



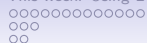
English and \LaTeX for Mathematicians

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Outline

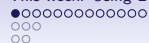
8th March: Introduction

This week: Using \LaTeX for publications
Typesetting mathematics I

Typesetting mathematics II
Bibliography

Next:
Giving a presentation

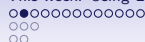




Using L^AT_EX

- + logical structure,
- + professional typesetting,
- + compatibility with journals;
 - longer learning time (no WYSIWYG),

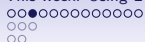




Programs

- editor** any utf-8 editor, e.g. PSPAD or Komodo Edit (on Mac); see also IDEs
- typesetter** MikT_EX or teT_EX containing L^AT_EX, pdfL^AT_EX, X₃L^AT_EX, and Chinese fonts
Internet source: mirrors.ustc.edu.cn/CTAN
- viewer** any PDF-viewer, e.g. Adobe Acrobat, FoxIt Reader, or Preview (on Mac)
- IDEs** WinEdit or T_EXShop (on Mac),
- bundles** Easiest to use a complete bundle of applications: T_EXlive or MacT_EX (on Mac)
- documentation** in the installation (look for pdf-files), or en.wikibooks.org/wiki/LaTeX online, [lshort-zh-cn.pdf](#) (Chinese) the not so short introduction to L^AT_EX.





General structure

```
\documentclass[12pt]{article}  
\usepackage{amsmath,amsthm,mathfrak,mathbbol}
```

```
\title{Document's title}
```

```
\author{Your name}
```

```
\date{Publication date}
```

```
further header
```

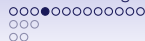
```
\begin{document}
```

```
\maketitle
```

```
Your paper
```

```
\end{document}
```





Ignoring spaces

- L^AT_EX ignores most spaces in your source except between letters.
- single or multiple space or newline \Rightarrow word separator,
- double or multiple newline \Rightarrow paragraph separator.
- Adjusting space: Mostly done by automatically. Problems: dot \cdot in abbreviations, e.g. “e.g.” Needs to be typed as e.g.\ .





Document classes

The documentclass is defined at the beginning of the document via **\documentclass**

<code>article</code>	For typesetting small and intermediate articles,
<code>book</code>	For typesetting books,
<code>letter</code>	For typesetting letters,
<code>beamer</code>	For typesetting projector presentations,
<code>exam</code>	producing exams.
<code>a0poster</code>	producing posters

⋮

Class options

<code>12pt</code>	typesetting in 12pt font size,
<code>daft</code>	typesetting without the images,
<code>a4paper</code>	typesetting on A4 paper





Packages

Packages are included with the `\usepackage` command.

<code>amsmath</code>	extended typesetting of mathematical formulas,
<code>amsthm</code>	definition of theorem-like environments,
<code>mathbbol</code>	command <code>\mathbb</code> for blackboard bold letters,
<code>[utf8]{inputenc}</code>	document in utf8 encoding,
<code>cjk</code>	typesetting of Chinese language documents,
<code>hyperref</code>	<code>\href{<URL>}{<text>}</code> for making clickable elements,
<code>graphicx</code>	<code>\includegraphics[<options>]{<file name>}</code> ,
<code>xypic</code>	<code>\[\xymatrix{...} \]</code> making diagrams or graphs
...	





Special characters and T_EX commands

special characters: # \$ % ^ _ & { } \ ~ @ < >

# \$ % _ & { }	<code>\# ...</code>
^	<code>\^{}</code>
~	<code>\(\sim\)</code>
@	<code>\texttt{@}</code>
< >	work only in math mode (see later)
and many more	<code>amssymb.pdf</code>

T_EX commands begin with a backslash `\`, e.g. `\textbackslash` which produces a `\`.

Grouping is done via `{` and `}`. This is necessary, e.g. for the arguments of a command, e.g. `\emph{emphasis}` which produces *emphasis*.





Structuring documents

An article can have the following elements

`\part{Part title}` – optional

`\appendix` – starts the appendix (chapters numbered with letters)

`\chapter{Chapter Title}` – only in a book

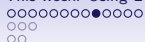
`\section{Section Title}`

`\subsection{Subsection}`

`\subsubsection{Subsubsection}`

You can produce a table of contents with `\tableofcontents`, but you need to typeset the document twice to get the actual table of contents.





Environments

Environments are used as follows:

```
\begin{proof}
```

This is rather obvious.

```
\end{proof}
```

Proof.

This is rather obvious. □

```
itemize
```

```
enumerate
```

```
description
```

```
{tabular}[h!]{rcl|c}
```

```
equation, align, gather, split
```

```
equation*, align*, gather*
```

```
thebibliography
```

itemization via **\item**

enumeration via **\item**

description of notions via **\item**[<na

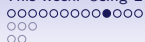
tables

math environments (numbering equ

math environments (no numbering)

bibliographic data





When trouble strikes

L^AT_EX stops on errors and asks for immediate input

⟨Enter⟩ to accept auto correction,

l⟨data⟩ to insert code, e.g. the correct command,

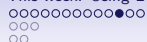
'q' to continue silently, or

'x' abort typesetting.

missing \$ inserted means that some command is only allowed in math mode (see below). If you just forgot beginning the math mode, that will help. Otherwise the remainder of the document will possibly be garbled.

runaway argument suggests, that you forgot to close a block. Look starting at the suggested line and insert }.





References

You can set a label referring to the current element by `\label{<name>}`. You can refer to it via `Example~\ref{<name>}` which produces something like Example 27 (and automatically updates the number).¹ You can refer to the page of the label via `\pageref{<name>}`. You need to typeset twice in order to get actual labels.

¹You have to typeset twice to obtain the update.



Macros

If you have some lengthy sequence you need to insert several times, you can define a command that produces the sequence with the command `\newcommand⟨command⟩{⟨substitute⟩}`. L^AT_EX will warn you, if the name is already used. Note that digits, and interpuctation symbols are special characters, thus you can define a command `\1`, but not a command `\11` or `\def1`. Note however, that `\newcommand` is only allowed in the header.

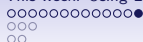
```
\newcommand\X{{\mathfrak{X}}}
```

```
⋮
```

```
\(\X\X\)
```

ææ





Macros with parameters

Macros can also have parameters. You declare the number of parameters as the first optional argument after the command name, e.g. [3] for three arguments. You refer to them by #1, #2, #3,

The first argument can be made optional by giving its default value as second optional argument after the command name.

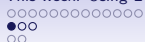
```
\newcommand\pfrac[2]{%
\frac{\partial#1}{\partial#2}}
```

```
:
```

```
\[
\pfrac{^2 f}{x^2}
\]
```

$$\frac{\partial^2 f}{\partial x^2}$$





Typesetting mathematics I

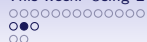
Short formulas go between `\(` and `\)`. In math mode spaces are generally ignored. There are the special commands `\,`, `\;`, and `\quad` for producing small, intermediate, and large space.

Larger formulas need to be displayed by typing them between `\[` and `\]`.

```
\[
\int_0^{e^2} \sum_{n=1}^3
\frac{\sqrt[3]{1+x}}{x^n} \, dx
\]
```

$$\int_0^{e^2} \sum_{n=1}^3 \frac{\sqrt[3]{1+x}}{x^n} dx$$





parentheses and arrays

```
\[
\Bigg|\bigg|\Big\{\big[(1+x)\big]
\Big}\bigg|\Bigg|
\]
```

$$\left| \left| \left\{ [(1+x)] \right\} \right| \right|$$

```
\[
\left(\begin{array}{rcl|c}
1 & 2 & 3 & 4 \\
\hline
0.1 & 0.1 & 0.1 & 1
\end{array}\right)
\right]
```

$$\left(\begin{array}{ccc|c} 1 & 2 & 3 & 4 \\ [1.1] & 2.1 & 3.1 & 5 \\ \hline 0.1 & 0.1 & 0.1 & 1 \end{array} \right)$$





typesetting units

While variables are typeset in `mathit`, units need to be typeset in `mathrm`

```
\newcommand\ufrac[2]{\frac{%
\mathrm{#1}}{\mathrm{#2}}}
```

```
:
```

```
\(v=1.5\,\ufrac{m}{s})
```

$$v = 1.5 \frac{\text{m}}{\text{s}}$$

with a concentration of

```
\(1.5\,\mathrm{mmol\,l}^{-1})
```

with a concentration
of 1.5 mmol l^{-1}





Using $X_{\text{}}\LaTeX$

- + support for most Unicode characters,
- + support for most fonts installed on the system,
 - not supported by some journals





Differences to L^AT_EX

```

% !TEX TS-program = xelatex
% !TEX encoding = UTF-8
\documentclass[12pt]{article}
\usepackage{xltextra,polyglossia}
\usepackage[BoldFont]{xeCJK}
\usepackage{amsmath,amsthm}

\title{\langle title \rangle}
\author{\langle author \rangle}
\date{\langle publication date \rangle}

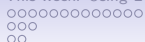
% polyglossia specifications
\setdefaultlanguage[variant=american]{english}
\setotherlanguage{chinese}
\defaultfontfeatures{Mapping=tex-text,Scale=MatchLowercase}
\setCJKmainfont{STSong}
% give a font on your system that has Chinese glyphs

\begin{document}
\maketitle

\langle Your document \rangle
\end{document}

```





Definitions, Theorems, and Examples

These environments can be defined with the `\newtheorem` command from the package `amsthm`.

```
\newtheorem{defn}{Definition}[section]
```

```
\newtheorem{thm}{Theorem}
```

```
\theoremstyle{definition}
```

```
\newtheorem{ex}[defn]{Example}
```

```
⋮
```

```
\begin{defn} A prime is \dots.
```

```
\end{defn}
```

```
\begin{thm}[Euclid] There are
infinitely many primes.
```

```
\end{thm}
```

```
\begin{ex} 2, 3, 5, 7, 11, 13, 17, 19,...
```

```
\end{ex}
```

Definition

A prime is

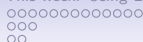
Theorem (Euclid)

There are infinitely many primes.

Example

2, 3, 5, 7, 11, 13, 17,
19, . . .





Numbered equations

These are typed in the environment `equation`. You can define a label in them with `\label{<name>}` and refer to it via `\eqref{<name>}`.

```
\begin{equation}\label{binom}
```

```
(x+y)^n = \sum_{k=0}^n
```

```
\binom{n}{k}x^k y^{n-k}
```

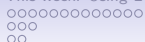
```
\end{equation}
```

`\eqref{binom}` is the binomial formula.

$$(x + y)^n = \sum_{k=0}^n \binom{n}{k} x^k y^{n-k} \quad (1)$$

(1) is the binomial formula.





Multiline equations

split environment within a gather or gather* environment.

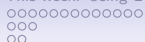
```

\newcommand\bi{\mathbf{i}}
\newcommand\R{\mathbb{R}}
:
\begin{gather*}
\begin{split}
Q(f)(\phi)(x)
:=\int_{\mathbb{R}^{2n}}
\phi(x+v)\times\dots\backslash
&\dots\times
f(x,p)e^{\mathbf{i}/\hbar\langle p,v\rangle}
p,v\rangle} \, dp, dv
\end{split}
\end{gather*}

```

$$Q(f)(\phi)(x) := \int_{\mathbb{R}^{2n}} \phi(x+v) \times \dots \\ \dots \times f(x,p) e^{i/\hbar \langle p,v \rangle} dp dv$$





Mutually aligned equations

```
\DeclareMathOperator\Div{div}
```

```
\DeclareMathOperator\Curl{curl}
```

```
:
```

```
\begin{align*}
```

```
\Div B &= 0 & \Div D &= \rho
```

$$\operatorname{div} B = 0$$

$$\operatorname{div} D = \rho$$

```
//
```

```
\Curl H &= j + \dot{D} &
```

$$\operatorname{curl} H = j + \dot{D}$$

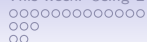
$$\operatorname{curl} E = -\frac{1}{c^2} \dot{B}$$

```
\Curl E &=
```

```
-\tfrac{1}{c^2} \dot{B}
```

```
\end{align*}
```





Arrows

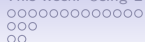
<code>\(f\colon X\to Y:x\mapsto f(x)\)</code>	$f: X \rightarrow Y : x \mapsto f(x)$
<code>\(X\xrightarrow[f]{\sim} Y\)</code>	$X \xrightarrow[f]{\sim} Y$
<code>\(C(X)\leftarrow C(Y)\)</code>	$C(X) \leftarrow C(Y)$
<code>\(A\land B\Rightarrow A\)</code>	$A \wedge B \Rightarrow A$
<code>\(A\Leftarrow B\)</code>	$A \Leftrightarrow B$
<code>\(f,g\colon G\Rightarrow M\)</code>	$f, g: G \rightrightarrows M$
<code>\(\ker f\hookrightarrow X\)</code> <code>\twoheadrightarrow Y\)</code>	$\ker f \hookrightarrow X \twoheadrightarrow Y$
<code>\(2\mathrm{H}_2\mathrm{O}\rightleftharpoons\mathrm{H}_3\mathrm{O}^++\mathrm{OH}^-\)</code>	$2\mathrm{H}_2\mathrm{O} \rightleftharpoons \mathrm{H}_3\mathrm{O}^+ + \mathrm{OH}^-$



Fonts

<code>\mathbb{A,B,C,a,b,c,\dots}</code>	A, B, C, a, b, c, \dots <code>mathbbol</code>
<code>\mathbf{A,B,C,a,b,c,\dots}</code>	A, B, C, a, b, c, ...
<code>\boldsymbol{\alpha, \prod, \dots}</code>	$\alpha, \beta, \prod, \dots$
<code>\mathcal{A,B,C,\dots}</code>	$\mathcal{A}, \mathcal{B}, \mathcal{C}, \dots$ only capital letters
<code>\mathfrak{A,B,C,a,b,c,\dots}</code>	$\mathfrak{A}, \mathfrak{B}, \mathfrak{C}, a, b, c, \dots$
<code>\DeclareMathOperator\Div{div}</code>	<code>div</code>
<hr/>	
<code>\emph{emphasized}</code>	<i>emphasized</i>
<code>\textbf{bold}</code>	bold





Bibliography, embedded

You can cite other papers via `\cite[where]{name}`.

In order to define the bibliography, you use an environment as follows:

```
\begin{thebibliography}{LamXX}
```

```
\bibitem[Lam94]{lamport94}
```

L. Lamport:

```
\emph{\LaTeX} -- A Document Preparation System}.
```

Addison Wesley, Massachusetts,

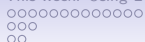
2nd Edition, `\textbf{(1994)}`.

```
\end{thebibliography}
```



L. Lamport, *\LaTeX – A Document Preparation System*.
Addison Wesley, Massachusetts, 2nd Edition, **(1994)**.





Using bibT_EX

You cite as before and can include further bibliography with `\nocite{\langle papers \rangle}`, but instead of the `thebibliography` environment you give the commands

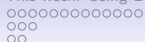
```
\bibliographystyle{\langle style \rangle}
```

```
\bibliography{\langle file name \rangle}
```

In order to obtain the bibliography, you need to L^AT_EX once, then bibT_EX, and then L^AT_EX twice more. Possible styles are `plain`, `abbrv`, `alpha`, or you generate your own style with

```
\LaTeX makebst
```





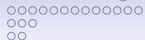
Sample bibliography file

```

@Article{BCG07,
  author   = "Henrique Bursztyn and Gil R. Cavalcanti and Marco
             Gualtieri",
  title    = "Reduction of Courant algebroids and generalized complex
             structures",
  journal  = "Adv. Math.",
  volume   = "211",
  number   = "2",
  year     = "2007",
  pages    = "726--765",
  eprint   = "math.DG/0509640",
}
@Book{Helg,
  author   = "Helgason, Sigurdur",
  title    = "Differential Geometry, Lie Groups, and Symmetric Spaces",
  publisher = "AMS",
  year     = "2001",
  series   = "Graduate Studies in Mathematics",
  volume   = "34",
  address  = "Providence, Rhode Island",
}

```





Including pictures

This needs the package `graphicx` and is done via the command `\includegraphics[height= \langle height \rangle]{filename}`. Supported formats are `eps`, `pdf`, `png`, and `jpg`. Other options are `width`, or `clip`.





Making exams I

```

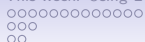
\documentclass[12pt,fleqn]{exam}
\usepackage{amsmath,amssymb,latexsym}
\usepackage{color,graphicx}
\usepackage[left=2.3cm,right=2.3cm,top=3cm,bottom=3cm]{geome

\addpoints
\begin{document}

\thispagestyle{empty}
\begin{center}
  {\Large <title>} \\[2ex]
  \textcolor{red}{Cheating in the exam is punishable by
expulsion from class!}
\end{center}

```





Making exams II

This exam consists of `\numquestions{}` questions and has `\numpoints{}` points in total. You may not use a calculator or prewritten notes in this exam. Please turn off your cell-phone.

```
\begin{questions}
```

```
\question[20] Simplify the following expression!
```

```
\[ \int_{-\infty}^{\infty} e^{-\tfrac{1}{2}x^2} \, dx
```

```
\]
```

```
\vspace{5cm}
```

```
\question
```

```
\begin{parts}
```

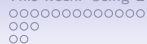
```
\part[5] Compute the derivative of  $(f(x)=\sin\log(x^2+1))!$ 
```

```
\vspace{3cm}
```

```
\part[5] Find the local extrema!
```

```
\end{parts}
```





Making exams III

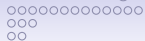
`\newpage`

`\question[20] ...`

`\end{questions}`

`\end{document}`





Sample exam

Midterm Calculus for Engineers I, Fall 2010

Cheating in the exam is punishable by expulsion from class!

This exam consists of 3 questions and has 50 points in total. You may not use a calculator or prewritten notes in this exam. Please turn off your cell-phone.

1. (20 points) Simplify the following expression!

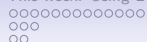
$$\int_{-\infty}^{\infty} e^{-\frac{1}{2}x^2} dx$$

2. (a) (5 points) Compute the derivative of $f(x) = \sin \log(x^2 + 1)$!

- (b) (5 points) Find the local extrema!

3. (20 points) ...





Making hyper-links

Via the package `hyperref`. Options are, e.g. `linktoc=page` makes the page numbers in the table of contents link to the section, subsection,

`\href{⟨URL⟩}{⟨text⟩}` where the URL can contain special characters and clicking it opens a browser (in Acrobat and Preview).

When you encounter problems like argument of `\Hy@setref@link` has an extra `}`, you compiled before adding the `hyperref` package. Just trash the aux-files (`*.aux,*.toc,*.lof,...`) and typeset again.





Next week: Giving a presentation

- using document class `beamer`,
- what to consider and what to avoid

