &= \int_{x=0}^1 \lambda h e^{-\lambda h x} - [e^{-\mu h y}]_{y=0}^{1-x} dx \\
 &= \int_{x=0}^1 \lambda h e^{-\lambda h x} - e^{-\mu h (1-x)} \lambda h e^{-\lambda h x} dy \\
 &= [-e^{-\lambda h x} - \frac{\lambda h e^{-\mu h}}{h(\mu - \lambda)} e^{(\mu - \lambda) h x}]_{x=0}^1 \\
 &= 1 + \frac{\lambda h e^{-\mu h}}{h(\mu - \lambda)} - e^{-\lambda h} - \frac{\lambda h e^{-\mu h}}{(\mu - \lambda) h} e^{(\mu - \lambda) h} \\
 &= 1 + \frac{\lambda e^{-\mu h}}{\mu - \lambda} - e^{-\lambda h} - \frac{\lambda e^{-\mu h}}{\mu - \lambda} e^{(\mu - \lambda) h} \\
 &= 1 - \frac{\lambda e^{-\mu h} - \mu e^{-\lambda h}}{\lambda - \mu}
 \end{aligned}$$

## 4 Pseudocode

There are lots of different packages for Pseudocode! Go here for a complete list and information about them. <http://en.wikibooks.org/wiki/LaTeX/Algorithms>

I personally use the `algpseudocode` package (which extends `algorithmicx`), and the `hwheader` file has some macros for this package. You can add comments to the right of each line as well.

Here is an example.

```
function CALCULATE RANGE(Array  $A[1 \dots n]$ )  
     $Mx = -\infty$   
     $Mn = \infty$                                 ▷ Initialize Max, Min values  
    for  $i = 1$  to  $n$  do  
         $Mx = \max(Mx, A[i])$   
         $Mn = \min(Mx, A[i])$   
    return  $Mx - Mn$ 
```

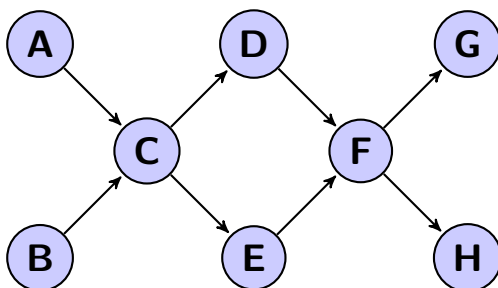
## 5 Spacing

Sometimes Latex makes things too close together or far apart, and you need more control over spacing. Because Latex eliminates whitespace from the input file, there are special commands that you can use. The easiest is to just “\ ”, or escape a space. Also, there are the `\quad` or `\qquad`, which are rendered as the following spaces between the two “+”’s: + +, + + +. For a lot of space at once, use the command `\hspace` so that text will show up over here. For these commands, you specify a distance in a unit of measurement like “pt”, “in”, or “ex”, which is the width of an “x” character.

There is a corresponding `\vspace` command for vertical space. You can use negative values to decrease spacing.

## 6 Advanced

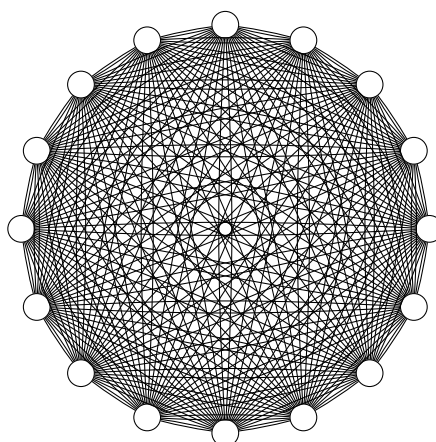
TikZ is a powerful package that allows you to create graphics using TeX. Below is an example of a very simple graph, created using this package.



TikZ is actually very advanced, and examples of all the things you can do with it can be found at [TikZ Examples](#). If you ever need a graphic, you can often find something close on this website and modify it a bit. Here are much more advanced examples of what you can do with TikZ, placed side by side using subfloats! (with captions)



(a) Three solid disks!



(b) A complete graph!

## 7 Other Help

The most common reasons your L<sup>A</sup>T<sub>E</sub>X won't compile are that you have mismatched brackets, mismatched begin/end environments, or are in math mode when you are not supposed to be, or vice versa. This is especially annoying because the L<sup>A</sup>T<sub>E</sub>X compiler isn't particularly helpful at debugging errors. It will often announce that the error is at the end of a long block of math when it is in fact somewhere in the middle. This will certainly frustrate you at some point, as it often frustrates me.

Make sure that you are always using the latest header file - I may add to it if needed or comment it further to make it more useful. Also make sure that you are using the latest version of Latex and all relevant packages. Your best resources are probably the Wikibooks Wiki, and Google (which will often link to the Wikibooks Wiki.) If you need additional help, please contact the TA or instructor.