Sample Latex File

Your TA will love it if you hand in a typed version of your assignment! The text below gives some ideas of how to use the latex symbols. Lots of additional examples, and list of commands, can be found on the internet.

To turn the raw Latex file (the *source file*), with ending ".tex", into a pdf (or dvi) file, you'll have to format it. Eventually, you probably want to have some latex installation on your computer (so you don't need access to the web). You can download everything for free from the internet, but it may take some time to get it running.[1]

Alternatively, its also possible to use online compilers. For the homework problems, this may be quite enough. For example, if you use

`http://latex.informatik.uni-halle.de/latex-online/latex.php`

(switch to English), you just copy-and-paste the entire raw text (=source file) into the window, press *compile*, and the scroll down to retrieve the pdf file. Note that you sometimes have to compile twice, to get the cross-references right. For example, you could try it with the latex source file for this document, titled `sample_latex_file.tex`.

1. Latex basics

There's lots of information on the internet, I don't have to repeat it. Just enter 'latex for beginners' or similar into your search engine.

Important: any command "`\begin{...}`" gets closed with "`\end{...}`", `\left{..}` gets closed with `\right{..}` , and any curly bracket that opens up "`{`" also gets closed, "`}`". If there are too many errors of that sort, the compiler will balk, or the outcome is a mess.

Also, whatever comes after `%` on a given line in the source file, the compiler will ignore. We can e.g. use this to put comments into the source file, as reminders for ourselves.

2. Matrices and vectors

Here is a typical matrix.

$$\begin{pmatrix} 7 & -1 & 3 \\ -10 & 5 & 2 \end{pmatrix}$$

We can also do this :

$$\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{pmatrix}$$

[1] Don't ask me, I'm not good with computers. I managed to do it myself, but forgot.

A column vector is a matrix with one column, as in the following equation

$$\begin{pmatrix} 7 & -1 & 3 \\ -10 & 5 & 2 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 17 \\ -1 \end{pmatrix}$$

Here is the same equation written as a system of equations.

$$7x - y + 3x = 17,$$

$$-10x + 5y + 2z = -1.$$

That doesn't look so great, does it? Better is:

$$\begin{aligned} 7x - y + 3x &= 17 \\ -10x + 5y + 2z &= -1. \end{aligned}$$

Here I used the `\begin{align*}`, `\end{align*}` environment in order to align the equations nicely, along the = signs. (Without the stars, one gets numbered equations – see below.)

At some stage, you may also need 'augmented matrices', such as

$$\left(\begin{array}{ccc|cc} A_{11} & \cdots & A_{1n} & b_1 & c_1 \\ \vdots & & \vdots & \vdots & \vdots \\ A_{m1} & \cdots & A_{mn} & b_m & c_m \end{array}\right)$$

For this to work, you must have a certain blurb in the preamble – take a look at the preamble to the source file. Ask me not what this is doing, I just copied it off the web. (Whenever you don't know how to typest something, you'll usually find the answer on the internet.)

A few more things:

- $$\underbrace{1 + 1 + \ldots + 1}_{n \text{ times}}$$

  Here I used `\mbox` to write text in the equation.
- Sets:

  $$A \subseteq B, \quad A \times B, \quad x \in A, \quad \bigcap_{i=1}^{n} A_n = \emptyset, \qquad \mathbb{N} = \{1, 2, 3, \ldots\}.$$

- Sums, fractions:

  $$6 \cdot \sum_{i=1}^{n} \frac{1}{n^2} = \pi^2.$$

- Other fonts: $\mathfrak{A}, \mathfrak{B}$ or $\mathcal{A}, \mathcal{B}$ or A, B, also in lower case: $\mathfrak{a}, \mathfrak{b}$, etc.. Greek letters: $\alpha, \beta, \gamma, \delta$, and so on.

3. Proofs

Here are some symbols that you may encounter in analysis:

$$\forall \epsilon > 0 \exists \delta > 0 \forall x \colon |x - a| < \epsilon \Rightarrow |f(x) - f(a)| < \delta.$$

This looks jumbled because of bad spacings. Using "`\`" and "`\,`", we can adjust the spacings:

$$\forall \epsilon > 0 \ \exists \delta > 0 \ \forall x \colon |x - a| < \epsilon \ \Rightarrow \ |f(x) - f(a)| < \delta.$$

That's better!

Here is a typical proof.

Theorem. In the field $\mathbb{C}$ of complex numbers, $1 = -1$.

Proof. We use $i = \sqrt{-1}$, as follows:

$$\begin{aligned} -1 = i \cdot i &\Rightarrow -1 = \sqrt{-1} \cdot \sqrt{-1} \\ &\Rightarrow -1 = \sqrt{(-1) \cdot (-1)} \\ &\Rightarrow -1 = \sqrt{1} \\ &\Leftrightarrow -1 = 1. \end{aligned}$$

□

Remark: This proof (from lecture notes of Dror Bar-Natan) is completely wrong, of course!! But at least, it is neatly arranged. Could also write it as a one-liner:

$$-1 = i \cdot i = \sqrt{-1} \cdot \sqrt{-1} = \sqrt{(-1) \cdot (-1)} = \sqrt{1} = 1.$$

4. Numberings

If there are several parts to an argument, you can use the `\itemize` or `\enumerate` environments to organize them. `\itemize` gives

- First item,
- Second item.

while `\enumerate` produces

(1) First item,
(2) Second item.

If you want to enumerate displayed equations, instead of using `$$`, use the `{equation}` environment. (Latex will put the numbers automatically, but you can also customize it.) Use `\label` to give your equation a label, and `\ref` to refer to it later. (You have to compile twice so that latex will understand.) For instance,

$$\forall \epsilon > 0 \ \exists \delta > 0 \ \forall x \colon |x - a| < \epsilon \ \Rightarrow \ |f(x) - f(a)| < \delta. \tag{1}$$

or

$$E = mc^2 \tag{2}$$

will be referred to as (1) and (2).

Enjoy!