

L^AT_EX learning guide

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1. Introduction

This learning guide contains basic concepts and applications of \LaTeX for blind or visually impaired students. The goal of this guide is not the creation of documents by the students themselves but to get familiar with the .tex documents in order to have more ways for work (and read) math in college.

2. Category codes

1. The backslash symbol tells to \LaTeX to start looking for a command. We can write it as the usual backslash symbol.

A fundamental aspect to avoid mistakes is noting that when we start writing a command, Overleaf (and generally some \LaTeX editors as TexMaker) present to us the options of available commands i.e. if for example we want to use the frac command, at the initial moment and when we write the f letter, the system will show us a mini window with all the options of commands with the letter f. Unfortunately the screen reader NVDA (maybe JAWS do it) isn't accessible for this tool. So we recommend strongly write the full command and then press enter.

2. The left brace parenthesis opens a group. To close it we use the right brace parenthesis. We can write them as the usual way.
3. The dollar symbol tells Overleaf that we are writing in math mode. We can write it as the usual dollar symbol.
4. The et symbol is used to align. We can write it as the usual et symbol.
5. The percentage symbol ignore everything that follows until the end of the line. It is used as a comment character.

3. Math modes

\LaTeX allows us two kind of writing for math expressions. The first one consists on write formulas when they are part of a text. The second one consists on write expression which are not part of a text, or a paragraph, hence the formula is in a different line of the text.

Consider an example of the first way of writing: Let us recall that the derivative of a function is the limit $\lim_{h \rightarrow 0} \frac{f(x+h)-f(x)}{h}$. When this limit exists we say that the derivative exists.

The previous example could have been written between two dollar symbols or in the math environment $\lim_{h \rightarrow 0} \frac{f(x+h)-f(x)}{h}$.

For the second way of writing: Let us recall that the derivative of a function is the following limit:

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

When this limit exists we say that the derivative exists.



The previous example could have been written between four dollar symbols or in the displaymath environment

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

4. Spaces in math mode

When we are writing in math mode (between dollar symbols) we can't take space as in the usual way of writing (text mode), but resolve this problem is easy and exists several ways to do it. We present them in a align environment for math symbols.

$$\begin{aligned} f(x) &= x^2 + 3x + 2 \\ f(x) &= x^2 + 3x + 2 \\ f(x) &= x^2 + 3x + 2 \\ f(x) &= x^2 + 3x + 2 \end{aligned}$$

5. Subscripts and superscripts

We denote the subscripts with an underscore symbol and the superscript with a circumflex symbol. It is important to say that in order to have a good and readable writing we must group the subscripts or superscripts with brace parenthesis. For example

$$a_{n-1}^2, x^{1+t}.$$

The first example denotes a under n minus 1 square, and the second example denotes x to 1 + t.

6. Binomials and fractions

The command to write fractions is given by `\frac`. We start writing it with the backslash symbol then we write `frac` and then we write two consecutive groups of brace parenthesis in order to write the numerator in the first and the denominator in the second one.

It's important to mention that $\frac{1}{2} = 1/2$. The difference between use the `frac` command and use a slash to divide the fraction is that inside the groups of the `frac` command we can write more than one object to represent a fraction with more components. For example

$$\frac{\frac{1}{2}}{x^2 + 3}$$

This object is a fraction that contains the number 1/2 in the numerator and the expression $x^2 + 3$ in the denominator.



The binomial command is given by $\binom{n}{k}$. As usual, we use backslash to start the command and then we write binom. Then we use two consecutive groups of brace parenthesis in order to write the numbers or letters of the binomial coefficient. For example

$$\binom{4}{2} = \frac{4!}{(4-2)!2!} = \frac{4!}{2!2!} = 6.$$

This example describe a binomial coefficient, specifically four over two. This is equal to the following fraction: four factorial over four minus two factorial times two factorial (all the last things in the denominator). Thus we compute the fraction and get six as a result. We recall that the factorial symbol it is written in math symbol as a exclamation sign.

7. Matrices

Before we start talking about the command to write matrices, we need to know how to import a package of \LaTeX . When we work in the preamble of a document (i.e. before start writing inside the document environment) it is possible to import a package using the usepackage command. It is important to mention that all this will be before the line begindocument and the screen readers will be read the packages written before the document itself.

Many times the templates of the documents comes prefixed with the packages that will be used, as example this one.

Returning to the matrices, the package amsmath gives the commands for the matrices with different delimiters. As example:

1. A matrix without parenthesis: $\begin{matrix} 1 & 2 & 3 \\ a & b & c \end{matrix}$

This give us an arrangement with two rows and three columns. The columns are separated by an et symbol, which we have mention in the beginning and it is used to align. The rows are separated by a double backslash.

2. A matrix with a round brackets: $\begin{pmatrix} 1 & 2 & 3 \\ a & b & c \end{pmatrix}$.

3. A matrix with a square brackets: $\begin{bmatrix} 1 & 2 & 3 \\ a & b & c \end{bmatrix}$.

4. A matrix with a curly brackets: $\begin{Bmatrix} 1 & 2 & 3 \\ a & b & c \end{Bmatrix}$.

The difference between this point and the previous one is that if we write a small b we will have a square bracket and if we write a capital B we will have a curly bracket.

5. A matrix with vertical lines: $\begin{vmatrix} 1 & 2 & 3 \\ a & b & c \end{vmatrix}$.

Usually when we write vertical lines to denote a matrix limits we refer to a determinant of a matrix.



8. Greek letters and miscellaneous symbols

Before presenting the letters and the symbols as commands is important to say that all must be written in math mode, i.e. between dollar symbols.

1. Greek letters.

Small:

$\alpha, \beta, \gamma, \delta, \epsilon, \rho, \zeta, \sigma, \eta, \tau, \theta, \nu, \iota, \pi, \phi, \kappa, \chi, \lambda, \psi, \mu, \nu, \omega, \xi$

Capital:

$\Gamma, \Delta, \Sigma, \Theta, \Upsilon, \Pi, \Phi, \Lambda, \Psi, \Omega, \Xi$

2. Symbols.

Some of the most used symbols are the following: $\infty, \forall, \exists, \nexists, \Re, \Im, \partial, <, >, \leq, \geq, \pm$. This symbols denote infinity, for all, exists, doesn't exists, real part, imaginary part, partial derivative, less than, greater than, less or equal, greater or equal and plus less respectively.

9. Arrows

Before presenting the arrows as commands is important to say that all must be written in math mode, i.e. between dollar symbols.

The first set of arrows represent arrows pointing to the left and to the right respectively. If we write a small first letter of the arrow, we will have one line in the arrow. If we write a capital first letter of the arrow we will have two lines in the arrow. We present them below:

$\leftarrow, \Leftrightarrow, \rightarrow, \Rightarrow$

The second set of arrows represent arrows pointing to the left and to the right simultaneously. If we write a small first letter of the arrow, we will have one line in the arrow. If we write a capital first letter of the arrow we will have two lines in the arrow. When we write harpoon inside the command we refer to a harpoon type of arrow. We present them below:

$\leftrightarrow, \Leftrightarrow, \rightleftarrows$

The third set of arrows represent arrows pointing up and down. If we write a small first letter of the arrow, we will have one line in the arrow. If we write a capital first letter of the arrow we will have two lines in the arrow. We present them below:

$\uparrow, \Uparrow, \downarrow, \Downarrow, \Updownarrow$

The fourth set of arrows represent the arrow that describe functions and the arrow that denote values of a function. We present this below:

\rightarrow, \mapsto

The fifth set of arrows represent arrows pointing diagonally. For example if we write \nearrow we will have an arrow pointing to the north and east simultaneously. We present this below:

$\nearrow, \searrow, \swarrow, \nwarrow$

The sixth and last set of arrows represent harpoon type arrows. For example if we write \leftarrow we will have an harpoon pointing to the left and that has the upper half of the arrowhead. We present this below:



$\leftarrow, \longleftarrow, \rightarrow, \longrightarrow$

Finally, we mention that we can write the word long (or Long) before each arrow in order to do a larger arrow. As example: \longrightarrow .

10. Set symbols

We present now the usual used symbols related to sets: $\subset, \subseteq, \supset, \supseteq, \cup, \cap, \in, \notin, \emptyset, \setminus$. Respectively we have contained, contained or equal, contains, contains or equal, union, intersection, belongs to, doesn't belong, empty set and set minus.

Also we present the set of numbers: $\mathbb{N}, \mathbb{Z}, \mathbb{Q}, \mathbb{R}, \mathbb{R} \setminus \mathbb{Q}, \mathbb{C}$. Respectively we have the natural numbers, the integers, the rationals, the reals, the irrationals and the complex numbers.

An alternative way to present the set of the irrational numbers is \mathbb{Q}^c , the complement of the rational numbers.

11. Operators

In the following paragraphs we will write the most used basic operators with a brief description of them:

1. Trigonometric functions: $\cos x, \sin x, \tan x, \sec x, \csc x, \cot x$. The recently written operators correspond to the trigonometric functions with their reciprocals. We have: cosine, sine, tangent, secant, cosecant and cotangent respectively. Let us recall also that after write some trigonometric function we can group the argument of the function in a brace parentheses (to do a group) or in a usual parentheses to describe in a correct way what goes inside the function. For example $\sin(x^2 + 1)$ denotes sine of $x^2 + 1$.
2. Inverse trigonometric functions: $\arccos x, \arcsin x, \arctan x$. The recently written operators correspond to the inverse trigonometric functions. We have: arc cosine, arc sine and arc tangent respectively. Let us recall also that after write some inverse trigonometric function we can group the argument of the function in a brace parentheses (to do a group) or in a usual parentheses to describe in a correct way what goes inside the function. For example $\arcsin(x^2 + 1)$ denotes arc sine of $x^2 + 1$.
3. Exponential function and logarithm: $\exp x, \log x, \ln x$. The recently written operators correspond to the exponential function, the logarithm and the natural logarithm respectively. It is important to mention that the base of the logarithms are the standard ones, i.e. the logarithm is in base ten and the natural logarithm is in base e. If we want to write a logarithm with a different basis only we have to denote it in a subscript. For example $\log_8(2 + x^2)$ denotes the logarithm of $2 + x^2$ in base eight.

12. Calculus symbols

We present now the most used calculus symbols:



1. Limit: $\lim_{x \rightarrow \infty} f(x) = L$. The code recently written denotes the limit when x tends to infinity of the function f of x and that this is equal to L . Is important to say again that in order to write the previous code correctly we need to group some things in brace parentheses. In this case we write the `lim` command, then we write an underscore to denote a subscript and inside of a brace parentheses we write x tends to infinity ($x \rightarrow \infty$). A good example is the following:

$$\lim_{x \rightarrow 0} \frac{1}{x^2 - 1} = -1.$$

2. Sum: $\sum_{i=1}^n a_n$. The code recently written denotes the sum since $i = 1$ until n of the sequence a_n . Is important to say again that in order to write the previous code correctly we need to group some things in brace parentheses. In this case we write the `sum` command, then we write an underscore and inside of a brace parentheses we write i equal to 1. Then we write a superscript that contains the number where the sum stops (in this case n). A good example is the following:

$$\sum_{i=1}^n i = \frac{n(n+1)}{2}.$$

3. Integral: $\int f(x)dx$. The code recently written denotes the indefinite integral of the function f of x with differential x . Now, using subscripts and superscripts we can write a definite integral with more components. For example

$$\int_1^{\cos x} \frac{1}{t} dt = \ln \cos x$$

represent the integral of 1 to cosine of x of 1 over t with differential t . This integral is equal to natural logarithm of cosine of x .

13. Example

The next example is a question of a test of the course MAT116, calculus 1, of the Universidad Católica de Chile of the year 2019, first semester.

1. Let $f: \mathbb{R} \rightarrow \mathbb{R}$ defined by

$$f(x) = \begin{cases} -1 & x < 3/2, \\ 4 - 2x & 3/2 < x < 2, \\ 2 & x > 2. \end{cases}$$

Sketch the graph of f , and since this graph, sketch the graph of the following functions

$$x \mapsto f(x - 2), \quad x \mapsto f(2 - x), \quad x \mapsto f(x/2).$$



The code of this question describes a lot of important things. The first one is that $f: \mathbb{R} \rightarrow \mathbb{R}$ denotes that the function f has domain and range in the real numbers. By other hand, when the function is defined in the cases environment it's says to us that we have a piecewise function. This function is equal to -1 when we have $x < 3/2$ (we can separate this with the et symbol and for the next part of the function we can use the double backslash as a line break). For values between $3/2$ and 2 the function is equal to $4 - 2x$ and for values greater than 2 the function is equal to 2 .

The second part of the problem tell us which functions we have to sketch. As a example when we have $x \mapsto f(x - 2)$ we have that x goes to the value $f(x - 2)$, i.e. the function f evaluated in the point $x - 2$.