A Basic LaTeX Tutorial for **Math** Students

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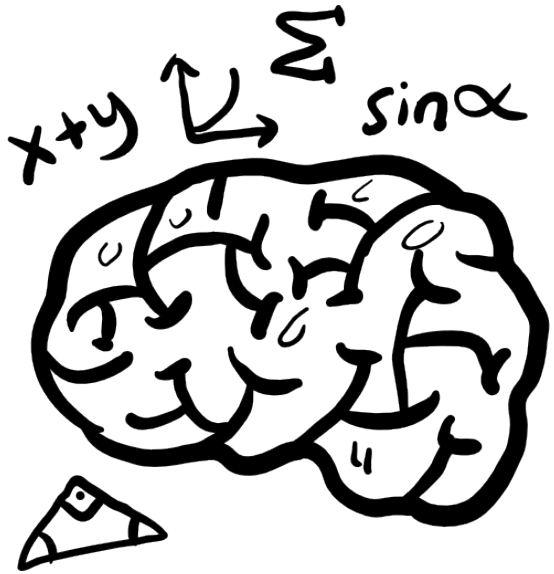
Outline

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

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	`$\varphi$`

- 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}`.

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.

Figure

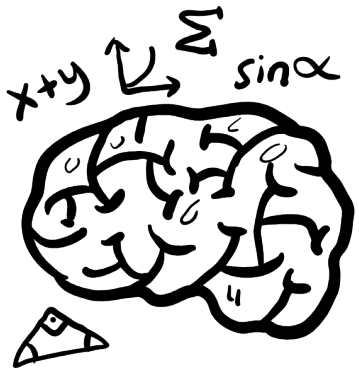


Figure: This is caption

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

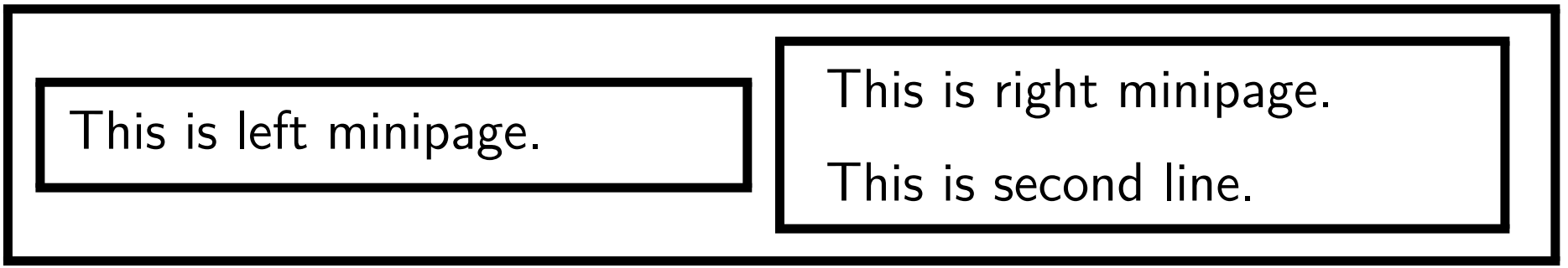
- There are two method to control the size of figure: `[scale=??]` or `[width=??]`
- Usually, we will create a folder to collect figures, *e.g.* `fig/name.png`.
- The package `\usepackage{graphicx}` should be included.
- The command `H` is introduced next page.

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



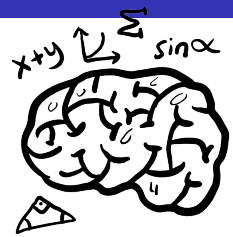

```
\noindent
\begin{minipage}{1.0\textwidth}
\noindent
\begin{minipage}{0.48\textwidth}
This is left minipage.
\end{minipage}
\hfill
\begin{minipage}{0.48\textwidth}
This is right minipage.
\end{minipage}
\end{minipage}
```

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)**.