

L^AT_EX Tutorial

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Outline

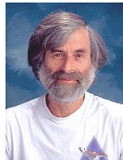
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What is L^AT_EX?

- L^AT_EX (read as /'leɪtɛk/ or /'lɑ:tɛk/) is a document markup language and document preparation system. It is totally free. You are welcome to visit the following sites.
 - <http://www.latex-project.org/>
 - <http://en.wikibooks.org/wiki/LaTeX>
 - <http://www.ctan.org/>
- It allows you to produce high quality text documents such as *books, letters, articles, thesis, presentation slides, etc.*
- Among other contributors, we owe the thanks to Knuth and Lamport.



Donald Knuth



Leslie Lamport

How does \LaTeX work?

Input source: `.tex` file \implies Compile source (**TWICE**) \implies

Output file: `.pdf` or `.ps` or `.dvi`

- It is **not** WYSIWYG (What You See Is What You Get) editor as LibreOffice, Microsoft Word.
- \LaTeX mainly consist of three parts.
 - Input text editor. We save file as `.tex` file. Recommend: **TexMaker** <http://www.xmlmath.net/texmaker/>
 - Compiler. This the core part. As beginner, we just use it as a black box and no need to know how it works.
 - MS Windows: **MiKTeX** <http://miktex.org/>
 - Mac OS X: **MacTeX** <http://www.tug.org/mactex>
 - Linux (Ubuntu): **TeXLive**
<http://www.tug.org/texlive/>
 - Cloud (based on web): **ScribTeX**
<http://www.scribtex.com/>
 - Output viewer. Viewer for `.pdf` `.ps` `.dvi` files.

Why use \LaTeX ?

- Producing high quality document.
- Totally free in the sense that
 - free of charge;
 - free software by LaTeX Project Public License (LPPL). You can distribute the software to others.
- It needs some time to learn, but after we know how to use it, it will save us a lot of times.
- Efficient. Automatically
number/tag/cite/hyperlink/index/table of content/...
- You can concentrate on the contents without considering the pattern and layout.
- Many academic journals only accept \LaTeX file.

Basic example, input source Model1.tex

```
\documentclass[12pt,a4paper]{article}
\usepackage{amsmath} % package.
\begin{document}
  \title{Basic Model}
  \author{Author Name}
  \date{} % add date in braces, or use \today
  \maketitle % show document title, author, date, etc.
  \begin{abstract}
    Write abstract here.
  \end{abstract}
  Here is a formula in the in-line mode
   $\sin^2 \theta + \cos^2 \theta = 1$ .
  The same formula is in the math mode
  
$$\sin^2 \theta + \cos^2 \theta = 1.$$

  The same formula is in the math mode with
  equation numbering
  \begin{equation}
    \sin^2 \theta + \cos^2 \theta = 1.
  \end{equation}
\end{document}
```

The output layout of Model1.pdf

Basic Model

Author Name

Abstract

Write abstract here.

Here is a formula in the in-line mode $\sin^2 \theta + \cos^2 \theta = 1$. The same formula is in the math mode

$$\sin^2 \theta + \cos^2 \theta = 1.$$

The same formula is in the math mode with equation numbering

$$\sin^2 \theta + \cos^2 \theta = 1. \tag{1}$$

Document classes

The main document classes are the following.

- `article` suitable for scientific article, homework.
- `book` suitable for book, thesis, lecture notes.
- `beamer` suitable for presentation.
- `letter`
- `report` suitable for thesis, report.

When use `report` or `book`, it is better to write each chapter in a separated `tex` file and use a Main file to include each chapter.

Packages

Many commands/functions are defined by some particular packages. For the beginner, they are totally black box. The best way to learn how to use each package is reading its manual. We list some packages below.

```
\usepackage{amsmath} % many math symbols
\usepackage{amsfonts} % many fonts
\usepackage{amssymb}
\usepackage{hyperref} % hyper-link reference, and URL
\usepackage{color}
\usepackage[all]{xy} % draw commutative diagram
\usepackage{verbatim} % display source codes
\usepackage{graphicx} % to manage external pictures
```

Check the web for more packages.

<http://en.wikibooks.org/wiki/LaTeX/Packages>

Title, author, date, abstract, etc.

```
\title{Basic Model} %  
\author{Author Name} %  
\date{} % add date in braces, or use \today  
\address{HKUST}  
\email{xxx@ust.com}  
\maketitle % show document title, author, date  
  
\begin{abstract}  
Write abstract here.  
\end{abstract}  
  
\tableofcontents % generate contents, need compile twice  
\listoffigures % list of figures  
\listoftables % list of tables  
  
\section{The beauty of math.}
```

Document structure: input source Model2.tex

```
\documentclass[12pt,a4paper]{book}
\begin{document}
\chapter{Chapter title} % only with book and report
  \section{Section title}
    Hello.
  \section*{Section title} % section without number
    Section without number.
  \section{Another section}
    \subsection{Subsection name}
      \paragraph{Paragraph name}
        \subparagraph{Subparagraph name}
          We show that ...
    \end{subsection}
  \end{section}
\end{chapter}
\end{document}
```

The output layout of `Model2.pdf`

Chapter 1

Chapter title

1.1 Section title

Hello.

Section title

Section without number.

1.2 Another section

1.2.1 Subsection name

Paragraph name

Subparagraph name We show that ...

Fonts style, size

The style of a font describes its appearance. Traditional styles are roman, **boldface**, *italic*, *slanted*, typewriter, SMALL CAPITAL and sans serif.

Traditional styles are `\textrm{roman}`, `\textbf{boldface}`, `\textit{italic}`, `\textsl{slanted}`, `\texttt{typewriter}`, `\textsc{Small Capital}` and `\textsf{sans serif}`.

THE *size* of a font is normally measured in printer's points, where 72.27 points equal 1 inch.

```
\Huge{\textsf{The}} \huge{\emph{size}} \texttt{\LARGE{of}} \Large{a}
\large{font} \normalsize{is} \small{normally} \footnotesize{measured}
\scriptsize{in} \tiny{printer's} \normalsize{points},
```

Special characters

The following symbols are *reserved characters* which have some special meaning in \LaTeX .

\$ % { } ~ _ ^ \

The above (output) display of these symbols come from the codes

`\# \ $ \% \{ \} \~{} _{} \^{} \\backslashslash`

% explain symbol; & address symbol; \$ math symbol; ~ will not be seen in the output display, but has the function of "non-split", usually used in the name. For example

D.~E.~Knuth, Figure~1.

Basic commands

- Most commands have some optional parameters and arguments. For example:

```
\commandname[option1,option2,...]{argument1}{argument2}  
\documentclass[12pt,a4paper,twoside]{article}
```

- The environmental mode should appear in pairs. Here `environment =equation, theorem, figure, table, etc.`

```
\begin{math}  
f(x)=\tan x  
\end{math}
```

```
\begin{equation*}  
f(x)=\tan x.  
\end{equation*}
```

- We have short-cut for above two environmental modes.

```
$ f(x)=\tan x $  
$$ f(x)=\tan x. $$
```

The basic Math mode

When the math formula is written as the in-line part of a sentence, the math code should be written between two single-dollar symbols. This is called *inline Math mode*. When we want to display a formula in a separated line, we use *display Math mode*. The codes are double-dollars or `\begin{equation} \end{equation}` etc.

Warning: If the code is in the ending of a sentence, do not forget to write the period **outside** the single-dollar or **inside** the double-dollars.

Let S be the polynomial ring $k[x_0, \dots, x_n]$. If T is any set of homogeneous elements of S , we define the `\emph{zero set}` of T to be

$$Z(T) = \{P \in \mathbb{P}^n \mid f(P) = 0 \text{ for all } f \in T\}.$$

Let S be the polynomial ring $k[x_0, \dots, x_n]$. If T is any set of homogeneous elements of S , we define the *zero set* of T to be

$$Z(T) = \{P \in \mathbb{P}^n \mid f(P) = 0 \text{ for all } f \in T\}.$$

Blank space and text in Math mode.

The blank space will be disappear in the output of math mode. The text will be auto-italic. We need extra commands. We can manually tag formula by `\eqno` and `\leqno`.

Warning: In the first formula, the period should be **inside** the double-dollars.

```

$$ Z(T)=\{P\in \mathbb{P}^n| f(P)=0 \text{ for all } f\in T\}.$$.
$$ Z(T)=\{P\in \mathbb{P}^n| f(P)=0 \text{for all} f\in T\}. \leqno (A)$$
$$ Z(T)=\{P\in \mathbb{P}^n| f(P)=0 \text{for all } f\in T\}. \eqno (B)$$
$$ Z(T)=\{P\in \mathbb{P}^n| f(P)=0 \quad\text{for all} \quad f\in T\}.$$.
$$ Z(T)=\{P\in \mathbb{P}^n| f(P)=0 \quad\text{for all} \quad \quad\quad f\in T\}.$$.

```

$$Z(T) = \{P \in \mathbb{P}^n | f(P) = 0 \text{for all } f \in T\}$$

(A) $Z(T) = \{P \in \mathbb{P}^n | f(P) = 0 \text{for all } f \in T\}.$

$$Z(T) = \{P \in \mathbb{P}^n | f(P) = 0 \text{ for all } f \in T\}. \quad (B)$$

$$Z(T) = \{P \in \mathbb{P}^n | f(P) = 0 \quad \text{for all } f \in T\}.$$

$$Z(T) = \{P \in \mathbb{P}^n | f(P) = 0 \quad \text{for all} \quad f \in T\}.$$

Multi-lines formulas

```

\newcommand{\dif}{\, \mathrm{d}} % put at the beginning of document
\begin{eqnarray*}
\int \ln x \dif x % function and operators are in Roman style
&=& x \ln x - \int x \dif (\ln x) \quad \text{integration by parts} \\
&=& x \ln x - x + \mathrm{C}.
\end{eqnarray*}

```

The function name, operators are usually in math-Roman font style.
The first line gives the example of how to define a new operator.

$$\begin{aligned}
 \int \ln x \, dx &= x \ln x - \int x \, d(\ln x) \quad \text{integration by parts} \\
 &= x \ln x - x + C.
 \end{aligned}$$

Multi-lines formulas with label and reference

```

\begin{eqnarray}
\int \ln x \, dx
&=& x \ln x - \int x \, d(\ln x) \quad \label{log-integration} \\
&=& x \ln x - \int x \frac{1}{x} \, dx \quad \nonumber \\
&=& x \ln x - x + \mathrm{C}.
\end{eqnarray}

```

We use the integration by parts rule in ([\ref{log-integration}](#)).

$$\int \ln x \, dx = x \ln x - \int x \, d(\ln x) \tag{1}$$

$$= x \ln x - \int x \frac{1}{x} \, dx$$

$$= x \ln x - x + C. \tag{2}$$

We use the integration by parts rule in (1).

Another Multi-lines formulas

```
\begin{equation}
f(x)=\left\{\begin{array}{ll}
\mathrm{e}^{-\frac{1}{x^2}} & \quad x\neq 0; \\
0 & \quad x=0.
\end{array}\right.
\end{equation}
```

The following code is a special pair.

```
\left\{

\right.
```

$$f(x) = \begin{cases} e^{-\frac{1}{x^2}} & x \neq 0; \\ 0 & x = 0. \end{cases} \quad (3)$$

Matrix and more Math

```


$$\begin{matrix}
\begin{matrix} \leq & \geq \\ \neq & \cong \end{matrix} & \begin{matrix} \infty & \lim \\ \forall & \exists \end{matrix} & \begin{matrix} \int & \iint \\ \oint & \sum \end{matrix} \\
\begin{matrix} \oplus & \otimes \\ \circ & \subset \end{matrix} & \begin{matrix} \frac{1}{2} & a^2 \\ \sqrt{5} & a_{22} \end{matrix} & \begin{matrix} \{ & \$ \\ \% & \backslash \end{matrix}
\end{matrix}$$


```

For more math code, please visit

<http://en.wikibooks.org/wiki/LaTeX/Mathematics>

http://en.wikibooks.org/wiki/LaTeX/Advanced_Mathematics

Tables

```
\begin{center}
  \begin{tabular}{ l | c || r }
    \hline
     $x$  & \textbf{Address} & \textit{Name} \\ \hline
     $\sin x$  & 5 & 6 \\ \hline
     $\frac{1}{3}$  & 8 & 9 \\ \hline
  \end{tabular}
\end{center}
```

x	Address	<i>Name</i>
$\sin x$	5	6
$\frac{1}{3}$	8	9

<http://en.wikibooks.org/wiki/LaTeX/Tables>

Figures

The \LaTeX has some basic commands to draw lines, arrow lines, circles, rectangular etc. For more complicated graph, you may need other software. It is not an easy task.

- **Asymptote**: a Vector Graphics Language.
<http://asymptote.sourceforge.net/>
- **Inkscape**: an Open Source Vector Graphics Editor.
<http://inkscape.org/>
- **GIMP**: the GNU Image Manipulation Program.
<http://www.gimp.org/>
- **Xy-pic**: a \LaTeX package for typesetting graphs and diagrams using the principle of logical composition of visual components.
<http://www.tug.org/applications/Xy-pic/>
- **MATLAB**: It generates `eps` picture file from some original computation data.
- Other softwares such as **Scilab**, **ImageMagick**, **gnuplot**, **MathGV**...

Including external graphs

We need to use the `graphicx` package at the beginning of the document.

```
\usepackage{graphicx}
```

Put the external graphs in the same directory as your source `tex` file.

```
\begin{figure}
  \centering
  \includegraphics[scale=.25]{ctan_lion.jpg}
  \caption{The  $\TeX$  lion! \label{lion}}
  % \label SHOULD be after or in \caption
\end{figure}
```

```
\begin{center}
  \includegraphics[width=4cm]{tugboat_tfz.png}
\end{center}
```

- Only `eps`, `ps` file. Compile **TWICE** by `latex`, then compile by `dvips` → `ps2pdf`.
- Only non-`eps` file (`jpg`, `png`, `pdf`). Compile **TWICE** by `pdflatex`.

Warning: \LaTeX **CANNOT** compile both `eps` and `jpg` together. We need to use some software to convert `eps` to `jpg` or `pdf`. Please search `eps to jpg` or `eps to pdf` online.

We can find more commands online.

http://en.wikibooks.org/wiki/LaTeX/Importing_Graphics

Below are the display of last page's commands.



Figure 1: The T_EX lion!



Using labels and cross-referencing

Label is one of the most wonderful feature of \LaTeX than other WYSIWYG text editor. Almost all the environment (=equation, theorem, figure, table, etc) can be labelled. We do not need to care the number/name of an environment. \LaTeX will take care for us. The code is very easy.

```
\begin{environment} \label{NAMEofLabel}
...
\end{environment}
```

To refer picture and cite bibliography, we use the following codes.

```
Figure~\ref{lion} is drawn by \emph{Duane Bibby}.
The \cite{Voss10} is a free book.
\bibitem[Vo{\ss}10]{Voss10}{Herbert Vo\ss, \emph{Math mode}, version 2.47, 2010.
\tiny{\texttt{http://www.tex.ac.uk/tex-archive/info/math/voss/mathmode/Mathmode.pdf}}}
```

Figure 1 is drawn by *Duane Bibby*. The [VoB10] is a free book.

Good habits in coding L^AT_EX

- Structure writing for books, reports. Use a main file to include each chapter.
- Structure writing for a research paper, using `Lemma`, `Proposition`, `Theorem`, `Remark`, `Example`, `Definition` etc.
- Structure writing for codes. Write those pairs of codes at the same time.
- Every sentence should be ending with punctuation.
- Make full use of labels. Give label name systematically.
- Focus on the material and forget about the format when writing.
- Create new commands for commonly-used symbols.
- Fix a capitalization scheme for the titles (of section/subsection etc) and use it consistently. We have three schemes: only the "important" words are capitalized; only the first word is capitalized; all words are capitalized.

Bonus: the following code is useful when you use `article/book/report` and compile **TWICE** with

either `latex → dvips → ps2pdf`
or `pdflatex`.

```
\usepackage[colorlinks,linkcolor=blue,urlcolor=cyan,citecolor=green,pagebackref]{hyperref}
```

Bibliography

- Latex template for your thesis from our department site
<http://intranet.math.ust.hk/announcements.asp?category=pg>
- In the Math arXiv site, many files can be downloaded as source. Please visit <http://arxiv.org/> Go into a particular paper site, for example:
<http://arxiv.org/abs/math/0702396>
Other formats → **Download source**, then change the source file name to `xxxx.tex`. Sometimes when the source file is delivered as a gzipped tar file we may try to extract them by some file manager to obtain the source `tex` file, for example:
<http://arxiv.org/abs/1207.2085>
- Please find the following free books for further learning.

[OPSH11] Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl, *The not so short introduction to $\text{\LaTeX}2_{\epsilon}$* , version 5.01, 2011.

<http://www.ctan.org/tex-archive/info/lshort/english/>

[Voß10] Herbert Voß, *Math mode*, version 2.47, 2010.

<http://www.tex.ac.uk/tex-archive/info/math/voss/mathmode/Mathmode.pdf>

[Wiki] Wikibooks community, *LaTeX Wikibooks*.

<http://en.wikibooks.org/wiki/LaTeX>