

A Basic \LaTeX Tutorial for **Math** Students

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- 3 More Skills on \LaTeX
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Outline

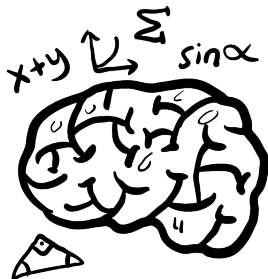
- 1 Preamble
- 2 Introduction to \LaTeX
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Preamble

- This slides is for **math**. In fact, \LaTeX is good to typesetting, e.g. CV, poster or thesis.
- This slides is for **searching keywords** instead of studying so I set the hyperlink in outline.
- If I add *, the method in this slides would be seldom used.

How to Write tex

Compiler? Editor?



Recommend

Use Overleaf and change the compiler to “xelatex”.

Outline

- 1 Preamble
- 2 Introduction to \LaTeX
 - Basic command
 - Math
- 3 More Skills on \LaTeX
- 4 Reference

Add the following in preamble

```
\usepackage{fontspec}  
\usepackage{xeCJK}  
\setCJKmainfont{標楷體}  
\XeTeXlinebreaklocale "zh"  
\XeTeXlinebreakskip = 0pt plus 1pt
```

The first line is to set Chinese font. Note that 標楷體 doesn't work on Overleaf 又

Rules

- Each command is start from “backslash symbol” (`\`).
e.g. `\LaTeX`, `\LaTeX`; `\`, `\textbackslash`.
- Comment some text using “percentile symbol” `%`
- New line using “double backslash symbol” (`\\`)
- There is no different between one space and multiple space.
- The following is environment
`\begin{environment}\end{environment}`
- “quotation mark” is ```quotation mark''`.

Space

The following table listed some command which are most often used

| Display | Command |
|------------|-----------------------|
| $a b$ | <code>a\!b</code> |
| ab | <code>ab</code> |
| $a\,b$ | <code>a\,,b</code> |
| $a\, b$ | <code>a~b</code> |
| $a\, b$ | <code>a\, b</code> |
| $a\quad b$ | <code>a\quad b</code> |

For instance, integral $\int \cos \theta \, d\theta$ (`\int\cos\theta\,,d\theta`) or second fundamental form II (`\mathrm{I\!I}`).

Font variance

| Display | Command |
|--------------------|-------------------------------|
| Roman ¹ | <code>Roman</code> |
| <i>italic</i> | <code>{\it italic}</code> |
| boldface | <code>{\bf boldface}</code> |
| sans serif | <code>{\sf sans serif}</code> |
| typewriter | <code>{\tt typewriter}</code> |
| SAMLL CAPS | <code>{\sc Samll Caps}</code> |

For instance, refer to W. RUDIN, *Principles of Mathematical Analysis*, (`{\sc W. Rudin}`, `{\it Principles of Mathematical Analysis}`)

¹Actually, this is not Roman font in beamer.

Font size

| Display | Command |
|--------------|---|
| footnotesize | <code>{\footnotesize footnotesize}</code> |
| small | <code>{\small small}</code> |
| Normalsize | <code>Normalsize</code> |
| Large | <code>{\Large Large}</code> |

Outline for Math

- Function and Greek Symbols
- Math Font
- Inline and Display Mode
- Align and Aligned
- Label and Ref
- Tag
- Conditional Function
- Array
- Matrix
- Bracket (Matrix + Align)
- Box

Function and Greek symbols

Just Google LaTeX symbols! Note that:

- There are two type of some Greek symbols

ϵ `\epsilon` ε `\varepsilon`

ϕ `\phi` φ `\varphi`

- Please don't use \forall , which is not a formal symbol.
- If you hope to use function which is not defined, two method:
for example `cosec`, instead of *cosec*.

- 1 Declare in preamble `\DeclareMathOperator{cosec}{cosec}` and use

`\cosec`

- 2 Just use `\operatorname{cosec}x` instead of `\mathrm{cosec}x`, `\cosec x` instead of `cosec x`.

Math font

| Display | Command |
|---------------|--|
| <i>italic</i> | <code>\$\textit{italic}\$</code> |
| R | <code>\$\mathrm{\mathrm{R}}\$</code> |
| \mathbf{v} | <code>\$\mathbf{\mathbf{v}}\$</code> |
| \mathbb{R} | <code>\$\mathbb{\mathbb{R}}\$</code> |
| \mathcal{M} | <code>\$\mathcal{\mathcal{M}}\$</code> |
| p | <code>\$\mathsf{\mathsf{p}}\$</code> |
| \Re | <code>\$\Re{\mathfrak{Re}}\$</code> |
| $\mathbb{1}$ | <code>\$\mathbb{\mathds{1}}\$</code> |

Note that if the command `$\mathds{1}$` is used, `\usepackage{dsfont}` should be included.

Inline mode and Display mode

- **Inline mode** use `$ $`.

For all $\epsilon > 0$ exist $\delta > 0$ such that if $|x - x_0| < \delta$,

```
For all  $\epsilon > 0$  exist  $\delta > 0$  such that if  $|x - x_0| < \delta$ ,
```

- **Display mode** use `$$ $$` or `\[\]` or `\begin{equation*}\end{equation*}`.

then

$$|f(x) - f(x_0)| < \epsilon.$$

```
then  
\begin{equation*}  
\left|f(x)-f(x_0)\right|<\epsilon\,,.  
\end{equation*}
```

Note that don't forget punctuation marks.

Display style in inline mode*

Use `\limits_` to force it under the operator.

- **Limit:** $\lim_{x \rightarrow 3} f(x)$ instead of $\lim_{x \rightarrow 3} f(x)$

`$\lim\limits_{x \to 3} f(x)$, $\lim_{x \to 3} f(x)$`

- **Summation:** $\sum_{n=1}^{\infty} a_n$ instead of $\sum_{n=1}^{\infty} a_n$

`$\sum\limits_{n=1}^{\infty} a_n$, $\sum_{n=1}^{\infty} a_n$`

Actually, I seldom use this method.

Align and Aligned

Use & to align multiple equation.

$$\begin{aligned} |a - b| &\leq |a - c| + |c - b| \\ &\leq |a - c| + |c - d| + |d - b| \end{aligned}$$

```
\begin{align*}
|a-b| &\&\leq |a-c|+|c-b|\\
&\&\leq |a-c|+|c-d|+|d-b|
\end{align*}
```

or

```
\begin{equation*}
\begin{aligned}
|a-b| &\&\leq |a-c|+|c-b|\\
&\&\leq |a-c|+|c-d|+|d-b|
\end{aligned}
\end{equation*}
```

Label and Ref*

Use `\ref` and `\label` or `\nonumber`. **Note that * is for number and so does `equation` environment.**

$$\nabla \cdot \mathbf{E} = \rho / \epsilon_0 \tag{1}$$

$$\nabla \cdot \mathbf{B} = 0$$

The Equation (1) is Gauss's law.

```
\begin{align}
&\nabla \cdot \mathbf{E} = \rho / \epsilon_0 \label{eq:gauss} \\
&\nabla \cdot \mathbf{B} = 0 \nonumber
\end{align}
The Equation (\ref{eq:gauss}) is Gauss's law.
```

Actually, I usually use next method when I just write a report.

I could just label what I hope to label in environment `equation*` and `align*` when I just write homework or report.

$$\nabla \cdot \mathbf{E} = \rho / \epsilon_0 \quad (\spadesuit)$$

$$\nabla \cdot \mathbf{B} = 0$$

The Equation (\spadesuit) is Gauss's law.

```
\begin{align*}
&\nabla\cdot\mathbf{E}=\rho/\epsilon_0 \ \label{eq:spade}\tag*{($\spadesuit$)}\\
&\nabla\cdot\mathbf{B}=0
\end{align*}
The Equation \ref{eq:spade} is Gauss's law.
```

Fun fact of tag

| | |
|---|---------------------------------|
| ♠ | <code>\$\spadesuit\$</code> |
| ♣ | <code>\$\clubsuit\$</code> |
| ♦ | <code>\$\blacklozenge\$</code> |
| ★ | <code>\$\bigstar\$</code> |
| ■ | <code>\$\blacksquare\$</code> |
| ▲ | <code>\$\blacktriangle\$</code> |
| * | <code>\$\ast\$</code> |

Note that I usually use filled symbols, instead of ♥, `\heartsuit` or ★, `\star`. However, the package `$\usepackage{fdsymbol}$` is included for filled heart, `\varheartsuit`.

Conditional function

Use `\begin{cases}\end{cases}` and `\mbox`.

$$\mathbb{1}_{\mathbb{Q}}(x) = \begin{cases} 1 & \text{if } x \in \mathbb{Q} \\ 0 & \text{if } x \notin \mathbb{Q} \end{cases}$$

```
\begin{equation*}
\mathds{1}_{\mathbb{Q}}(x)=
\begin{cases}
1 & \mbox{if } x \in \mathbb{Q} \\
0 & \mbox{if } x \notin \mathbb{Q}
\end{cases}
\end{equation*}
```

Array

Use `\begin{array}{} \end{array}`.

$$\begin{array}{ccc} \frac{1}{1} & \frac{1}{2} & \cdots \\ \frac{2}{1} & \frac{2}{2} & \cdots \\ \vdots & \vdots & \ddots \end{array}$$

```
\begin{equation*}
\begin{array}{clr}
\frac{1}{1} & \frac{1}{2} & \cdots \\
\frac{2}{1} & \frac{2}{2} & \cdots \\
\vdots & \vdots & \ddots
\end{array}
\end{equation*}
```

Note that `c`, `l`, `r` means center, left and right respectively.

Fun fact of dot

| | | |
|-----------------------|-------------------------------------|---------------|
| $a \dots b$ | <code>\$a\ldots b\$</code> | lie on line |
| $a \cdots b$ | <code>\$a\cdots b\$</code> | lie on center |
| $a \vdots b$ | <code>\$a\vdots b\$</code> | vertical |
| $a \ddots b$ | <code>\$a\ddots b\$</code> | diagonal |
| $a \cdot\cdot\cdot b$ | <code>\$a\cdot\cdot\cdot b\$</code> | back diagonal |
| $a \cdot b$ | <code>\$a\cdot b\$</code> | one dot |
| $a \bullet b$ | <code>\$a\bullet b\$</code> | big dot |
| \dot{a} | <code>\$\dot{a}\$</code> | as you seen |
| \ddot{a} | <code>\$\ddot{a}\$</code> | as you seen |

If you hope to use back diagonal, you should define

`\newcommand{\biddots}{\rotatebox[origin=c]{70}{\ddots}}` in preamble.

Matrix

This is `pmatrix`

$$\begin{pmatrix} \sigma_{xx} & \sigma_{xy} \\ \sigma_{yx} & \sigma_{yy} \end{pmatrix}$$

```
\begin{equation*}
\begin{pmatrix}
\sigma_{xx} & \sigma_{xy} \\
\sigma_{yx} & \sigma_{yy}
\end{pmatrix}
\end{equation*}
```

This is `bmatrix`

$$\begin{bmatrix} \sigma_{xx} & \sigma_{xy} \\ \sigma_{yx} & \sigma_{yy} \end{bmatrix}$$

```
\begin{equation*}
\begin{bmatrix}
\sigma_{xx} & \sigma_{xy} \\
\sigma_{yx} & \sigma_{yy}
\end{bmatrix}
\end{equation*}
```


(**Warning !**) Please use `\left` and `\right`!

- `\left(\frac{1}{2}\right)`

$$\left(\frac{1}{2}\right)$$

- `\left|\int f\right|`

$$\left|\int f\right|$$

Warning

Some professors put great emphasis on this detail.

Bracket and Align

Use `\left\{`, `\right.` and environment `aligned`.

$$\begin{cases} \Delta u + \lambda u = 0 & x \in \Omega \\ u = 0 & x \in \partial\Omega \end{cases}$$

```
\begin{equation*}
\left\{
\begin{aligned}
&\Delta u + \lambda u = 0 \quad x \in \Omega \\
&u = 0 \quad x \in \partial\Omega
\end{aligned}
\right.
\end{equation*}
```

Bracket + Array = Matrix*

Use `\left[`, `\right]` and `\left(`, `\right)` and environment `array`.

$$\left(\begin{array}{cc} a & b \\ c & d \end{array} \right)$$

```
\begin{equation*}
\left(
\begin{array}{cc}
a & b \\
c & d
\end{array}
\right)
\end{equation*}
```

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$$

```
\begin{equation*}
\begin{pmatrix}
a & b \\
c & d
\end{pmatrix}
\end{equation*}
```

I usually use the environment `bmatrix` or `pmatrix`

Bracket + Array = Align*

$$\left\{ \begin{array}{ll} u_t = \Delta u \\ \lim_{t \rightarrow 0} u = f(x) & \text{I.C.} \\ u(0, t) = g(x) & \text{B.C.} \end{array} \right.$$

```
\begin{equation*}
\left\{\begin{array}{ll}
u_t=\Delta u \\\
\lim_{t\to 0}u=f(x) & \mbox{I.C.}\\
u(0, t)=g(x) & \mbox{B.C.}
\end{array}\right.
\end{equation*}
```

$$\left\{ \begin{array}{ll} u_t = \Delta u \\ \lim_{t \rightarrow 0} u = f(x) & \text{I.C.} \\ u(0, t) = g(x) & \text{B.C.} \end{array} \right.$$

```
\begin{equation*}
\left\{\begin{aligned}
&u_t=\Delta u \\\
&\lim_{t\to 0}u=f(x) \quad \quad \mbox{I.} \\
&\hspace{1cm} \text{C.} \\
&u(0, t)=g(x) \quad \quad \mbox{B.C.}
\end{aligned}\right.
\end{equation*}
```

Note that array is **inline mode** but it can align many times.

Outline

- 1 Preamble
- 2 Introduction to \LaTeX
- 3 More Skills on \LaTeX
 - Item and Enumerate
 - Figure, Table and Minipage
 - Footnote
 - Miscellaneous Method

- 4 Reference

Item

- A
- B
- ♣ C
- ! D

```
\begin{itemize}  
\item A  
\item B  
\item [$\clubsuit$] C  
\item [!] D  
\end{itemize}
```

Enumerate

a. A

(i) A-a

(ii) A-b

b. B

```
\begin{enumerate}[a.]  
  \item A  
  \begin{enumerate}[(i)]  
    \item A-a  
    \item A-b  
  \end{enumerate}  
\end{enumerate}  
  
\item B  
  
\end{enumerate}
```

Fun fact of enumerate

Begin Use `\setcounter{enumi}{}`

4. A

5. B

```
\begin{enumerate}  
\setcounter{enumi}{3}  
\item A  
\item B  
\end{enumerate}
```

Separation Use `\itemsep`

1. A

2. B

```
\begin{enumerate}  
\itemsep=+3mm  
\item A  
\item B  
\end{enumerate}
```

- The command `itemsep` is commonly used which make each answer to problem separate clearly.
- The package `\usepackage{enumerate}` should be included.

Figure

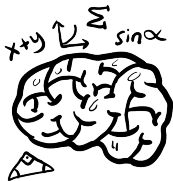


Figure: This is caption

```
\begin{figure}[H]
\begin{center}
\includegraphics[scale=??]{path}
\caption{This is caption}
\end{center}
\end{figure}
```

- There are two method to control the size of figure: `[scale=??]` or `[width=??]`
- Usually, we will create a folder to collect figures, e.g. `fig/name.png`.
- The package `\usepackage{graphicx}` should be included.
- The command `H` is introduced next page.

Fun fact of float

| Command | Description |
|----------------|---|
| <code>h</code> | Place here! Not recommend! |
| <code>t</code> | Place at the top of the page. |
| <code>b</code> | Place at the bottom of the page. |
| <code>H</code> | Place it at precisely the location in the LaTeX code. |

- The command `H` should include `\usepackage{float}`.
- `H` preserve a whole text width minipage. Thus, we will introduce how to **make figure and text side by side** next.

Minipage

This is left minipage.

This is right minipage.
This is second line.

```
\noindent  
\begin{minipage}{1.0\textwidth}  
\noindent  
\begin{minipage}{0.48\textwidth}  
This is left minipage.  
\end{minipage}  
\hfill  
\begin{minipage}{0.48\textwidth}  
This is right minipage.  
\end{minipage}  
\end{minipage}
```

Remark of minipage

- Use `\hfill` to fill the horizontal space, which flush left the left minipage and flush right the right minipage so separate two minipage.
- Using a big `\minipage` to wrap two minipage is because make sure we could fix the begin of next new line.
- Using `\noindent` make sure there is no indent.

Minipage and Figure (figure and text side by side)

$$G_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$



```
\noindent\begin{minipage}{1.0\textwidth}
\noindent\begin{minipage}{0.48\textwidth}
\begin{equation*}
G_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}
\end{equation*}
\end{minipage}
\hfill
\begin{minipage}{0.48\textwidth}
\begin{figure}[H]\begin{center}
\includegraphics[scale=0.15]{fig/brain.png}
\end{center}\end{figure}
\end{minipage}
\end{minipage}
```

Table

You could use online table generator to help you create a clear latex code.

| Chap | StuA | StuB |
|------|------|------|
| 1 | 100 | 95 |
| 2 | 60 | 80 |

```
\begin{table}[H]
\begin{tabular}{|r||l c|}
\hline
Chap & StuA & StuB \\ \hline
1 & 100 & 95 \\
2 & 60 & 80 \\ \hline
\end{tabular}
\end{table}
```

Width and Rule of table (1/2)

| | | | |
|------|---|---|---|
| name | 1 | 2 | 3 |
| name | 1 | 2 | 3 |
| name | 1 | 2 | 3 |

- The package `\usepackage{booktabs}` is for rule.
- The package `\usepackage{tabularx}` is for width.
- Replace the vert `|` by `!\vrule width ??pt`
- Replace the `\hline` by `\noalign{\hrule height ??pt}`
- Replace the vert `c` by `>{\centering\arraybackslash}m{??cm}`, and similar work for `l` and `r`. Ragged means uneven.

Width and Rule of table (2/2)

```
\begin{table}[H]
\begin{tabular}
{!{\vrule width 1.5pt}
>{\raggedright\arraybackslash}m{3.5cm} |
*2{>{\centering\arraybackslash}m{1cm} |}
>{\raggedleft \arraybackslash}m{1cm}
!\vrule width 1.5pt}}
\noalign{\hrule height 1.5pt}
name & 1 & 2 & 3\\
\noalign{\hrule height 1.5pt}
name & 1 & 2 & 3\\ \hline
name & 1 & 2 & 3\\
\noalign{\hrule height 1.5pt}
\end{tabular}
\end{table}
```


Footnote

- If you refer to some reference, you should write down precisely².
- You hope to add annotation for your answer³.

```
If you refer to some reference, you should write down precisely\  
  footnote{This is footnote.}
```

```
You hope to add annotation for your answer\footnotemark .  
  
\footnotetext{Actually, I copy my friend's answer.}
```

²This is footnote.

³Actually, I copy my friend's answer.

Make your report easy to read (1/2)

As title.

- `\hspace{length}`, `\vspace{length}`: separate from horizontal and vertical space.
- `\hfill`, `\vfill`: flush right and left, *i.e.* horizontal separation; flush up and down, *i.e.* vertical separation.
- `\newpage`: for new page.
- `\noindent`, `\indent`: for indent. Note that if you space lines in your code, the new line will contain a indent.

Make your report easy to read (2/2)

(cont'd)

- `\setlength{\parindent}{??ex}` in preamble could be used to change indent length.
- `\setlength{\parskip}{??ex}` in preamble could be used to change paragraph space.
- `\renewcommand{\baselinestretch}{2.0}` in preamble could change the line spacing.

Fun fact of Length

| Command | Display | Description |
|-----------------|---------|------------------|
| <code>pt</code> | . | a point |
| <code>ex</code> | — | height of an 'x' |
| <code>em</code> | — | width of an 'M' |
| <code>mm</code> | - | a millimeter |
| <code>cm</code> | — | a centimeter |
| <code>in</code> | — | a inch |

Usually, `pt` for rule; `ex`, `em` for indent or paragraph space; and `mm`, `cm`, `in` for figure.

Boxed and Fbox

Use `\boxed` in math mode and `\fbox` in text mode. For instance, the following is the Gauss-Bonnet Theorem on two dimensional surface with boundary $\partial\mathcal{M}$

$$\int_{\mathcal{M}} K dA + \int_{\partial\mathcal{M}} \kappa_g ds = 2\pi\chi(\mathcal{M}).$$

```
the following is the \fbox{Gaussian-Bonnet Theorem} on two dimensional
    surface with boundary $\partial\mathcal{M}$
\begin{equation*}
\boxed{\int_{\mathcal{M}} K\,dA+\int_{\partial\mathcal{M}} \kappa_g\,
    ds=2\pi\chi(\mathcal{M})}\,,.
\end{equation*}
```

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Reference

- [1] G.J LEE, 大家來學 \LaTeX , (2004).