$\LaTeX 2_\varepsilon$-Course — Slides

Intensivkurs Mathematik 1996
Pascal Hitzler

1 The Preamble

```
\documentclass[12pt,a4paper,german]{book}
\usepackage[german]{babel}
\usepackage{amstex}

\pagestyle{headings}
\addtolength{\textwidth}{3cm}

\setlength{\parskip}{1.5ex}  % vertical skip preceding a new paragraph
\setlength{\parindent}{0em}  % horizontal skip, first line of a new paragra

\frenchspacing       % spacing as used in Europe
\sloppy              % don't worry too much about bad linebreaks

\begin{document}
```

Body

```
\end{document}
```

1.1 Document Classes

```
article              % for articles
report               % for reports
book                 % for books
```

1.2 Document Class Options

```
10pt, 11pt, 12pt     % main font size
a4paper, a5paper     % paper size
twoside              % for double-sided printing
german               % german hyphenation pattern, titles etc.
```

1.3 Packages

```
babel                    % supports other languages
amstex                   % special mathematics package
theorem                  % for defining new theorem environments
```

1.4 Page Styles

```
empty                    % just empty
plain                    % page numbers at the bottom
headings                 % header with title of chapter etc. at the top
```

1.5 Adjusting Page Layout Parameters

```
\addtolength{\textwidth}{3cm}
\addtolength{\textheight}{2cm}
\addtolength{\topmargin}{-2cm}
```

1.6 Units

`pt`	$\frac{1}{72.27}$in = 0.351mm
`mm`	
`cm`	
`in`	1 Inch = 25.4mm = 72.27pt
`ex`	Height of a small “x“ of the current font
`em`	Width of a capital “M“ of the current font

2 Typesetting Text

2.1 Line- and Pagebreaking

```
\\, \newline                     % forced linebreak
\newpage                         % forced pagebreak
```

`\mbox{`*text*`}`	prohibits a line break in *text*
`~`	blank prohibiting a line break
`\␣`	blank

2.2 Spacing

```
\fill              % rubber length
```

2.2.1 Horizontal Space

```
\enspace                 % half a quad
\quad                    % em value of current font
\qquad                   % two quads
\hfill                   % rubber length
\hspace{2cm}             % space is removed at a line boundary
\hspace*{2cm}            % space is kept at a line boundary
\hspace*{\fill}          % non-removeable rubber length
```

2.2.2 Vertical Space

```
\smallskip      \medskip       \bigskip
\vfill          \vspace{1ex}   \vspace*{\vfill}
```

2.3 Special Characters, Symbols, and Commands

disk-space	`disk-space`
pages 10–15	`pages 10--15`
yes — or no?	`yes --- or no?`
Munich, Berlin, ...	`Munich, Berlin, \dots`
„Das Tübinger Schloß“	`\glqq Das T"ubinger Schlo"s\grqq`

```
\tableofcontents              % prints the table of contents
\listoffigures                % prints the list of figures
\listoftables                 % prints the list of tables
```

2.4 Sectioning

```
\chapter{...}      \chapter[...]{...}  % [...] optional different entry
\section{...}      \section[...]{...}  %    in table of contents

\subsection{...}        \subsubsection{...}
\paragraph{...}         \subparagraph{...}

\section*{...}                % no number, please, and no entry in table
\subsection*{...}             %       of contents
...
```

2.5 Fonts

2.5.1 Font Selection

`\textrm{...}`	`{\rmfamily ...}`	roman family
`\textsf{...}`	`{\sffamily ...}`	sans serif family
`\texttt{...}`	`{\ttfamily ...}`	`typewriter family`
`\textmd{...}`	`{\mdseries ...}`	medium series
`\textbf{...}`	`{\bfseries ...}`	**bold series**
`\textup{...}`	`{\upshape ...}`	upright shape
`\textit{...}`	`{\itshape ...}`	*italic shape*
`\textsl{...}`	`{\slshape ...}`	*slanted shape*
`\textsc{...}`	`{\scshape ...}`	SMALL CAPS SHAPE
`\emph{...}`	`{\em ...}`	*emphasized*
`\textnormal{...}`	`{\normalfont ...}`	main document font

2.5.2 Font Size

tiny	`\tiny`	scriptsize	`\scriptsize`
footnotesize	`\footnotesize`	small	`\small`
normalsize	`\normalsize`	large	`\large`
Large	`\Large`	LARGE	`\LARGE`
huge	`\huge`	Huge	`\Huge`

2.6 Cross References

point of reference: `\label{`*mylabel*`}`

reference: `\ref{`*mylabel*`}`

reference to the pagenumber: `\pageref{`*mylabel*`}`

2.7 Environments

2.7.1 Tables

A table		
centered	right	left
c	r	l

```
\begin{tabular}{|c|r l|}
\hline
\multicolumn{3}{|c|}{A table}\\
\hline
\hline
centered & right & left \\
\hline
c & r & l \\
\hline
\end{tabular}
```

2.7.2 Enumerations

- first
- second
  - second.one
  - second.two
- third

```
\begin{itemize}
\item first
\item second
  \begin{itemize}
  \item second.one
  \item second.two
  \end{itemize}
\item third
\end{itemize}
```

1. first
2. second
   (a) second.one
   (b) second.two
3. third

```
\begin{enumerate}
\item first
\item second
  \begin{enumerate}
  \item second.one
  \item second.two
  \end{enumerate}
\item third
\end{enumerate}
```

2.7.3 Alignment

THIS LINE IS CENTERED

```
\begin{center}
\textsc{This Line Is Centered}
\end{center}
```

```
\begin{flushleft} ... \end{flushleft}
\begin{flushright} ... \end{flushright}
```

2.7.4 Quotations

> This is a quotation!

```
\begin{quote}
This is a quotation!
\end{quote}
```

2.8 Floating Bodies

```
\begin{figure}[htb]
\caption[...]{...}   % [...] entry in list of figures (optional)
...
\end{figure}
```

```
\begin{table}[htb]
\caption[...]{...}   % [...] entry in list of tables (optional)
...
\end{table}
```

2.8.1 Placement Specifiers

`h`	exactly here (use for small floats only)
`t`	top of a page
`b`	bottom of a page
`p`	seperate page containing only floats

3 Typesetting Mathematics

3.1 A First Example

$$\sum_{i=0}^{\infty} q^i = \frac{1}{1-q}$$	`$$ \sum_{i=0}^{\infty} q^i = \frac{1}{1-q} $$`

3.2 Spacing

`\,`	`\thinspace`	`\!`	`\negthinspace`
`\:`	`\medspace`		`\negmedspace`
`\;`	`\thickspace`		`\negthickspace`
	`\quad`		
	`\qquad`		

$x \in \mathrm{I}\!\mathrm{R}$	`$x\in\mbox{\rmfamily I}\!\mbox{\rmfamily R}$`

3.3 Fonts

3.3.1 Font Selection

$\mathbf{x, y, A}$	`$\mathbf{x, y, A}$`
$\boldsymbol{\pi}, \pi$	`$\boldsymbol{\pi}, \pi$`
$\mathcal{ABCD}$	`${\cal A B C D}$`
$\mathbb{NQRZ}$	`$\Bbb{NQRZ}$`
$\mathfrak{E = mc^2}$	`$\frak{E = mc^2}$`
$math mode \text{ --- text mode}$	`$math mode \text{ --- text mode}$`

3.3.2 Size Selection

```
\displaystyle
\textstyle
\scriptstyle
\scriptscriptstyle
```

3.4 Environments

3.4.1 Entering Math Mode

```
math, $ ... $             % inside text paragraph
displaymath, $$ ... $$    % display centered
equation                  % one-line formula, numbered
equation*                 % no number
align(*)                  % list of formulas, aligned at a single place
gather(*)                 % no alignment
multiline(*)              % multiline equation
```

3.4.2 Inside Math Mode

```
split                     % split into multiple lines
aligned                   % as align
gathered                  % as gather
cases                     % "Case"-constructions
pmatrix                   % for matrices
smallmatrix               % matrices inside text paragraph
```

3.5 More Examples

$$\lim_{x\to 0}\frac{\sin x}{x} = 1$$ `$$ \lim_{x\to 0}\frac{\sin x}{x} = 1 $$`

$$\left(\sum_{n=0}^\infty \alpha_n \right) \cdot \left(\sum_{m=0}^\infty \beta_m \right) \not= \left(\sum_{i=0}^\infty \alpha_i\beta_i \right)$$

```
$$ \left( \sum_{n=0}^\infty \alpha_n \right) \cdot
   \left( \sum_{m=0}^\infty \beta_m \right)
   \not= \left( \sum_{i=0}^\infty \alpha_i\beta_i \right) $$
```

$$\sqrt{e^{x^2}}\not=e^x$$ `$$\sqrt{e^{x^2}}\not=e^x$$`

$$\int_{x=0}^1 f'(x) \textrm{d}x = \dots$$ `$$ \int_{x=0}^1 f'(x) \textrm{d}x = \dots $$`

$${n \choose k}$$ `$${n \choose k}$$`

$$\underbrace{a+b+c+d}_{\Omega}+\overline{\mathcal A}$$ `$$\underbrace{a+b+c+d}_{\Omega}+\overline{\cal A}$$`

3.6 Further Examples

Sei $f:[a,b]\longrightarrow\mathbb{R}$ stetig und auf $]a,b[$ differenzierbar.

$$f(a) = f(b) \Longrightarrow \exists\ c\in (a,b) : f'(c) = 0$$

```
Sei $f:[a,b]\longrightarrow\Bbb{R}$ stetig und auf $]a,b[$ differenzierbar.
$$ f(a) = f(b) \Longrightarrow \exists\ c\in (a,b) : f'(c) = 0$$
```

$$\cos(z) = \frac{e^{iz}+e^{-iz}}{2} \tag{1}$$

```
\begin{equation}
\cos(z) = \frac{e^{iz}+e^{-iz}}{2}
\end{equation}
```

$$\begin{aligned}
a &\equiv b+1 \pmod{n^2} && (2)\\
a &\equiv b+1 \mod{n^2} && (\ast)\\
a &\equiv b+1 \pod{n^2} && (\text{cf. } 2)
\end{aligned}$$

```
\begin{align}
a & \equiv b+1 \pmod{n^2} \label{alabel} \\
a & \equiv b+1 \mod{n^2} \tag{$\ast$} \\
a & \equiv b+1 \pod{n^2} \tag{\text{cf. } \ref{alabel}}
\end{align}
```

$$\begin{gathered}
\cos x = (\sin x)' \\
1 + (\tan x)^2 = (\tan x)' \qquad (3)
\end{gathered}$$

```
\begin{gather}
\cos  x = (\sin x)' \notag \\
1 + (\tan x)^2 = (\tan x)'
\end{gather}
```

$$\begin{split}
(a+b)^4 &= (a+b)^2\cdot(a+b)^2 \\
&= (a^2+2ab+b^2)(a^2+2ab+b^2) \\
&= a^4+4a^3b+6a^2b^2+4ab^3+b^4
\end{split}$$

```
\begin{equation*}
\begin{split}
(a+b)^4 &= (a+b)^2\cdot(a+b)^2 \\
        &= (a^2+2ab+b^2)(a^2+2ab+b^2) \\
        &= a^4+4a^3b+6a^2b^2+4ab^3+b^4
\end{split}
\end{equation*}
```

$$f(n) \overset{\text{def}}{=} \begin{cases} 1 & \text{if } n = 1 \\ n\cdot(n-1) & \text{if } n\geq 2 \end{cases}$$

```
$$ f(n) \overset{\textrm{def}}{=}
\begin{cases}
1 &\text{if $n = 1$}\\
n\cdot(n-1) &\text{if $n\geq 2$}
\end{cases} $$
```

$$\begin{pmatrix} x_{11} & x_{12} & \ldots \\ x_{21} & x_{22} & \ldots \\ \vdots & \vdots & \ddots \end{pmatrix} \quad \begin{vmatrix} x_{11} & x_{12} & \ldots \\ x_{21} & x_{22} & \ldots \\ \vdots & \vdots & \ddots \end{vmatrix}$$

```
\begin{gather*}
\begin{pmatrix}
x_{11} & x_{12} & \ldots \\
x_{21} & x_{22} & \ldots \\
\vdots & \vdots & \ddots
\end{pmatrix}
\quad
\begin{vmatrix}
x_{11} & x_{12} & \ldots \\
x_{21} & x_{22} & \ldots \\
\vdots & \vdots & \ddots
\end{vmatrix}
\end{gather*}
```

3.7 Mathematical Symbols

$\hat a$	`\hat a`	$\tilde a$	`\tilde a`	$\dot a$	`\dot a`
$\widehat{a}$	`\widehat{a}`	$\bar{a}$	`\bar{a}`	$\vec{a}$	`\vec{a}`

α	`\alpha`	ι	`\iota`	ϱ	`\varrho`
β	`\beta`	κ	`\kappa`	σ	`\sigma`
γ	`\gamma`	λ	`\lambda`	ς	`\varsigma`
δ	`\delta`	μ	`\mu`	τ	`\tau`
ϵ	`\epsilon`	ν	`\nu`	υ	`\upsilon`
ε	`\varepsilon`	ξ	`\xi`	ϕ	`\phi`
ζ	`\zeta`	o	`o`	φ	`\varphi`
η	`\eta`	π	`\pi`	χ	`\chi`
θ	`\theta`	ϖ	`\varpi`	ψ	`\psi`
ϑ	`\vartheta`	ρ	`\rho`	ω	`\omega`

Γ	`\Gamma`	Ξ	`\Xi`	Φ	`\Phi`
Δ	`\Delta`	Π	`\Pi`	Ψ	`\Psi`
Θ	`\Theta`	Σ	`\Sigma`	Ω	`\Omega`
Λ	`\Lambda`	Υ	`\Upsilon`		

$\cap$	`\cap`	$\cup$	`\cup`	$\times$	`\times`
$\pm$	`\pm`	$\mp$	`\mp`	$\setminus$	`\setminus`

$\ast$	`\ast`	$\star$	`\star`	$\vee$	`\vee`
$\circ$	`\circ`	$\cdot$	`\cdot`	$\wedge$	`\wedge`

$\sum$	`\sum`	$\prod$	`\prod`	$\int$	`\int`
$\bigcap$	`\bigcap`	$\bigcup$	`\bigcup`		

$\leq$	`\leq`	$\geq$	`\geq`	$=$	`=`
$\not\leq$	`\not\leq`	$\not\geq$	`\not\geq`	$\not=$	`\not=`
$\equiv$	`\equiv`	$\sim$	`\sim`	$\perp$	`\perp`
$\parallel$	`\parallel`	$\approx$	`\approx`	$\subset$	`\subset`
$<$	`<`	$>$	`>`	$\supset$	`\supset`
$\in$	`\in`	$\ni$	`\ni`	$\subseteq$	`\subseteq`

$\leftarrow$	`\leftarrow`	$\longleftarrow$	`\longleftarrow`	$\uparrow$	`\uparrow`
$\Leftarrow$	`\Leftarrow`	$\Longleftarrow$	`\Longleftarrow`	$\Uparrow$	`\Uparrow`
$\rightarrow$	`\rightarrow`	$\longrightarrow$	`\longrightarrow`	$\downarrow$	`\downarrow`
$\Rightarrow$	`\Rightarrow`	$\Longrightarrow$	`\Longrightarrow`	$\Downarrow$	`\Downarrow`
$\leftrightarrow$	`\leftrightarrow`	$\longleftrightarrow$	`\long\dots`	$\updownarrow$	`\updownarrow`
$\Leftrightarrow$	`\Leftrightarrow`	$\Longleftrightarrow$	`\Long\dots`	$\Updownarrow$	`\Updownarrow`
$\mapsto$	`\mapsto`	$\longmapsto$	`\longmapsto`	$\nearrow$	`\nearrow`
				$\searrow$	`\searrow`

$\ldots$	`\ldots`	$\cdots$	`\cdots`	$\vdots$	`\vdots`
$\ddots$	`\ddots`	$\forall$	`\forall`	$\exists$	`\exists`
∞	`\infty`	$\emptyset$	`\emptyset`		

$\{$	`\{`	$\}$	`\}`	$\lfloor$	`\lfloor`
$\vert$	`|`	$\Vert$	`|`	$\rfloor$	`\rfloor`

`\sin`	`\cos`	`\tan`	`\arcsin`	`\arccos`	`\arctan`
`\max`	`\min`	`\lim`	`\log`	`\ln`	`\exp`
`\sup`	`\inf`	`\limsup`	`\liminf`	`\deg`	`\det`

4 Defining New Commands and Environments

4.1 Commands

$x_0, \dots, x_n$

```
\newcommand{\xvec}
   {\ensuremath{x_0,\dots,x_n}}
\xvec
```

$y_4, \dots, y_k$

```
\newcommand{\myvec}[3]
   {\ensuremath{#1_#2,\dots,#1_#3}}
\myvec{y}{4}{k}
```

4.2 Environments

Proof: This is an example for the user-defined `proof`-environment. □

```
\newenvironment{proof}{\textbf{Proof:}}{\hspace*{\fill} $\blacksquare$}

\begin{proof}
This is an example for the user-defined \texttt{proof}-environment.
\end{proof}
```

> Life is but a walking shadow …
> *William Shakespeare*

```
\newenvironment{cit}[1]
  {\sbox{\Citname}{\textit{#1}}
    \begin{quote}}
  {\newline\hspace*{4cm} \usebox{\Citname} \end{quote}}

\begin{cit}{William Shakespeare}
Life is but a walking shadow \dots
\end{cit}
```

4.3 Theorems

4.1 Proposition (Bernoullische Ungleichung)
Für alle $x \geq -1$ gilt

$$(1+x)^n \geq 1+nx.$$

Satz 4.2 (Bolzano-Weierstraß) *Jede beschränkte Folge im $\mathbb{R}^n$ hat eine konvergente Teilfolge.*

```
\newtheorem{theo}{Satz}[section]
\theoremstyle{changebreak}     % needs theorem-package
\theorembodyfont{\rmfamily}
\newtheorem{prop}[theo]{Proposition}

\begin{prop}[Bernoullische Ungleichung]
F"ur alle $x\geq -1$ gilt
\begin{equation*}
   (1+x)^n \geq 1+nx.
\end{equation*}
\end{prop}

\begin{theo}[Bolzano-Weierstra"s]
Jede beschr"ankte Folge im $\Bbb{R}^n$ hat eine konvergente Teilfolge.
\end{theo}
```