A Basic LaTeX Tutorial for **Math** Students

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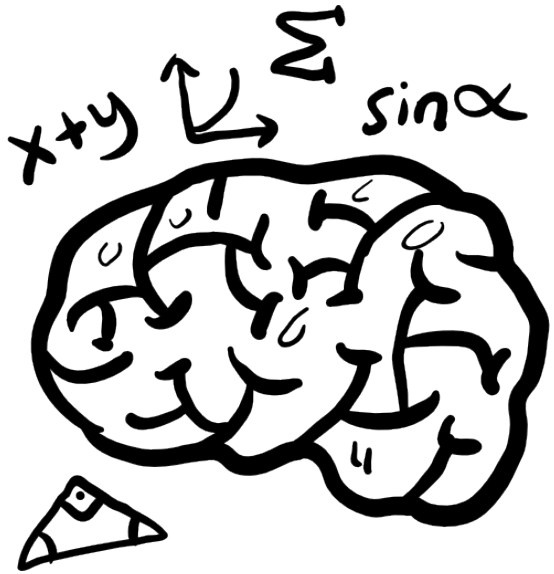
Outline

Preamble

- This slides is for **math**. In fact, LaTeXis 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

Chinese

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 does't work on Overleaf.

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
ab	a\!b
ab	ab
a b	a\,b
a b	a~b
a b	a b
a b	a\qaud b

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

Font variance

Display	Command
Roman[1]	`Roman`
italic	`{\it italic}`
boldface	`{\bf boldface}`
sans serif	`{\sf sans serif}`
`typewriter`	`{\tt typewriter}`
Samll Caps	`{\sc Samll Caps}`

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

[1] Actually, this is not Roman font in beamer.

Font size

Display	Command
footnotesize	{\footnotesize footnotesize}
small	{\small small}
Normalsize	Normalsize
Large	{\Large Large}

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`, $\operatorname{cosec} x$ instead of $\operatorname{cosec}x$.

Math font

Display	Command
$italic$	`$italic$`
R	`$\mathrm{R}$`
$\mathbf{v}$	`$\mathbf{R}$`
$\mathbb{R}$	`$\mathbb{R}$`
$\mathcal{M}$	`$\mathcal{M}$`
$\mathtt{p}$	`$\mathtt{p}$`
$\mathfrak{Re}$	`$\mathfrak{Re}$`
$\mathbb{1}$	`$\mathbb{1}$`

Note that if the command `$\mathbb{1}$` 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**: $\lim\limits_{x\to 3} f(x)$ instead of $\lim_{x\to 3} f(x)$

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

- **Summation**: $\sum\limits_{n=1}^{\infty} a_n$ 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.

$$|a-b| \leq |a-c|+|c-b|$$
$$\leq |a-c|+|c-d|+|d-b|$$

```
\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.

Tag

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

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

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

The Equation (♠) 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

♠	`$\spadesuit$`
♣	`$\clubsuit$`
♦	`$\blacklozenge$`
★	`$\bigstar$`
■	`$\blacksquare$`
▲	`$\blacktriangle$`
$*$	`$\ast$`

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*}
\mathbb{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}`.

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

```
\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

$a \ldots b$	`$a\ldots b$`	lie on line
$a \cdots b$	`$a\cdots b$`	lie on center
$a \vdots b$	`$a\vdots b$`	vertical
$a \ddots b$	`$a\ddots b$`	diagonal
$a \iddots b$	`$a\iddots b$`	back diagonal
$a \cdot b$	`$a\cdot b$`	one dot
$a \bullet b$	`$a\bullet b$`	big dot
$\dot{a}$	`$\dot{a}$`	as you seen
$\ddot{a}$	`$\ddot{a}$`	as you seen

If you hope to use back diagonal, you should define

`\newcommand{\bddots}{\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*}
```

Bracket

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

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

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

- `left|\int f\right|`

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

Warning

Some professors put great emphasis on this detail.

Bracket and Align

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

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

```
\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`.

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

```
\begin{equation*}
\left(
\begin{array}{ll}
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*

$$\begin{cases} u_t = \Delta u \\ \lim_{t\to 0} u = f(x) \quad \text{I.C.} \\ u(0,t) = g(x) \quad \text{B.C.} \end{cases}$$

```
\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*}
```

$$\begin{cases} u_t = \Delta u \\ \lim\limits_{t\to 0} u = f(x) \quad \text{I.C.} \\ u(0,t) = g(x) \quad \text{B.C.} \end{cases}$$

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

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

Outline

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}
\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

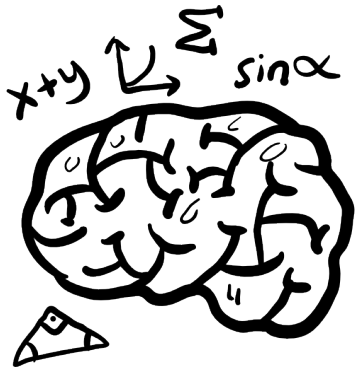


Figure: This is caption

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

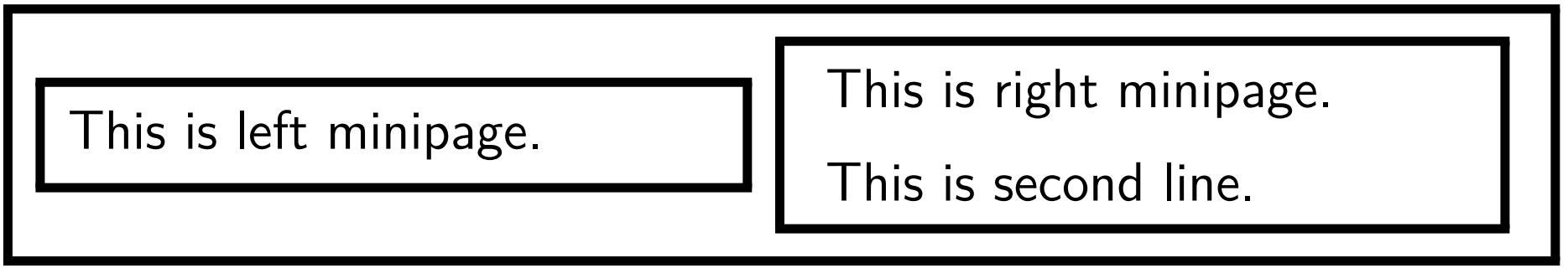
- There are two method to control the size of figure: `[scale=??]` or `[width=??]`
- Usually, we will create a folder to collect figures, *e.g.* `fig/name.png`.
- The package `\usepackage{graphicx}` should be included.
- The command `H` is introduced next page.

Fun fact of float

Command	Description
`h`	Place here! Not recommend!
`t`	Place at the top of the page.
`b`	Place at the bottom of the page.
`H`	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



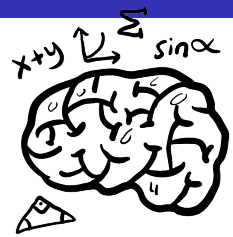

```
\noindent
\begin{minipage}{1.0\textwidth}
\noindent
\begin{minipage}{0.48\textwidth}
This is left minipage.
\end{minipage}
\hfill
\begin{minipage}{0.48\textwidth}
This is right minipage.
\end{minipage}
\end{minipage}
```

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 precisely[2].
- You hope to add annotation for your answer[3].

```
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.}
```

[2] This is footnote.

[3] Actually, 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
`pt`	.	a point
`ex`	x	height of an 'x'
`em`	M	width of an 'M'
`mm`	-	a millimeter
`cm`	———	a centimeter
`in`	———————	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 $\boxed{\text{Gauss-Bonnet Theorem}}$ on two dimensional surface with boundary $\partial\mathcal{M}$

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

```
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*}
```

Outline

Reference

[1] G.J Lee, **大家來學 LaTeX, (2004)**.