

WRITTEN WORK 0: INTRODUCTION TO L^AT_EX

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1. INTRODUCTION

Virtually all mathematics (and many works in computer science and the natural sciences) are produced using the L^AT_EX document preparation system. L^AT_EX is not particularly hard to learn, but it will take a little bit of time before you are completely comfortable.

You will write your written homework in L^AT_EX. This is a precondition for passing the assignment! Having a typed version of your work will also help you revise your it based on initial feedback.

Here is my best advice for completing homework using L^AT_EX:

- ♦ **Solve the problem before writing it up!** In other words, scratch paper is your friend. Work out the details in as messy a fashion as you want, but take care to write things in a logical way, as though you were writing a short essay.
- ♦ **Google is your friend when you can't find that symbol you want!** If you can think of something you want to do in L^AT_EX, chances are it can be done, and someone has written about it on the Internet somewhere. The number of times I've searched something like “`latex blah symbol`” is high uncountable.
- ♦ This guide is helpful, too: <https://prof.mkjanssen.org/ds/LaTeX/latexcheatsheet.pdf>
- ♦ Detexify is useful for determining the command for a symbol:
<http://detexify.kirelabs.org/classify.html>
- ♦ **Google is your friend when you're presented with a compiler error!** I would guess that approximately 95% of the L^AT_EX compiler errors you will see this semester will be the result of a missing ‘`}`’ or using a command/environment that is undefined (or misspelled). But for all other errors, try Google first.
- ♦ **L^AT_EX helpfully ignores most whitespace!** Hitting a carriage return once after a period is the same as pressing space after a period. It is good form to put every sentence on a new line, as the errors will refer to a line number, and this will cut down the area you need to search when presented with an error.
- ♦ **Send me an email!** One advantage of using L^AT_EX is that it gives us a way to discuss mathematics (or L^AT_EX itself) via email, so if you can't find what you're looking for on Google, make sure to send me your questions.

2. THE ASSIGNMENT

2.1. Getting Started. Instructions. Some of the exercises that follow have multiple parts. In the L^AT_EX document you create in Exercise 1, you should create one new section per exercise, following the Introduction, which you should rename to ‘Exercise 1’ e.g., `\section{Exercise 2}`, etc. I have done my best to **bold** text which describes something that should go into your final document. When you are done, download the PDF and submit it on Canvas.

There are several ways you can write in L^AT_EX, all of them free.

- (1) By far the easiest choice is Overleaf, found at <http://overleaf.com>, which you can think of as Google Docs for L^AT_EX. **You should register for an account there.**

- (2) Alternatively, if you have a Mac, MacTeX is great: <http://www.tug.org/mactex/>. The downside is that the download and installation take up a lot of space on your drive, but the upside is that you no longer need internet access to use L^AT_EX. MacTeX comes with the T_EXShop editor.
- (3) If you are using Windows, the usual choice of engine is MiKTeX: <https://miktex.org>. T_EXnicCenter is a solid choice for an editor.

Exercise 1. Create a new document. If you are using Overleaf, create a blank document. You should end up with something like this:

```
\documentclass{article}
\usepackage[utf8]{inputenc}

\title{Intro to LaTeX}
\author{Mike Janssen}
\date{January 2019}

\begin{document}

\maketitle

\section{Introduction}

\end{document}
```

Rename the Introduction section to be ‘Exercise 1’.

Type “Hello, world” into the Introduction section.

Exercise 2. This blank document is nice and simple, but we want to add features to our document that makes it easier to produce mathematical symbols.

- (a) One of the major strengths of L^AT_EX is that it allows you to easily insert mathematical symbols in either *inline math mode* or *display math mode*.

Inline math mode refers to the insertion of mathematical symbols and expressions in the middle of a sentence/paragraph. It is done between dollar signs. For example, typing:

‘‘The Fundamental Theorem of Calculus says, roughly, that $\int_a^b f'(x) dx = f(b) - f(a)$ ’’

yields “The Fundamental Theorem of Calculus says, roughly, that $\int_a^b f'(x)dx = f(b) - f(a)$ ”.

Display math mode makes some symbols (such as summations or integrals) a bit larger, and puts the expression on its own line. (When typing in display math mode, it’s helpful to give the code its own line, too.) There are two options for display math mode: double dollar signs, or slashes and square brackets, as follows:

```
The Fundamental Theorem of Calculus says, roughly, that
\[
\int_a^b f'(x) dx = f(b) - f(a)
\]
```

This yields:

“The Fundamental Theorem of Calculus says, roughly, that

$$\int_a^b f'(x)dx = f(b) - f(a)''$$

Now, figure out how to typeset the limit definition of the derivative function, which I'll show in display math mode:

$$f'(x) = \lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}.$$

Do the FTC and limit definition of the derivative look better in display math mode or inline? Why do you answer the way you do?

- (b) Eventually we will need symbols not accessible to our simple document; for example, \mathbb{Z} is the standard notation for the set of all integers. **Try typesetting `\mathbb{Z}`**. What happens?
- (c) We can extend the functionality of our document by including new packages in the preamble (the part before `\begin{document}`). **In the line after `\usepackage[utf8]{inputenc}`**, type `\usepackage{amssymb}` and recompile. Now what happens?

Exercise 3. In order to make your solutions and proofs more readable, it is often advisable to move Very Important Steps into the center of the page. There are multiple ways to do this. When you just have one line, using display math mode is easiest: `\[math goes here]`. If you have a single line you'd like to refer to later, using the equation environment is best.

```
\begin{equation}\label{Equation:IBP}
\int u\, dv = uv - \int v\, du.
\end{equation}
```

- (a) **Reproduce the equation environment from above.** Then, in a line after the equation, type `\ref{Equation:IBP}` and recompile. What do you notice?

A final reason you might want to center math in the page is to show a series of steps. You can do this with the `array` environment or the `align*` environment:

```
\begin{align*}
1 + 2 + \cdots + k + (k+1) &= \frac{k(k+1)}{2} + k + 1 \\
&= \frac{k^2 + k}{2} + \frac{2k+2}{2} \\
&= \frac{k^2 + 3k + 2}{2} \\
&= \frac{(k+1)(k+2)}{2} \\
&= \frac{(k+1)((k+1)+1)}{2}.
\end{align*}
```

Here, the lines are aligned along the ampersands, and the double backslash `\\` creates a new line.

But oh! What error do we see? Let's fix it by adding the `amsmath` package to our preamble (the part before `\begin{document}`.)

- (b) **Try typesetting the `align*` example above. After recompiling, remove the asterisk from the opening and closing align commands. What happens?**

Exercise 4. As described above, L^AT_EX helpfully ignores most white space (spaces and carriage returns).

- (a) **Rather than putting spaces between sentences, you can hit return. Type the following into your document.**

For He must reign until He has put all His enemies under His feet. The last enemy to be destroyed is death.

For He must reign until He has put all His enemies under His feet.
The last enemy to be destroyed is death.

The advantage to putting new sentences on new lines is that, when the compiler detects an error, it typically reports a line number. It's much easier to scan a sentence for an error than a paragraph.

- (b) The best way to create a new line in \LaTeX is by putting a blank line into the text document. **Type the following into your document.**

But Christ has indeed been raised from the dead, the firstfruits of those who have fallen asleep. For since death came through a man, the resurrection of the dead comes also through a man. For as in Adam all die, so in Christ all will be made alive. But each in his own turn: Christ the firstfruits; then at His coming, those who belong to Him.

Then the end will come, when He hands over the kingdom to God the Father after He has destroyed all dominion, authority, and power. For He must reign until He has put all His enemies under His feet. The last enemy to be destroyed is death.

Let me emphasize: *this is the desired way for you to start new paragraphs*. Do not use forced new lines unless absolutely necessary.

Exercise 5. You will likely make several \LaTeX errors as you learn to use it. Here are two of the most common.

- (a) Many \LaTeX commands involve typing curly braces, { and }. A very common error is to forget the closing curly brace. **Try typing the following into your document. Then, replace the faulty command with the type of error message you receive.**

`$ \frac{\int x\, dx}{2} $`

Notice that we have forgotten the right curly brace on the denominator of our fraction.

- (b) Another common error is to forget to start math mode. **Try typing**
`\frac{\int x\, dx}{2}`.

In the document, replace the faulty command with the type of error message you receive.

Exercise 6. \LaTeX is a *typesetting* language, meaning that your job is to provide the text of your document and use commands to tell \LaTeX what the various types of text are. It worries about how to format and present them. We have seen that it will typeset text/commands in math mode as mathematical expressions, and that it ignores lots of whitespace. The last big idea we'll explore is that of an *environment*. Environments typically begin with `\begin{environment name}` and end with `\end{environment name}`.

- (a) The `enumerate` and `itemize` environments are good for making lists. Use the following as a guide, and **make a grocery list with at least four items on it** (you choose the items):

```
\begin{enumerate}
\item Your first item goes here
\end{enumerate}
```

- (b) **Make a copy of your list, but change `enumerate` to `itemize`.** What happens?
 (c) We will use the `theorem` and `proof` environments to contain our theorems and proofs. Our document gained support for the `theorem` environment when we added the `amsmath` package, but we need to add the `amsthm` package to get the `proof` environment. Now, create a new theorem in the preamble with `\newtheorem{theorem}{Theorem}`.

With the help of your resources (cheat sheet, internet, etc.), type the following exactly as it appears:

Theorem 1. *For all natural numbers n , $n^2 + 3n + 2$ is even.*

Proof. Let n be a natural number. Observe that

$$n^2 + 3n + 2 = (n + 1)(n + 2).$$

We notice that $n + 1$ and $n + 2$ are consecutive integers, and by Statement 2.18, their product is even. Therefore, $n^2 + 3n + 2$ is even. \square

Exercise 7. Finally, read over the L^AT_EX cheat sheet found at

<https://prof.mkjanssen.org/ds/LaTeX/latexcheatsheet.pdf>.

What questions do you have?

There is, of course, a lot more to learn. My hope is that this gives you a solid foundation for writing your portfolio.

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