

# L<sup>A</sup>T<sub>E</sub>X<sub>2</sub><sub>ε</sub>-Course — Slides

Intensivkurs Mathematik 1996  
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## 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 para

\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
\lq             blank
```

## 2.2 Spacing

```
\fill                % rubber length
```

### 2.2.1 Horizontal Space

```
\enspace             % half a quad  
\quad                % em value of current font  
\qqquad              % 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

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

### 2.5.2 Font Size

tiny	<code>\tiny</code>	scriptsize	<code>\scriptsize</code>
footnotesize	<code>\footnotesize</code>	small	<code>\small</code>
normalsize	<code>\normalsize</code>	large	<code>\large</code>
Large	<code>\Large</code>	LARGE	<code>\LARGE</code>
huge	<code>\huge</code>	Huge	<code>\Huge</code>

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

```
\begin{itemize}  
\item first  
\item second  
  \begin{itemize}  
    \item second.one  
    \item second.two  
  \end{itemize}  
\item third  
\end{itemize}  
  
\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 separate page containing only floats

## 3 Typesetting Mathematics

### 3.1 A First Example

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

### 3.2 Spacing

<code>\,</code>	<code>\thinspace</code>	<code>\!</code>	<code>\negthinspace</code>
<code>\:</code>	<code>\medspace</code>		<code>\negmedspace</code>
<code>\;</code>	<code>\thickspace</code>		<code>\negthickspace</code>
	<code>\quad</code>		
	<code>\qquad</code>		

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

### 3.3 Fonts

#### 3.3.1 Font Selection

<code>x, y, A</code>	<code>\mathbf{x, y, A}</code>
<code>\pi, \pi</code>	<code>\boldsymbol{\pi}, \pi</code>
<code>ABCD</code>	<code>\cal A B C D</code>
<code>NQRZ</code>	<code>\Bbb{NQRZ}</code>
<code>E = mc<sup>2</sup></code>	<code>\frac{E = mc^2}</code>
<code>mathmode</code> — text mode	<code>\math mode \text{ --- text mode}</code>

#### 3.3.2 Size Selection

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

## 3.4 Environments

### 3.4.1 Entering Math Mode

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

### 3.4.2 Inside Math Mode

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

## 3.5 More Examples

$$\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1 \quad \text{\$ \$ \lim_{x \to 0} \frac{\sin x}{x} = 1 \$ \$}$$

$$\left( \sum_{n=0}^{\infty} \alpha_n \right) \cdot \left( \sum_{m=0}^{\infty} \beta_m \right) \neq \left( \sum_{i=0}^{\infty} \alpha_i \beta_i \right)$$

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

$$\sqrt{e^{x^2}} \neq e^x \quad \text{\$ \$ \sqrt{e^{x^2}} \not= e^x \$ \$}$$

$$\int_{x=0}^1 f'(x) dx = \dots \quad \text{\$ \$ \int_{x=0}^1 f'(x) \text{d}x = \dots \$ \$}$$

$$\binom{n}{k} \quad \text{\$ \$ {n \choose k} \$ \$}$$

$$\underbrace{a+b+c+d}_{\Omega} + \overline{A} \quad \text{\$ \$ \underbrace{a+b+c+d}_{\Omega} + \overline{\text{cal A}} \$ \$}$$



### 3.6 Further Examples

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

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

Sei  $f : [a, b] \rightarrow \mathbb{R}$  stetig und auf  $]a, b[$  differenzierbar  
 $f(a) = f(b) \implies \exists c \in (a, b) : f'(c) = 0$

$$\cos(z) = \frac{e^{iz} + e^{-iz}}{2} \quad (1) \qquad \begin{array}{l} \begin{array}{l} \begin{array}{l} \end{array} \\ \end{array} \\ \end{array}$$

$$a \equiv b + 1 \pmod{n^2} \qquad (2)$$

$$a \equiv b + 1 \pmod{n^2} \qquad (*)$$

$$a \equiv b + 1 \pmod{n^2} \qquad (\text{cf. } 2)$$

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

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

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

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

```
\begin{equation*}
\begin{array}{l} \end{array} \\
\begin{array}{l} \end{array} \\
(a+b)^4 \quad \&= \quad (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{array} \\
\end{equation*}
```

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

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

```

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

```

```

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

```

### 3.7 Mathematical Symbols

$\hat{a}$	<code>\hat a</code>	$\tilde{a}$	<code>\tilde a</code>	$\dot{a}$	<code>\dot a</code>
$\widehat{a}$	<code>\widehat{a}</code>	$\bar{a}$	<code>\bar{a}</code>	$\vec{a}$	<code>\vec{a}</code>
$\alpha$	<code>\alpha</code>	$\iota$	<code>\iota</code>	$\varrho$	<code>\varrho</code>
$\beta$	<code>\beta</code>	$\kappa$	<code>\kappa</code>	$\sigma$	<code>\sigma</code>
$\gamma$	<code>\gamma</code>	$\lambda$	<code>\lambda</code>	$\varsigma$	<code>\varsigma</code>
$\delta$	<code>\delta</code>	$\mu$	<code>\mu</code>	$\tau$	<code>\tau</code>
$\epsilon$	<code>\epsilon</code>	$\nu$	<code>\nu</code>	$\upsilon$	<code>\upsilon</code>
$\varepsilon$	<code>\varepsilon</code>	$\xi$	<code>\xi</code>	$\phi$	<code>\phi</code>
$\zeta$	<code>\zeta</code>	$o$	<code>o</code>	$\varphi$	<code>\varphi</code>
$\eta$	<code>\eta</code>	$\pi$	<code>\pi</code>	$\chi$	<code>\chi</code>
$\theta$	<code>\theta</code>	$\varpi$	<code>\varpi</code>	$\psi$	<code>\psi</code>
$\vartheta$	<code>\vartheta</code>	$\rho$	<code>\rho</code>	$\omega$	<code>\omega</code>
$\Gamma$	<code>\Gamma</code>	$\Xi$	<code>\Xi</code>	$\Phi$	<code>\Phi</code>
$\Delta$	<code>\Delta</code>	$\Pi$	<code>\Pi</code>	$\Psi$	<code>\Psi</code>
$\Theta$	<code>\Theta</code>	$\Sigma$	<code>\Sigma</code>	$\Omega$	<code>\Omega</code>
$\Lambda$	<code>\Lambda</code>	$\Upsilon$	<code>\Upsilon</code>		
$\cap$	<code>\cap</code>	$\cup$	<code>\cup</code>	$\times$	<code>\times</code>
$\pm$	<code>\pm</code>	$\mp$	<code>\mp</code>	$\setminus$	<code>\setminus</code>

*	<code>\ast</code>	*	<code>\star</code>	∨	<code>\vee</code>
○	<code>\circ</code>	·	<code>\cdot</code>	∧	<code>\wedge</code>
∑	<code>\sum</code>	∏	<code>\prod</code>	∫	<code>\int</code>
∩	<code>\bigcap</code>	∪	<code>\bigcup</code>		
≤	<code>\leq</code>	≥	<code>\geq</code>	=	<code>=</code>
≠	<code>\not\leq</code>	≠	<code>\not\geq</code>	≠	<code>\not=</code>
≡	<code>\equiv</code>	≈	<code>\sim</code>	⊥	<code>\perp</code>
∥	<code>\parallel</code>	≈	<code>\approx</code>	⊂	<code>\subset</code>
<	<code>&lt;</code>	>	<code>&gt;</code>	⊃	<code>\supset</code>
∈	<code>\in</code>	∋	<code>\ni</code>	⊆	<code>\subseteq</code>
←	<code>\leftarrow</code>	←	<code>\longleftarrow</code>	↑	<code>\uparrow</code>
⇐	<code>\Leftarrow</code>	⇐	<code>\Longleftarrow</code>	↑	<code>\Uparrow</code>
→	<code>\rightarrow</code>	→	<code>\longrightarrow</code>	↓	<code>\downarrow</code>
⇒	<code>\Rightarrow</code>	⇒	<code>\Longrightarrow</code>	↓	<code>\Downarrow</code>
↔	<code>\leftrightarrow</code>	↔	<code>\longleftrightarrow</code>	↕	<code>\updownarrow</code>
⇔	<code>\Leftrightarrow</code>	⇔	<code>\Longleftrightarrow</code>	↕	<code>\Updownarrow</code>
↦	<code>\mapsto</code>	↦	<code>\longmapsto</code>	↗	<code>\nearrow</code>
				↘	<code>\searrow</code>
...	<code>\ldots</code>	...	<code>\cdots</code>	:	<code>\vdots</code>
⋯	<code>\ddots</code>	∀	<code>\forall</code>	∃	<code>\exists</code>
∞	<code>\infty</code>	∅	<code>\emptyset</code>		
{	<code>\{</code>	}	<code>\}</code>	⌊	<code>\lfloor</code>
	<code> </code>		<code>\ </code>	⌋	<code>\rfloor</code>
<code>\sin</code>	<code>\cos</code>	<code>\tan</code>	<code>\arcsin</code>	<code>\arccos</code>	<code>\arctan</code>
<code>\max</code>	<code>\min</code>	<code>\lim</code>	<code>\log</code>	<code>\ln</code>	<code>\exp</code>
<code>\sup</code>	<code>\inf</code>	<code>\limsup</code>	<code>\liminf</code>	<code>\deg</code>	<code>\det</code>

## 4 Defining New Commands and Environments

### 4.1 Commands

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

\newcommand{\myvec}[3]
{y_1, \dots, y_k}
\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]
Für 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  $\mathbb{R}^n$  hat eine konvergente Teilfolge.
\end{theo}
```