Introduction to the Typesetting System LaTeX

day one

Moritz Brinkmann
mail@latexkurs.de

March 2024

Learning Objectives

After the two workshop days, you will be able to:

- create simple documents in LaTeX
- find assistance in class and package documentation
- create multilingual documents
- incorporate images and create tables
- generate reference lists
- typeset mathematical formulas
- structure larger projects

Logistics

Dates

- Two sessions per date:
  - Saturday, February 17
  - Sunday, February 18

or

  - Saturday, March 2
  - Sunday, March 3
- Each session from 10 am to 3 pm
- Approximately 45 minutes break

Materials

- All materials are available on the workshop website or in ILIAS for download:

  `https://ma.latexkurs.de/`

Organizational Matters

Exercises

- Theory and practical phases alternate.
- You are allowed (and encouraged) to try examples *at any time* on your computer.
- Feel free to experiment with something new *immediately*!
- Don’t hesitate to ask if you’re having trouble with anything.
- If you are using Overleaf, you can share your source code with `overleaf@latexkurs.de` when you have questions.

LaTeX Flavor

The content of this course is based on the (relatively modern) variant LuaLaTeX.

Content I

Content II

Part I

The Name of the Game

The Name of the Game

- Program TEX (Since 1977)
  Written by Donald E. Knuth for his book “The Art of Computer Programming”.
  “TeX” from Greek τέχνη
- Macro package plainTEX
  Makes TEX usable for regular users.
- Extended macro package LaTEX (Early 1980s)
  By Leslie Lamport: “Lamport’s TEX“.
  Many simplifications for the average user.
- Current stable version: LaTEX 2_ε (1994)
  “in an ε-environment of 2”
- Future development: LATEX3
  not yet independently available, but as a package `expl3` in LATEX 2_ε

What is TEX – and what is it not?

LATEX is well-suited for...

- All documents with a logical structure
  - Scientific papers (excellent mathematical typesetting)
  - Humanities papers (excellent multilingual support, bibliography creation, apparatus creation, etc.)
  - Articles, bachelor's theses, dissertations, etc.
  - Book series, letters
  - Presentations

LATEX is less suitable for...

- Documents without a logical structure
  - Presentations (colorful, rotating, blinking, "chaotic")
  - Flyers
  - Posters
- Documents with many inconsistent images that are freely moved

How does TEX work?

- WYSIWYM
- Plain text files
- No hidden settings
- Text formatting using special commands:
  - “I want to write an article!”
  - “Create a heading!”
  - “Make the following bold!”
  - “Create a table that...”

How does TEX work?

Advantages

- Stability and portability
- Small file sizes
- Editable with any text editor
- Text files are always readable
- Consistent output everywhere

Disadvantages

- Result not immediately visible
- Non-intuitive interface
- Steep learning curve
- Changes require recompilation
- Complex layout desires are hard to achieve

A simple TEX document

How can text be distinguished from commands?

Approach in *classical* programming languages:

```
print ( "Hello, World!" );
```

$\Longrightarrow$ unsuitable for a typesetting program

A simple TEX document

- TEX is a markup language
- Individual characters have special meanings
- Backslash (\) serves as an escape character and marks the beginning of a command: `\chapter \section \author`

Simplest TEX document:

```
Hello, World! \bye
```

```
$ tex document.tex
```

creates a `.dvi` document and a `.log` file

A simple LaTeX document

```
\documentclass{minimal}
\begin{document}
Hello, World!
\end{document}
```

Hello, World!

Assignment

Create your first LaTeX document by typing this minimal example in your editor!

Command Characters

`\`	*escape character*, marks the beginning of commands
`{}`	*grouping character*, groups related characters together e.g., arguments `\textbf{bold}`
`$`	*math character*, starts and ends math mode
`&`	*tabbing character*, separates columns in tables
`%`	*comment character*, comments out the rest of the line
`^_~#`	other characters with special meaning

Part II

Basic Operation

Document Classes

Document classes define fundamental properties of the document:

- Layout
- Default fonts
- Text margins
- Sectioning commands
- Appearance of lists, tables, enumerations, etc.

Properties can be customized by changing options or loading packages.

Document Classes

Standard Classes

article	(Short) articles
report	Reports, conference reports
book	Books
letter	Letters
minimal	For minimal examples

KOMA-Script

scrartcl	Extension of article
scrreprt	Extension of report
scrbook	Extension of book
scrlttr2	Very powerful letter class

Special Classes

beamer	For presentations
tikzposter	Scientific posters

Packages

- Packages provide additional functionality
- Work facilitators
- Error corrections
- Include in the preamble using \usepackage[⟨*option(s)*⟩]{⟨*package name*⟩}:

```
\documentclass{article}
\usepackage{
  amsmath,
  hyperref,
}
\usepackage[left=2cm]{geometry}
```

Sectioning Commands

- Sectioning structures organize documents
- Enable automatic numbering, entry in tables of contents, column titles, etc.
- Defined by the document class
- Basic structure defined in the kernel

$\Longrightarrow$ certain elements always available

```
\teil{Part I}
\chapter{Chapter}
\section{Section}
\subsection{Subsection}
\subsubsection{Subsubsection}
\paragraph{Paragraph}
\subparagraph{Subparagraph}
```

try this in Overleaf

http://qn3.de/tex21

Basic Commands

General

`\textrm{Serif}`	Serif Abcdxyz
`\textit{italic}`	*italic* *Abcdxyz*
`\textsl{slanted}`	*slanted* *Abcdxyz*
`\textsf{sans-serif}`	sans-serif Abcdxyz
`\textbf{bold}`	**bold** **Abcdxyz**
`\texttt{typewriter}`	`typewriter` `Abcdxyz`
`\textsc{Small Caps}`	Small Caps Abcdxyz
`\emph{emphasis}`	*emphasis* *Abcdxyz*
`\\`	Line break
`\par` or blank line	Paragraph break
`$E = \frac{p^2}{2m}$`	Inline math mode: $E = \frac{p^2}{2m}$
`\[E = \frac{p^2}{2m}\]`	Display math mode: $$E = \frac{p^2}{2m}$$
`\tableofcontents`	Produces table of contents
`\today`	Current date

Basic Commands

Font Sizes

`\tiny`	tiny
`\small`	small
`\normalsize`	normal
`\large`	large
`\Large`	larger
`\LARGE`	even larger
`\huge`	huge
`\Huge`	even huger

Auxiliary Files

	Input
.tex	TEX file with document text
	Output
.pdf	pdfTEX output or conversion from (x)dvi
	Auxiliary files (write only)
.log	Log file with information, warnings, errors
	Auxiliary files (read and write)
.aux	Auxiliary file with temporary information
.toc	table of contents
.lof	list of figures
.synctex.gz	required for the SyncTEX feature
⋮	⋮

Part III

Basics of Typography

Macrotypography

- Text Area
- Header and Footer
- Font Selection
- Formatting Spacing
- Appearance of Index, Footnotes, etc.

Assignment

Download the file `exercise_layout.tex` from the workshop website. Apply all typographic settings discussed to this file step by step.
Ideally, choose values that meet the requirements for your upcoming thesis.

“Style

Format	one-sided DIN A4
Font Size	12 pt
Line Spread	1.5 pt
Alignment	justified (“Blocksatz”)
Left and right margin	3 cm

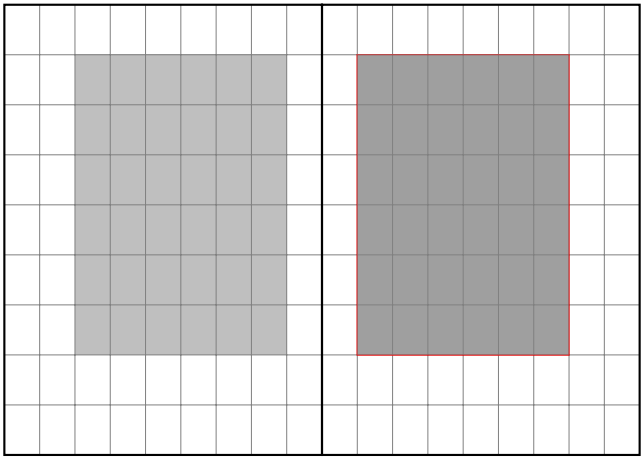
Guidelines for Bachelor theses ”

Text Area

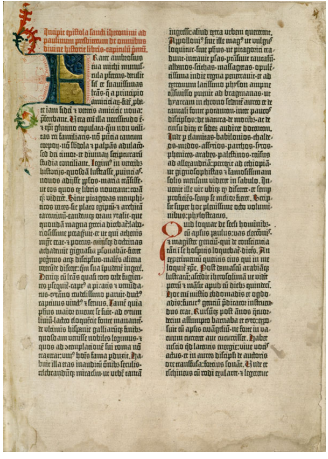
The text area refers to the portion of the page covered by the text (as opposed to the margins).

- Single or double-sided layout?
- Font size, line width,
- Header and footer
- Text columns

Modern Text Area Construction



Text Area in Gutenberg's Printing



Text Area with KOMA-Script

- KOMA-Script provides optimal text area construction through its own package `typearea`.
- Adjustment is usually necessary only for exceptionally wide or narrow fonts:
  Option `DIV=`⟨*Factor*⟩
  Automatic calculation based on page size: `DIV=calc`
  Calculation based on medieval book page canon: `DIV=classic`
- Binding correction using option `BCOR=`⟨*Length*⟩

```
\documentclass[DIV=9, BCOR=12mm]{scrbook}
```

For non-KOMA classes, `typearea` must be loaded directly:

```
\usepackage[DIV=13, BCOR=2cm]{typearea}
```

Text Area with geometry

Package geometry allows manual adjustment of the text area:

```
\usepackage[top=2cm, bottom=5cm]{geometry}
```

or:

```
\usepackage{geometry}
\geometry{top=2cm, bottom=5cm}
```

Text Area with geometry

Possible Options

paper
left, right, inner, outer, hmargin
top, bottom, vmargin
margin
bindingoffset, textwidth, textheight
twocolumn, columnsep, marginparsep, footnotesep
headsep, footsep, nofoot, nohead
hoffset, voffset, offset
includehead, includefoot

Line Spacing

Package setspace allows adjustment of line spacing:

```
\usepackage{setspace}
\singlespacing
\onehalfspacing
\doublespacing
```

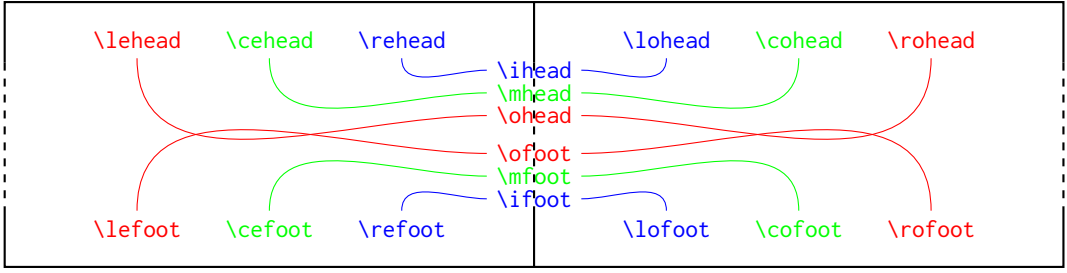
Spacing in footnotes, etc., remains the same.
Fine-tuning: \setstretch{⟨*Factor*⟩}

Headers and Footers

- Headers and footers contain important information about the document
  - Live column titles
  - Page numbers
- Adjustment using various packages
- Selection via `\pagestyle{`⟨*page style*⟩`}` or `\thispagestyle{`⟨*page style*⟩`}`
- Default settings: `empty`, `plain`, `headings`

Headers and Footers with scrlayer-scrpage

The package defines two page styles: `scrheadings` and `screadings.plain`
Adjustment is done through, e. g.
`\lehead[`⟨*content plain.scrheadings*⟩`]{`⟨*content scrheadings*⟩`}`




```
\documentclass{scrartcl}
\usepackage{scrlayer-scrpage}
\lohead*{Jane Smith}
\rohead*{Pagestyles with KOMA-Script}
\pagestyle{scrheadings}
```

Font Selection

- Many fonts are available as packages and can be loaded with \usepackage{⟨*package name*⟩}

```
\usepackage{nimbusserif}
```

- Fonts available in TEXlive can be found in the “LATEX Font Catalogue”
  http://www.tug.dk/FontCatalogue/

http://qn3.de/tex24

Font

- Package fontspec allows access to system fonts (OTF, AAT, TTF).
- Fonts are loaded via special commands
  `\setmainfont[⟨Options⟩]{⟨Font Name⟩}`

```
\usepackage{fontspec}
\setromanfont{Linux Libertine O}
\setsansfont{Linux Biolinum O}
\setmonofont[Scale=.95]{DejaVu Sans Mono}
```

- Loading specific fonts or features in the document with
  `\fontspec{⟨Font Name⟩}[⟨Features⟩]`

Font Size

The size of the main font can be changed by class option:

```
\documentclass[12pt]{scrartcl}
```

Size of `\large`, `\small`, etc. adjusts automatically.
Standard classes support `10pt`, `11pt`, and `12pt`.

For those who *know exactly* what they want:
`\fontsize{`⟨*Size*⟩`}{`⟨*Baseline Skip*⟩`}\selectfont`

```
\fontsize{10}{12}\selectfont
```

Implementation

Assignment

Adapt your document according to the specifications for bachelor theses!

Format	one-sided DIN A4
Font Size	12 pt
Line Spread	1.5
Alignment	justified
Left and right margin	3 cm

Environments

- LaTeX documents are often structured by environments:

```
\begin{⟨Environment⟩}[⟨Optional Arguments⟩]{⟨Arguments⟩}
...
\end{⟨Environment⟩}
```

- Commands are executed at the beginning and end to achieve specific behavior within the environment.
- Each environment is a group (like {})
  ⟹ All settings within an environment are local.

Environments

Important Environments

Itemization	`itemize`
Enumeration	`enumerate`
Description list	`description`
Verbatim	`verbatim`
Two-column layout	`twocolumn`
Quotation	`quotation`
Short quote	`quote`
Centered	`center`
Table	`tabular`, `tabularx`, `tabulary`, `supertabular` etc.
Figure	`figure`
Floating table	`table`
Equation	`align` (Math)
Matrix	`matrix` (Math)

Environments

Simple Lists

```
\begin{itemize}
  \item First item
  \item Second item
  \item[3] Third item
\end{itemize}
```

- First item
- Second item

3 Third item

```
\begin{enumerate}
  \item First item
  \item Second item
  \item[3] Third item
\end{enumerate}
```

1. First item
2. Second item

3 Third item

Appearance of `itemize` and `enumerate` is determined by document class.

Implementation

Assignment

Add one or more quotes to your document. Observe the difference between `quote` and `quotation`.
Also, test the appearance of other environments like `itemize` and `description`.

Microtypography

Microtypography refers to the design of fine details at the letter level:

protrusion Optical margin alignment

Lorem ipsum dolor sit amet consectetur, adipisici elit, sed eiusmod tempor incid-unt ut labore et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exer-citation ullamco laboris nisi ut aliquid ex ea commodi consequat. Quis aute iure reprehenderit in voluptate velit esse cil-lum dolore eu fugiat nulla pariatur. Excep-teur sint obcaecat cupiditat non proident, sunt in culpa qui officia deserunt mollit anim id est laborum.

Microtypography

Microtypography refers to the design of fine details at the letter level:

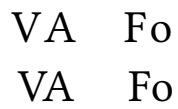
protrusion Optical margin alignment

expansion Adjustment of glyph width ($\leq 2\%$)

Microtypography

Microtypography refers to the design of fine details at the letter level:

protrusion	Optical margin alignment
expansion	Adjustment of glyph width (≤ 2%)
tracking	Adjustment of glyph spacing within words (≤ 3%)



Microtypography

Microtypography refers to the design of fine details at the letter level:

protrusion	Optical margin alignment
expansion	Adjustment of glyph width ($\leq 2\%$)
tracking	Adjustment of glyph spacing within words ($\leq 3\%$)
ligatures	Connection of multiple letters to a single glyph

fi fi
fl fl
ff ff
ffl ffl
Qu Qu

Microtypography

The package `microtype` takes care of these typographic subtleties.
Usually, the default settings are sufficient:

```
\usepackage{microtype}
```

- Automatically activates protrusion (in pdfTeX, XeTeX and LuaTeX) and expansion (in pdfTeX and LuaTeX)
- For further options: Documentation

Assignment

Activate optical margin alignment in your document.

Whitespace and Dashes

Good typography distinguishes between various width spaces and horizontal dashes

- normal space
- thin space: `\,`
- hair space: `\enskip`
- em space (white square): `\quad`
- negative space: `\!`
- explicit kerning: `a\kern-.1em b`

- en dash: `-`
- em dash, German hyphen: `--`
- horizontal bar, English hyphen: `---`
- minus sign: `$-$`

e.g. e.g. e.g.

a b

a b

ab

ab

a-b

a–b

a—b

$a - b$

$a + b$

Part IV

Documentation & Error Messages

Documentation

- (LA)TEX is excellently documented.
- Each class and package usually comes with its own manual.
- Documentation can be accessed using the `texdoc` command.

Documentation

On the command line:

- `$ texdoc` searches the LaTeX folders for documentation.
- `$ texdoc amsmath` opens `amsmath.pdf`.
- `$ texdoc -l amsmath` lists all results.
- `$ texdoc -s amsmath` provides results from an extended search.
- `$ texdoc --help` displays help.

Graphical interface: `texdoctk` / `texdoc-gui`
Web service: `http://texdoc.org`

Assignment

Open the English documentation of the KOMA-Script classes using the `texdoc` mechanism.

Handling Errors

What to do when LaTeX stops?

- Stay calm! (`tex` files cannot be damaged)
- Start troubleshooting with the latest changes.
- Correct any typos if necessary.
- Read the `log` file!
- Many editors assist in error detection by jumping to the line where the error occurred. (It may not be the faulty line.)

Error Messages

Typical error message:

```
! Undefined control sequence.
l.3 Ein \Latex-Dokument
                            .
?
! Emergency stop.
l.3 Ein \Latex-Dokument.
                            .
No pages of output.
Transcript written on document.log.
```

$\Longrightarrow$ Command misspelled in line 3

Error Messages

Typical error message:

```
Runaway argument?
{itemize \item First Item
! Paragraph ended before \begin was complete.
<to be read again>
                   \par
l.60

?
```

$\Longrightarrow$ Forgot a } or an \end{} somewhere after itemize.

Complete Minimal Working Example (MWE)

When seeking help in web forums/Usenet, a *complete minimal working example* (MWE) is usually requested.

1. Delete code from the document until only the error occurs.
2. Remove all unnecessary packages.
3. Use `minimal` if the document class does not matter.
4. If the error occurs only with a lot of text, use `blindtext`.

Often, you can find the error on your own while creating the MWE.

Assignment

Download the document `exercise_errors.tex` from the workshop homepage, create an MWE, and try to fix all errors if possible.

Part V

Languages

Languages

The document must be localized based on the input language.

- Hyphenation rules
- Names of directories, chapters, etc.
- Typographic peculiarities

```
\usepackage{polyglossia}
\setmainlanguage{english}
\setotherlanguage{german}
```

Loading Languages

`\setmainlanguage[`⟨*Options*⟩`]{`⟨*Language*⟩`}`
`\setotherlanguage[`⟨*Options*⟩`]{`⟨*Language*⟩`}`
`\setotherlanguages{`⟨*Languages*⟩`}`

Available Languages:

albanian	danish	icelandic	nko	slovenian
amharic	divehi	interlingua	norsk	spanish
arabic	dutch	irish	nynorsk	swedish
armenian	english	italian	occitan	syriac
asturian	esperanto	kannada	piedmontese	tamil
bahasai	estonian	khmer	polish	telugu
bahasam	farsi	korean	portuges	thai
basque	finnish	lao	romanian	tibetan
bengali	french	latin	romansh	turkish
brazil[ian]	friulan	latvian	russian	turkmen
breton	galician	lithuanian	samin	ukrainian
bulgarian	german	lsorbian	sanskrit	urdu
catalan	greek	magyar	scottish	usorbian
coptic	hebrew	malayalam	serbian	vietnamese
croatian	hindi	marathi	slovak	welsh
czech				

Switching Languages

Command \text⟨*Language*⟩{⟨*Text*⟩} for individual words
Environment \begin{⟨*Language*⟩} for longer passages

```
% in the preamble:
\setmainlanguage{english}
\setotherlanguages{french, greek}

% in the document:
The document body is in English, but single words can be in \textgreek{
ελληνικά} or \textfrench{français}.

\begin{french}
  Il est également possible d'écrire des phrases entières en français.
\end{french}
```

Localized Objects

Labels of elements in the text adapt to the language:

```
today is \today \\
\textgerman{heute ist der \today}\\
\textrussian{ сегодня, является \today }
```

today is 2024-03-01
heute ist der 1. März 2024
сегодня, является 1 марта 2024 г.

Assignment

Ensure correct hyphenation in at least two languages in your document.

Part VI

Floating Objects

What are Floating Objects?

- Objects that can freely “float” within the document
- Floating helps avoid large blank spaces
- TEX tries to achieve optimal positioning
- Considerations:
  - Objects should not appear before references
  - Objects should not swap order
  - Page breaks heavily depend on floating objects
  - *Optimal page breaks are not possible with TEX!*

Float Environments

A float environment consists of various parts:

- Content (image, table, text, ...)
- Automatic labeling: “Table 1:” (`\caption`)
- Caption: “Measurement results” (argument of `\caption{}`)
- Label for references: `\label{fig:comparison-data}`

- The label can be referenced in the text using `\ref{fig:comparison-data}`
- `\listoffigures` and `\listoftables` automatically create lists of figures and tables

Float Environments

- LaTeX provides various float environments:
- `table` for tables
- `figure` for images
- `float` package allows defining custom environments
- For two-column layout: `table*`, `figure*` spanning both columns

Float Environments

Positioning parameters for float environments:

`\begin{table}[`⟨*parameters*⟩`]`

- `!` Overrides internal parameters
- `h` Set object exactly at this point
- `t` Set object at the top of the page
- `b` Set object at the bottom of the page
- `p` Set object on a dedicated float page or column
- `H` “exactly here and nowhere else” – `float` package

table

```
\begin{table}
  \centering
  \begin{tabular}{ccc}
    a & b & c
  \end{tabular}
  \caption{A meaningless table}
  \label{tab:meaningless}
\end{table}

In the text, you can refer to Table
\ref{tab:meaningless}.
```

a b c

Table 1: A meaningless table

In the text, you can refer to Table 1.

Non-floating Float Environments

Present non-floating environments as floating environments:

caption package

```
A small image in a text that is not really an image:

\begin{minipage}[b]{3cm}
  \fbox{ I am not an image }
  \captionof{figure}{test}
\end{minipage}

In the \verb/minipage/, any content can be placed \dots
```

A small image in a text that is not really an image:

I am not an image

Figure 1: test

In the `minipage`, any content can be placed ...

Including External Graphics

```
\usepackage{graphicx}
```

- Basic command: `\includegraphics[`⟨*options*⟩`]{`⟨*file*⟩`}`
- `key=value` interface:

  `[scale = 0.5, angle=50]`
- File extension is not required
- Avoid using absolute path names (portability)

Including Graphics

```
\includegraphics[width=2cm]{raptor.pdf}
\includegraphics[width=.3\textwidth,angle=25]{raptor}
```

Options for includegraphics

\includegraphics has many options, e.g.,

scale	0.8
width	.2\textwidth, 15pt, ...
height	2em, 40mm, ...
keepaspectratio	true or false
angle	50
bb	0 0 10 20
clip	true or false

⟹ see documentation for graphicx

Multiple Images in One Figure

```
\usepackage{subcaption}

\begin{figure}
  \begin{subfigure}{.5\textwidth}
    \includegraphics{image1}
    \caption{First subfigure}
  \end{subfigure}
  \begin{subfigure}{.5\textwidth}
    \includegraphics{image2}
    \caption{Second subfigure}
  \end{subfigure}
  \caption{Caption for both images}
\end{figure}
```

The subcaption package provides the subfigure environment within the figure environment.

Further Reading I


Frank Mittelbach and Ulrike Fischer.
"The LaTeX companion."
Addison-Wesley, 2023.


Tobias Oetiker et al.
"The (Not So) Short Introduction to LaTeX 2_ε."
`texdoc lshort`


Robert Bringhurst.
"The Elements of Typographic Style."
Vancouver: Hartley & Marks, 1992.


Markus Kohm.
"KOMA-Script."
`texdoc koma-script`
2023.

Further Reading II

Robert Schlicht.
"The `microtype` package. Subliminal refinements towards typographical perfection."
`texdoc microtype`

Arthur Reutenauer, François Charette, and Elie Roux.
"polyglossia: An Alternative to Babel for XeLaTeX and LuaLaTeX."
`texdoc polyglossia`

Michael Goossens, Sebastian Rahtz, and Frank Mittelbach.
"The LaTeX Graphics Companion."
Addison-Wesley, 2008.

Happy TEXing