

L^AT_EX

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L^AT_EX for Beginners

A Comprehensive Guide

Mat Salim Selamat

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Universiti Teknologi MARA Negeri Sembilan Branch
Seremban Campus

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Preface

This book is designed to introduce beginners to $\text{\LaTeX}$, a powerful document preparation system widely used in academia and scientific publishing. The material progresses from basic concepts to advanced applications, with practical examples throughout.

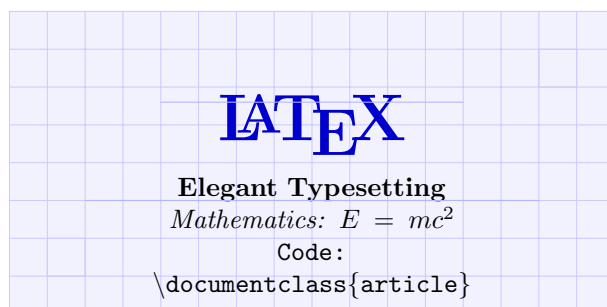


Figure 1: The $\text{\LaTeX}$ logo and its elegant typesetting

Who This Book Is For:

- Students writing theses, dissertations, or research papers
- Academics and researchers preparing publications
- Professionals creating technical documentation
- Anyone who wants to create beautiful, professional documents
- Beginners with no prior $\text{\LaTeX}$ experience

How This Book Is Organized

This book is organized into chapters that progressively build your $\text{\LaTeX}$ knowledge:

1. **Chapters 1-3:** Introduction and basic setup
2. **Chapters 4-7:** Text formatting, lists, tables, and figures
3. **Chapters 8-10:** Mathematics, cross-references, and bibliography
4. **Chapters 11-12:** Troubleshooting and advanced topics
5. **Chapters 13-17:** Exercises, resources, best practices, and examples

1. Introduction to L^AT_EX

1.1 What is L^AT_EX?

L^AT_EX (pronounced “LAY-tek” or “LAH-tek”) is a document preparation system for creating professional-looking documents. Unlike word processors (Microsoft Word, Google Docs), L^AT_EX uses plain text with markup commands to define the document’s structure and formatting. This separation of content from formatting ensures consistent and professional output, making it ideal for academic and scientific documents.

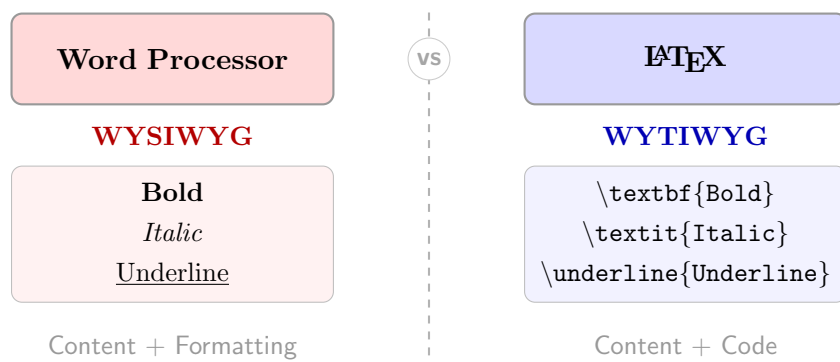


Figure 1.1: Comparison of document creation approaches

1.1.1 Key Features

- Professional typesetting for mathematical and scientific documents
- Automatic numbering of sections, equations, figures, and tables
- Superior handling of complex mathematical formulas
- Bibliography management with BibTeX/BibLaTeX
- Free and open-source software
- Platform independent (Windows, macOS, Linux)
- Excellent for large documents (theses, books, reports)

1.2 L^AT_EX vs. Word Processors

L^AT_EX and word processors take fundamentally different approaches to document creation. L^AT_EX separates content from formatting using markup commands, while word processors mix content and formatting.

Table 1.1: Comparison between L^AT_EX and word processors

L ^A T _E X	Word Processors
Separates content from formatting using markup commands	Combines content and formatting directly in the document
Consistent formatting across large documents	Formatting inconsistencies may arise in long documents
Superior mathematical typesetting	Limited support for complex mathematics
Automatic numbering and cross-referencing	Manual numbering often required
Efficient for large documents (books, theses)	Performance may degrade for very large files
Free and open-source	Often requires paid licenses
Steeper initial learning curve	Easier to learn initially

1.2.1 Try It Yourself

Create a simple document with the following content:

Code Example

```
\documentclass{article}
\begin{document}
My first LaTeX document!
\end{document}
```

Save it as `first.tex`, compile it, and view the PDF output. This is your first step in learning L^AT_EX!

2. Getting Started

2.1 Software Installation

There are two main approaches to using $\text{\LaTeX}$: through online editors or local installation. Online editors like Overleaf are highly recommended for beginners as they are easy to use and require no installation.

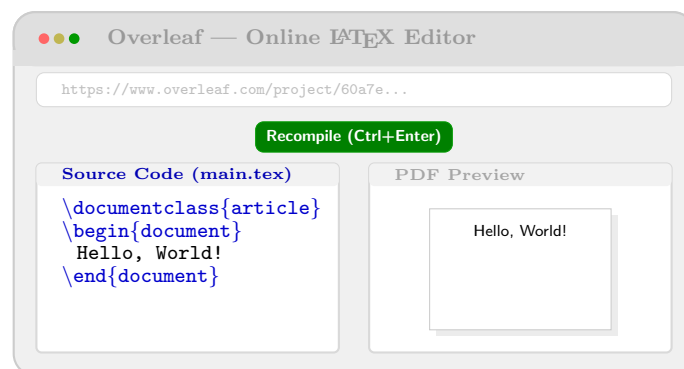


Figure 2.1: Overleaf online $\text{\LaTeX}$ editor interface

2.1.1 Option 1: Online Editors (Recommended for Beginners)

Overleaf - The Best Choice for Beginners

Overleaf (<https://www.overleaf.com>) is the most popular online $\text{\LaTeX}$ platform with the following features:

- No installation required: Access through web browser
- Real-time collaboration: Multiple users can edit the same document
- Templates and tutorials: Various templates for different document types
- Automatic compilation: Generate PDF automatically
- Cloud storage: Documents saved in cloud with automatic backup

Other Alternatives:

- ShareLaTeX (now merged with Overleaf)
- CoCalc (<https://cocalc.com>) for scientific computing

2.1.2 Option 2: Local Installation

For local installation, you need two components: a $\text{\LaTeX}$ distribution and a $\text{\LaTeX}$ editor.

$\text{\LaTeX}$ Distributions

- **TeX Live** (<https://tug.org/texlive/>) - Comprehensive distribution for all platforms
- **MiKTeX** (<https://miktex.org/>) - For Windows with automatic package installation
- **MacTeX** (<https://tug.org/mactex/>) - TeX Live version for macOS

Recommended Editors

- **TeXstudio** (<https://www.texstudio.org/>) - Feature-rich, cross-platform
- **WinEdt** (<https://www.winedt.com/>) - Specialized editor for Windows users
- **VS Code with LaTeX Workshop** - For programmers comfortable with VS Code
- **TeXmaker** (<http://www.xmmath.net/texmaker/>) - Simple, cross-platform
- **AUCTeX with Emacs** - For power users of Emacs

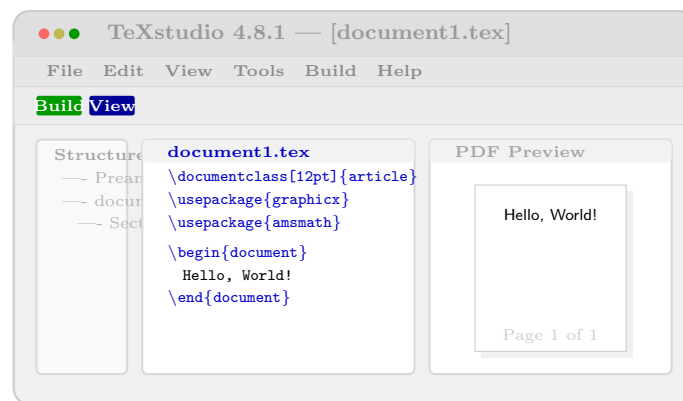


Figure 2.2: TeXstudio $\text{\LaTeX}$ editor interface

2.2 Installation Steps

Basic steps include downloading a TeX distribution, installing an editor (e.g., TeXstudio), and testing with a minimal document.

1. Download and install a LaTeX distribution (TeX Live, MiKTeX, or MacTeX)
2. Install a LaTeX editor of your choice (TeXstudio, WinEdit, etc.)
3. Test the installation with a basic LaTeX document
4. Learn basic compilation commands (pdflatex, bibtex, etc.)

2.2.1 Common Installation Issues

- **Permission errors:** Run installer as administrator
- **Missing packages:** Use package manager to install missing packages
- **Path issues:** Ensure LaTeX binaries are in system PATH
- **Font problems:** Install recommended fonts

3. Basic Document Structure

The most basic $\text{\LaTeX}$ document consists of:

1. Document class declaration
2. Document content within the document environment

Code Example

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

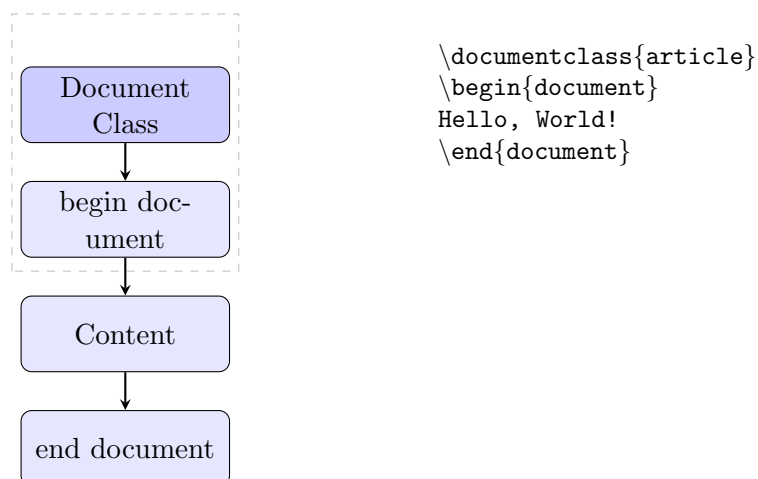
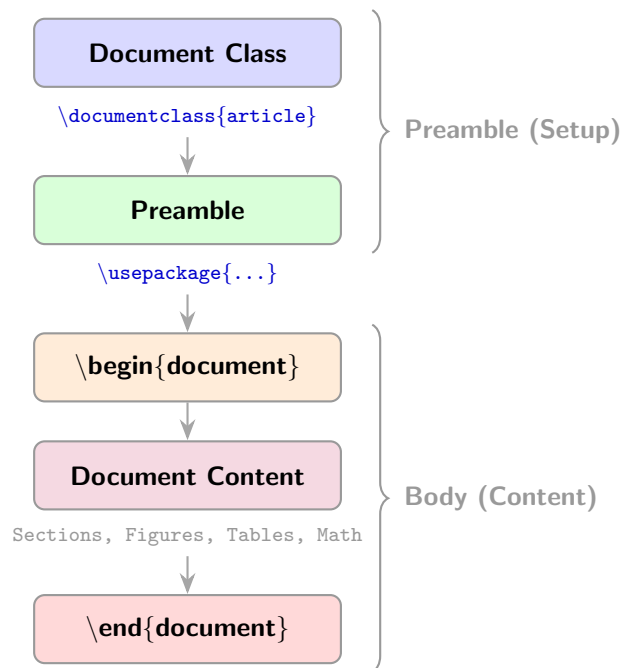


Figure 3.1: Minimal $\text{\LaTeX}$ document structure

This structure produces a PDF with the text “Hello, LaTeX World!”

3.1 Complete Document Structure

A complete $\text{\LaTeX}$ document has a more complex structure, comprising the preamble (packages, title), front matter (title, table of contents), main content, and back matter (bibliography, appendices).

Figure 3.2: Complete $\text{\LaTeX}$ document structure

Code Example

```

\documentclass[12pt,a4paper]{article} % Document class with options
% Preamble - packages and settings
\usepackage{graphicx} % For including images
\usepackage{amsmath} % For mathematics
\usepackage{hyperref} % For hyperlinks
% Document information
\title{Document Title}
\author{Author Name}
\date{\today}
\begin{document} % Start of document body
% Front matter
\maketitle % Generate title
\tableofcontents % Generate table of contents
\listoffigures % Generate list of figures (optional)
\listoftables % Generate list of tables (optional)
% Main content
\section{Introduction}
Document content goes here.
% Back matter
\bibliographystyle{plain}
\bibliography{references}
% Appendices (optional)
\appendix
\section{Appendix Title}
Appendix content.
\end{document} % End of document
  
```

3.2 Document Classes

Document classes determine the type of document being produced.

Table 3.1: Common L^AT_EX document classes

Class	Usage	Description
article	Articles, papers	Short documents without chapters
report	Reports, theses	Longer documents with chapters
book	Books	Double-sided printing, chapters, parts
beamer	Presentations	Slides with animations
letter	Letters	Formal letters
proc	Conference proceedings	Two-column format
memoir	Complex books	Highly customizable
exam	Exams	Questions and solutions

3.3 Document Class Options

Document class options allow customization of the document format. Options such as font size, paper size, and layout can be specified when declaring the document class.

Code Example

```
\documentclass[12pt,a4paper,twocolumn]{article}
% Options:
% - 10pt, 11pt, 12pt: Font size
% - a4paper, letterpaper: Paper size
% - twocolumn: Two-column layout
% - landscape: Landscape orientation
% - draft: Mark overfull boxes
% - final: Final version (default)
```

Common options include:

1. Font size: 10pt, 11pt, 12pt (default: 10pt)
2. Paper size: a4paper, letterpaper, a5paper
3. Layout: twocolumn, landscape
4. Mode: draft (mark overfull boxes), final (final version)

4. Text Formatting

L^AT_EX supports bold, italic, underline, monospace, small caps, and emphasis through commands.

4.1 Font Styles

Code Example

```
\textbf{Bold text} % Bold
\textit{Italic text} % Italic
\underline{Underlined} % Underline
\texttt{Typewriter} % Monospace
\textsc{Small Caps} % Small capitals
\emph{Emphasized} % Emphasis (context-sensitive)
```

Font Styles in L^AT_EX

COMMAND	OUTPUT
<code>\textbf{Bold}</code>	Bold
<code>\textit{Italic}</code>	<i>Italic</i>
<code>\underline{Underline}</code>	<u>Underline</u>
<code>\texttt{Typewriter}</code>	Typewriter
<code>\textsc{Small Caps}</code>	SMALL CAPS

Figure 4.1: Font style examples in L^AT_EX

Table 4.1: Font style commands in L^AT_EX

Command	Style
<code>\textbf{text}</code>	Bold text
<code>\textit{text}</code>	<i>Italic text</i>
<code>\underline{text}</code>	<u>Underlined text</u>
<code>\texttt{text}</code>	Typewriter text
<code>\textsc{text}</code>	SMALL CAPS TEXT
<code>\emph{text}</code>	<i>Emphasized text</i>

4.2 Font Sizes

Font sizes can be changed using commands or via document class options.

Table 4.2: Font size commands in $\text{\LaTeX}$

Command	Size
<code>\tiny</code>	tiny text
<code>\scriptsize</code>	scriptsize text
<code>\footnotesize</code>	footnotesize text
<code>\small</code>	small text
<code>\normalsize</code>	normal text
<code>\large</code>	large text
<code>\Large</code>	Large text
<code>\LARGE</code>	LARGE text
<code>\huge</code>	huge text
<code>\Huge</code>	Huge text

4.3 Text Alignment

Text can be left-aligned, right-aligned, centered, or justified using specific environments.

Code Example

```
\begin{center}
This text is centered.
\end{center}

\begin{flushleft}
This text is left-aligned.
\end{flushleft}

\begin{flushright}
This text is right-aligned.
\end{flushright}
```

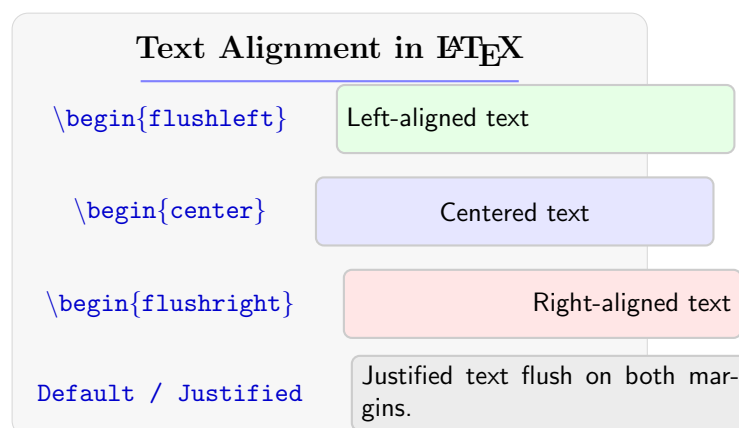


Figure 4.2: Text alignment environments and visual output

4.4 Special Characters

Certain special characters require special commands in $\text{\LaTeX}$:

Table 4.3: Special characters in $\text{\LaTeX}$

Character	Command
\$	<code>\\$</code>
%	<code>\%</code>
#	<code>\#</code>
&	<code>\&</code>
{	<code>\{</code>
}	<code>\}</code>
-	<code>_</code>
\	<code>\textbackslash</code>

5. Lists

5.1 Bulleted Lists (Itemize)

Creates unordered lists with bullet points.

Code Example

```
\begin{itemize}
\item First item
\item Second item
\item Third item
\end{itemize}
```

Output:

- First item
- Second item
- Third item

5.2 Numbered Lists (Enumerate)

Generates automatically numbered lists.

Code Example

```
\begin{enumerate}
\item First item
\item Second item
\item Third item
\end{enumerate}
```

Output:

1. First item
2. Second item
3. Third item

5.3 Description Lists

Used for lists with terms and their descriptions.

Code Example

```
\begin{description}
\item[Term 1] Description of term 1
\item[Term 2] Description of term 2
\item[Term 3] Description of term 3
\end{description}
```

Output

Term 1 Description of term 1

Term 2 Description of term 2

Term 3 Description of term 3

5.4 Nested Lists

Lists can be nested within other lists.

Code Example

```
\begin{enumerate}
\item First main item
\begin{itemize}
\item First sub-item
\item Second sub-item
\begin{description}
\item[Detail] More information
\item[Note] Important note
\end{description}
\end{itemize}
\item Second main item
\end{enumerate}
```

5.5 Customizing Lists

The `enumitem` package allows customization of bullet styles, numbering, and list layout.

Code Example

```

\usepackage{enumitem} % Add to preamble

% Custom bullet points
\begin{itemize}[label=$\star$]
\item Star item
\end{itemize}

% Custom numbering
\begin{enumerate}[label=\alph*]
\item Letter a
\item Letter b
\end{enumerate}

% Resume numbering
\begin{enumerate}[resume]
\item Continues from previous list
\end{enumerate}

% Inline lists
\begin{itemize*}[label=\textendash]
\item Inline item 1
\item Inline item 2
\end{itemize*}

```

Unordered (itemize)

- First item
- Second item
- Third item

Ordered (enumerate)

1. First item
2. Second item
3. Third item

Nested List Structure

- | | |
|-----------------------------|--------------------------------|
| 1. Main section item | <code>\begin{enumerate}</code> |
| • Sub-item level 1 | <code>\begin{itemize}</code> |
| • Sub-item level 1 | |
| — Detail level 2 | <code>\begin{itemize}</code> |
| — Detail level 2 | |
| 2. Second main section item | |

Figure 5.1: List environment structure and nesting examples in L^AT_EX

6. Tables

6.1 Basic Table Structure

Tables are built using the `tabular` environment with column specifiers.

Code Example

```
\begin{tabular}{lcr} % l=left, c=center, r=right
\hline
Left & Center & Right \\
\hline
Apple & 10 & \$1.00 \\
Orange & 5 & \$0.75 \\
Banana & 8 & \$0.50 \\
\hline
\end{tabular}
```

Table 6.1: Basic table example

Left	Center	Right
Apple	10	\$1.00
Orange	5	\$0.75
Banana	8	\$0.50

6.2 Professional Tables with `booktabs`

The `booktabs` package produces more professional tables without vertical lines.

Code Example

```
\usepackage{booktabs} % Add to preamble

\begin{tabular}{lcc}
\toprule
Fruit & Quantity & Price \\
\midrule
Apple & 10 & \$1.00 \\
Orange & 5 & \$0.75 \\
Banana & 8 & \$0.50 \\
\bottomrule
\end{tabular}
```

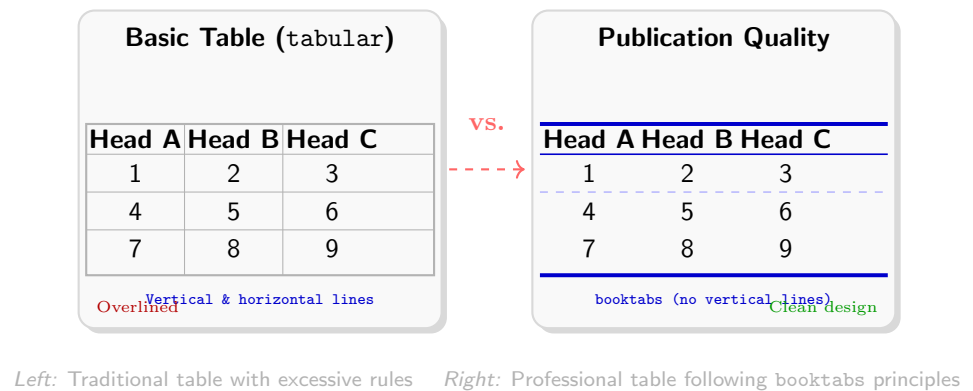


Figure 6.1: Comparison of basic and professional table styles

Table 6.2: Professional table with `booktabs`

Fruit	Quantity	Price
Apple	10	\$1.00
Orange	5	\$0.75
Banana	8	\$0.50

6.3 Multi-row and Multi-column Cells

The `multirow` and `multicolumn` packages allow merging cells.

Code Example

```

\usepackage{multirow} % Add to preamble

\begin{tabular}{|c|c|c|}
\hline
\multirow{2}{*}{Item} & \multicolumn{2}{c|}{Details} \\
\cline{2-3}
& Quantity & Price \\
\hline
Apple & 10 & \$1.00 \\
Orange & 5 & \$0.75 \\
\hline
\end{tabular}

```

Table 6.3: Multi-row and multi-column cells

Item	Details	
	Quantity	Price
Apple	10	\$1.00
Orange	5	\$0.75

6.4 The Table Environment

The `table` environment provides automatic numbering and captions:

Code Example

```

\begin{table}[h!]
\centering
\caption{Example table with fruits and prices}
\label{tab:fruits}
\begin{tabular}{lcc}
\toprule
Fruit & Quantity & Price \\
\midrule
Apple & 10 & \$1.00 \\
Orange & 5 & \$0.75 \\
Banana & 8 & \$0.50 \\
\bottomrule
\end{tabular}
\end{table}

```

6.5 Advanced Table Features

Advanced table features include:

- Fixed column width: `p{3cm}`, `m{3cm}`, `b{3cm}`
- Decimal alignment: Use the `siunitx` package

- Colored rows: Use the `xcolor` package

Code Example

```
% Fixed column width
\begin{tabular}{p{3cm} p{5cm} r}
Column 1 & Column 2 & Column 3 \\
\end{tabular}

% Colored rows
\usepackage[table]{xcolor}
\rowcolors{2}{gray!10}{white}
\begin{tabular}{ll}
Header 1 & Header 2 \\
Row 1 & Data \\
Row 2 & Data \\
\end{tabular}
```

7. Figures and Images

7.1 Including Images

Images are included with `\includegraphics` from the `graphicx` package.

Code Example

```
\usepackage{graphicx} % Add to preamble

\begin{figure}[h!]
\centering
\includegraphics[width=0.5\textwidth]{example-image}
\caption{Description of the image}
\label{fig:example}
\end{figure}
```

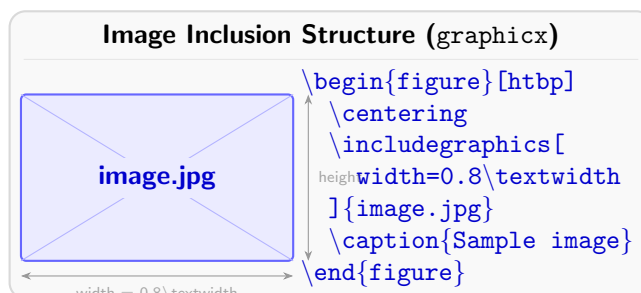


Figure 7.1: Sample image inclusion in $\text{\LaTeX}$

7.2 Image Options

Size, rotation, and clipping can be controlled via options.

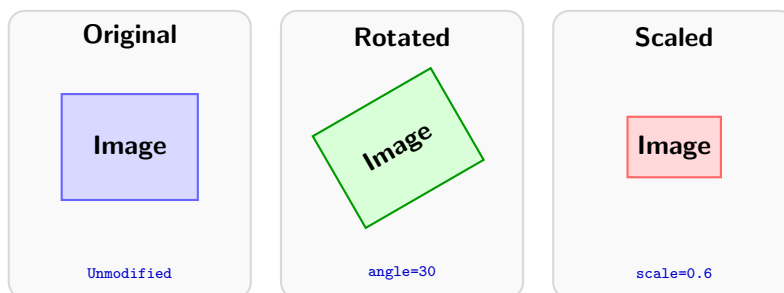


Figure 7.2: Image transformation options in $\text{\LaTeX}$

Table 7.1: Common `includegraphics` options

Option	Description
<code>width=0.5\textwidth</code>	Relative to text width
<code>height=5cm</code>	Fixed height
<code>scale=0.3</code>	Scale factor
<code>angle=45</code>	Rotation (degrees)
<code>keepaspectratio</code>	Maintain aspect ratio
<code>clip</code>	Clip to specified size
<code>trim=left bottom right top</code>	Trim edges

7.3 Multiple Images (Subfigures)

The `subcaption` package allows multiple images within one figure.

Code Example

```
\usepackage{subcaption} % Add to preamble

\begin{figure}[h!]
\centering
\begin{subfigure}[c]{0.45\textwidth}
  \includegraphics[width=\textwidth]{image1}
  \caption{First image}
  \label{fig:image1}
\end{subfigure}
\hfill
\begin{subfigure}[c]{0.45\textwidth}
  \includegraphics[width=\textwidth]{image2}
  \caption{Second image}
  \label{fig:image2}
\end{subfigure}
\caption{Two related images showing comparison.}
\label{fig:both}
\end{figure}
```

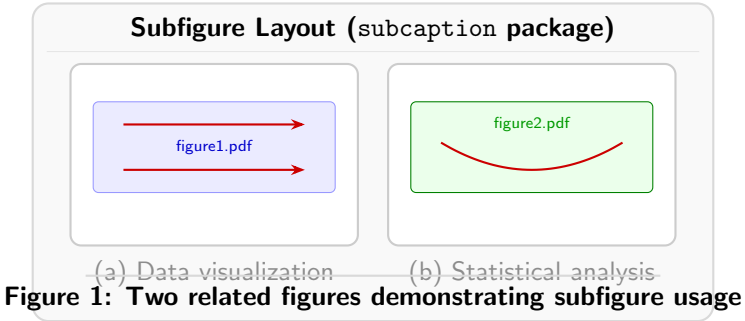


Figure 7.3: Structure and layout of subfigures in $\text{\LaTeX}$

7.4 Image Placement Specifiers

Placement options control where the figure appears in the document.

Table 7.2: Figure placement specifiers

Specifier	Meaning
h	Place approximately here
t	Place at top of page
b	Place at bottom of page
p	Place on special page for floats
!	Override internal parameters
H	Place exactly here (requires <code>float</code> package)

7.5 Image File Formats

Recommended formats for different use cases:

- PDF: Best for vector graphics (charts, diagrams)
- EPS: Legacy vector format (convert to PDF when possible)
- PNG: Best for photos with transparency
- JPEG: Good for photographs without transparency
- SVG: Convert to PDF for best results

8. Mathematical Equations

8.1 Math Environments

Includes inline math ($\dots$), numbered equations (`equation`), and aligned equations (`align`).

Code Example

```
\usepackage{amsmath} % Enhanced math support

% Inline math
Einstein's equation:  $E = mc^2$ 

% Display math (unnumbered)

$$E = mc^2$$


% Numbered equations
\begin{equation}
E = mc^2
\label{eq:emc2}
\end{equation}

% Multiple equations with alignment
\begin{align}
f(x) &= (x+1)^2 \quad \text{\nonumber} \\
&= x^2 + 2x + 1
\end{align}

% Cases
\begin{cases}
x^2 & \text{if } x \geq 0 \\
-x^2 & \text{if } x < 0
\end{cases}
```

Output

- Inline: $E = mc^2$
- Display:

$$E = mc^2$$
- Numbered:

$$E = mc^2 \tag{8.1}$$
- Aligned:

$$\begin{aligned} f(x) &= (x + 1)^2 \\ &= x^2 + 2x + 1 \end{aligned} \tag{8.2}$$
- Cases:

$$f(x) = \begin{cases} x^2 & \text{if } x \geq 0 \\ -x^2 & \text{if } x < 0 \end{cases}$$

Mathematical Typesetting in L ^A T _E X		
TYPE	LATEX CODE	RENDERED OUTPUT
Inline	<code>\$E = mc^2\$</code>	$E = mc^2$
Display	<code>\[E = mc^2 \]</code>	$E = mc^2$
Aligned	<code>\begin{aligned} f(x) &= (x+1)^2 \\ &= x^2 + 2x + 1 \end{aligned}</code>	$\begin{aligned} f(x) &= (x + 1)^2 \\ &= x^2 + 2x + 1 \end{aligned}$
Cases	<code>\begin{cases} x^2 & x \geq 0 \\ -x^2 & x < 0 \end{cases}</code>	$f(x) = \begin{cases} x^2 & x \geq 0 \\ -x^2 & x < 0 \end{cases}$

Figure 8.1: Mathematical typesetting in L^AT_EX

8.2 Common Mathematical Symbols

8.3 Matrices

Various matrix types: `matrix`, `pmatrix`, `bmatrix`, `Bmatrix`.

Table 8.1: Common mathematical symbols

Symbol	LaTeX Command	Example
Greek letters	<code>\alpha</code> , <code>\beta</code> , <code>\Gamma</code>	α , β , Γ
Fractions	<code>\frac{a}{b}</code>	$\frac{a}{b}$
Square root	<code>\sqrt{x}</code> , <code>\sqrt[n]{x}</code>	$\sqrt{x}$, $\sqrt[n]{x}$
Superscript	<code>x^2</code> , <code>x^{n+1}</code>	x^2 , x^{n+1}
Subscript	<code>x_1</code> , <code>x_{ij}</code>	x_1 , x_{ij}
Summation	<code>\sum_{i=1}^n</code>	$\sum_{i=1}^n$
Integral	<code>\int_a^b</code>	$\int_a^b$
Derivatives	<code>\frac{d}{dx}</code> , <code>\partial</code>	$\frac{d}{dx}$, ∂
Infinity	<code>\infty</code>	∞
Arrows	<code>\to</code> , <code>\rightarrow</code> , <code>\Leftrightarrow</code>	$\rightarrow$, $\rightarrow$, $\Leftrightarrow$

Code Example

```
% Plain matrix
\[
\begin{matrix}
a & b \\
c & d
\end{matrix}
\]

% Parentheses (pmatrix)
\[
\begin{pmatrix}
a & b \\
c & d
\end{pmatrix}
\]

% Brackets (bmatrix)
\[
\begin{bmatrix}
a & b \\
c & d
\end{bmatrix}
\]

% Braces (Bmatrix)
\[
\begin{Bmatrix}
a & b \\
c & d
\end{Bmatrix}
\]

% Determinant (vmatrix)
\[
\begin{vmatrix}
a & b \\
c & d
\end{vmatrix}
\]
```

<code>pmatrix</code>	<code>bmatrix</code>	<code>vmatrix</code>
$\begin{pmatrix} a & b \\ c & d \end{pmatrix}$	$\begin{bmatrix} a & b \\ c & d \end{bmatrix}$	$\begin{vmatrix} a & b \\ c & d \end{vmatrix}$
Parentheses	Brackets	Vertical Bars

Augmented Matrix (<code>array</code> environment)	
$\left[\begin{array}{cc c} 1 & 2 & 3 \\ 4 & 5 & 6 \end{array} \right]$	<pre>\left[\begin{array}{cc c} 1 & 2 & 3 \\ 4 & 5 & 6 \end{array} \right]</pre>

Figure 8.2: Matrix typesetting examples in L^AT_EX

8.4 Advanced Mathematical Typesetting

Code Example

```
% Multiple lines with alignment
\begin{align}
\nabla \cdot \mathbf{E} &= \frac{\rho}{\epsilon_0} \\
\nabla \cdot \mathbf{B} &= 0 \\
\nabla \times \mathbf{E} &= -\frac{\partial \mathbf{B}}{\partial t} \\
\nabla \times \mathbf{B} &= \mu_0 \mathbf{J} + \\
&\mu_0 \epsilon_0 \frac{\partial \mathbf{E}}{\partial t}
\end{align}

% Subequations
\begin{subequations}
\begin{align}
a &= b + c \quad \text{\label{eq:1a}} \\
d &= e + f \quad \text{\label{eq:1b}}
\end{align}
\end{subequations}

% Piecewise function
\[
\operatorname{sgn}(x) =
\begin{cases}
-1 & \text{if } x < 0, \\
0 & \text{if } x = 0, \\
1 & \text{if } x > 0.
\end{cases}
\]

% Mathematical operators
\DeclareMathOperator{\Var}{Var}
\DeclareMathOperator{\Cov}{Cov}
\[
\operatorname{Var}(X) = \operatorname{E}[X^2] - (\operatorname{E}[X])^2
\]
```

9. Cross-References and Labels

9.1 Labeling Elements

Sections, tables, figures, and equations can be labeled with `\label`.

Code Example

```
\section{Introduction}
\label{sec:intro}

\begin{figure}[h!]
\centering
\includegraphics[width=0.5\textwidth]{example}
\caption{Sample figure}
\label{fig:example}
\end{figure}

\begin{table}[h!]
\centering
\caption{Sample table}
\label{tab:example}
\begin{tabular}{cc}
A & B \\
1 & 2
\end{tabular}
\end{table}

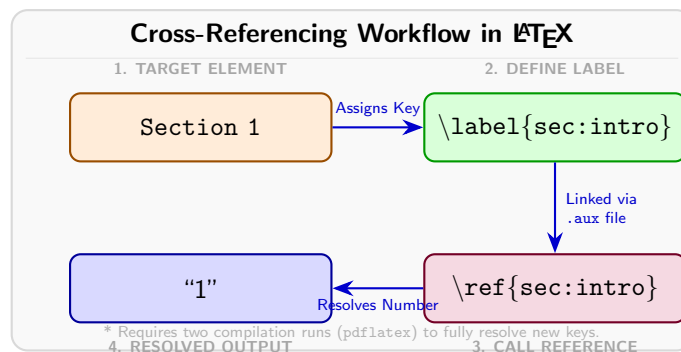
\begin{equation}
E = mc^2
\label{eq:emc2}
\end{equation}
```

9.2 Referring to Labels

References are made using `\ref`, `\pageref`, or `\eqref`.

Code Example

```
As shown in Section~\ref{sec:intro}, ...
Figure~\ref{fig:example} shows ...
Table~\ref{tab:example} presents ...
Equation~\eqref{eq:emc2} is famous.
```

Figure 9.1: Cross-referencing workflow in $\text{\LaTeX}$

9.3 Using the cleveref Package

The `cleveref` package provides intelligent and consistent cross-referencing.

Code Example

```
\cref{sec:intro} % "Section 1"
\Cref{sec:intro} % "Section 1" (capitalized)
\cref{eq:emc2} % "Equation (1)"
\cref{fig:example,tab:example} % "Figures 1 and 2"
\cpageref{sec:intro} % "on page 1"
```

9.4 Automatic Numbering

$\text{\LaTeX}$ automatically numbers:

- Sections, subsections, subsubsections
- Equations (in `equation` environment)
- Figures (in `figure` environment)
- Tables (in `table` environment)
- Pages (through `\pageref`)
- Footnotes (through `\footnote`)

10. Bibliography and Citations

10.1 Using BibTeX

The .bib file stores reference information.

10.1.1 Creating a .bib File

Code Example

```
@article{einstein1905,
  author = {Albert Einstein},
  title = {On the Electrodynamics of Moving Bodies},
  journal = {Annalen der Physik},
  volume = {322},
  number = {10},
  pages = {891-921},
  year = {1905},
  doi = {10.1002/andp.19053221004}
}

@book{knuth1984,
  author = {Donald E. Knuth},
  title = {The \TeX book},
  publisher = {Addison-Wesley},
  year = {1984},
  isbn = {0-201-13448-9}
}

@inproceedings{conference2023,
  author = {Author One and Author Two},
  title = {Conference Paper Title},
  booktitle = {Proceedings of Important Conference},
  pages = {100-110},
  year = {2023},
  publisher = {Springer}
}

@phdthesis{thesis2022,
  author = {Student Name},
  title = {PhD Thesis Title},
  school = {University Name},
  year = {2022}
}

@online{website2024,
  author = {Organization},
  title = {Webpage Title},
  url = {https://example.com},
  year = {2024},
  urldate = {2024-12-01}
}
```

10.1.2 Citing in Your Document

Code Example

```
\usepackage{natbib} % Better citation management

% Basic citations
\cite{einstein1905} % [1]
\citet{einstein1905} % Einstein (1905)
\citep{einstein1905} % (Einstein, 1905)

% Multiple citations
\cite{einstein1905, knuth1984} % [1,2]
\citep{einstein1905, knuth1984} % (Einstein, 1905; Knuth, 1984)

% Author and year only
\citeauthor{einstein1905} % Einstein
\citeyear{einstein1905} % 1905

% No citation in text, but include in bibliography
\nocite{einstein1905}
\nocite{*} % Include all entries from .bib file
```

10.1.3 Generating Bibliography

Code Example

```
% At the end of your document
\bibliographystyle{plainnat} % or apa, ieetr, acm, etc.
\bibliography{references} % without .bib extension
```

10.2 Bibliography Styles

Table 10.1: Bibliography styles

Style	Description
plain	Numbered references, alphabetical order
unsrt	Numbered references, citation order
abbrv	Abbreviated names and months
alpha	Alphanumeric labels (e.g., [Ein05])
ieetr	IEEE style
acm	ACM style
apa	APA style (requires natbib)
chicago	Chicago style
amsplain	AMS style

10.3 BibLaTeX (Modern Alternative)

A modern alternative with more customization options.

Code Example

```

\usepackage[style=authoryear,backend=biber]{biblatex}
\addbibresource{references.bib}

% In document
\printbibliography

% Citations
\autocite{einstein1905} % (Einstein, 1905)
\textcite{einstein1905} % Einstein (1905)
\parencite{einstein1905} % (Einstein, 1905)

```

10.4 Compilation Workflow

Compilation steps for documents with citations: $\text{\LaTeX} \rightarrow \text{BibTeX} \rightarrow \text{\LaTeX}(\text{twice})$.

1. `pdflatex document.tex` - Creates `.aux` file with citation info
2. `bibtex document` - Processes citations from `.bib` file
3. `pdflatex document.tex` - Inserts citations into document
4. `pdflatex document.tex` - Final formatting and reference resolution

Note: Most editors automate this process.

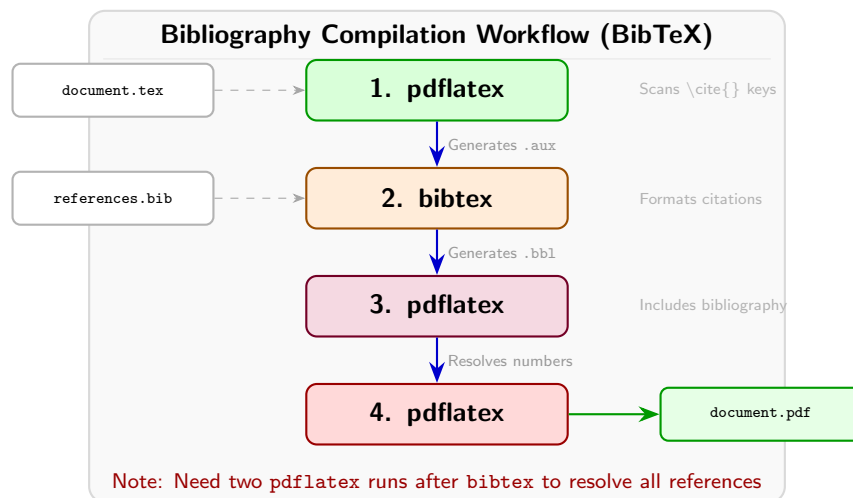


Figure 10.1: Bibliography compilation workflow using BibTeX

11. Troubleshooting Common Problems

11.1 Common Error Messages

Table 11.1: Common L^AT_EX errors and solutions

Error	Solution
Missing \$ inserted	Add \$ around math expressions
Undefined control sequence	Check spelling of commands
File not found	Check file path and extension
Overfull \hbox	Add line break or adjust text
Too many unprocessed floats	Add [!ht] or reduce floats per page
Package not available	Install missing package
Citation undefined	Run BibTeX and compile twice
Label multiply defined	Use unique label names

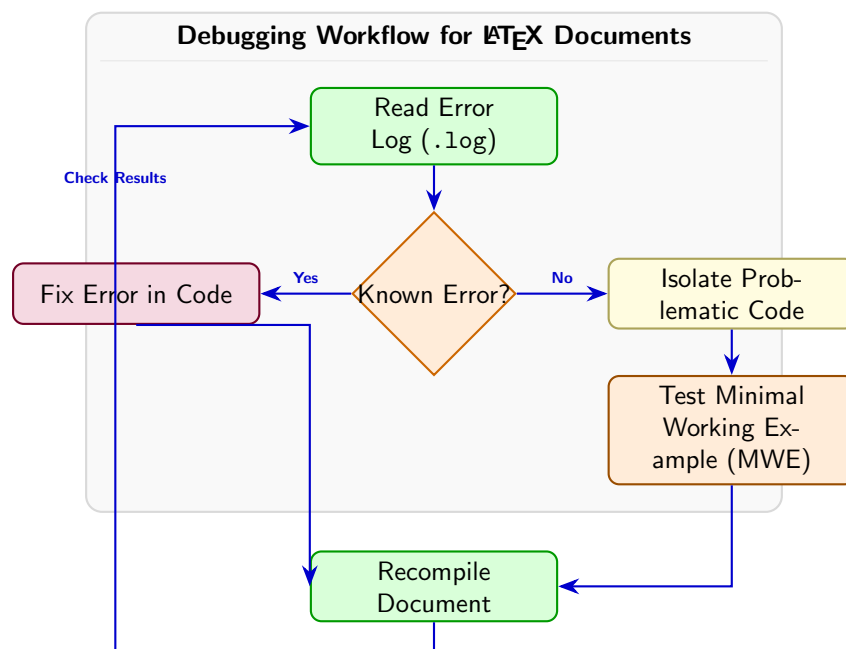
11.2 Debugging Strategies

1. Check the .log file: Contains detailed error information
2. Comment out code: Temporarily remove sections to isolate problems
3. Use minimal examples: Create small test files
4. Update packages: Use package manager to update
5. Check file permissions: Ensure write permissions for output files

11.3 Common Warnings

Warnings about overfull boxes, undefined references, or float placement.

1. Underfull/Overfull \hbox: Adjust text or margins
2. Float too large for page: Reduce figure/table size
3. Citation undefined: Run BibTeX
4. References may have changed: Compile again
5. No \cite commands: Remove unused .bib entries

Figure 11.1: Debugging workflow for L^AT_EX documents

12. Advanced Topics

12.1 Custom Commands and Environments

Define new commands with `\newcommand` or custom environments.

Code Example

```
% Custom commands
\newcommand{\R}{\mathbb{R}}
\newcommand{\N}{\mathbb{N}}
\newcommand{\todo}[1]{\textcolor{red}{[TODO: #1]}}

% Custom environments
\newtheorem{theorem}{Theorem}[chapter]
\newtheorem{definition}{Definition}[chapter]
\newtheorem{example}{Example}[chapter]

% Usage
The function is defined on  $\R$ .

\todo{Add more details here.}

\begin{theorem}
Every continuous function on a closed interval is bounded.
\end{theorem}
```

12.2 Packages for Specific Needs

12.3 Presentations with Beamer

Create presentation slides with themes and content blocks.

Table 12.1: Useful L^AT_EX packages

Package	Purpose
geometry	Page layout and margins
fancyhdr	Custom headers and footers
titlesec	Custom section headings
tcolorbox	Colored boxes and frames
tikz	Creating diagrams and graphics
pgfplots	Creating plots and graphs
algorithm	Typesetting algorithms
listings	Code listings with syntax highlighting
microtype	Micro-typographic extensions
siunitx	SI units and numbers
chemformula	Chemical formulas
circuitikz	Electrical circuit diagrams

Code Example

```

\documentclass{beamer}
\usetheme{Madrid}
\usecolortheme{whale}

\title{Presentation Title}
\author{Your Name}
\date{\today}

\begin{document}
\begin{frame}
\titlepage
\end{frame}

\begin{frame}{Outline}
\tableofcontents
\end{frame}

\section{Introduction}
\begin{frame}{Introduction}
\begin{itemize}
\item First point
\item Second point
\begin{itemize}
\item Sub-point
\end{itemize}
\end{itemize}
\end{frame}

\begin{block}{Important Note}
This is important!
\end{block}
\end{frame}
\end{document}

```

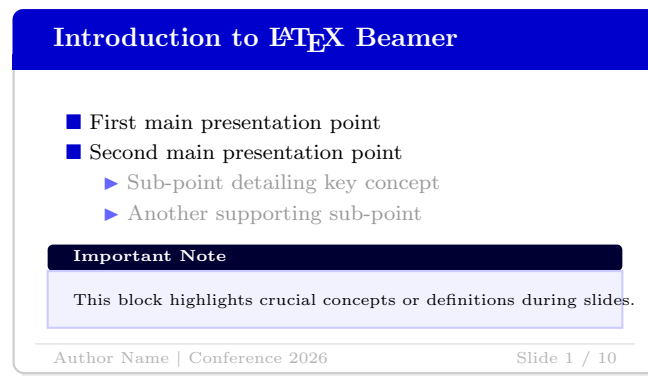


Figure 12.1: Beamer presentation slide layout preview

12.4 Theses and Long Documents

Structuring long documents with separate chapters, lists of figures/tables and glossaries.

Code Example

```
\documentclass[12pt,oneside]{report}
\usepackage[chapter]{algorithm}
\usepackage[backend=biber,style=apa]{biblatex}
\usepackage{glossaries}

% Multiple .tex files for chapters
\include{chapters/introduction}
\include{chapters/methodology}
\include{chapters/results}

% List of figures, tables, etc.
\listoffigures
\listoftables
\printglossary
\printbibliography
```

13. Practical Exercises

13.1 Exercise 1: Basic Document

Create a document with:

1. Title page with your name and date
2. Table of contents
3. Three sections with subsections
4. Numbered and bulleted lists
5. Page numbers in footer

13.2 Exercise 2: Academic Paper

Write a short paper (2-3 pages) with:

- Abstract section
- Introduction, Methods, Results, Discussion
- One table with sample data
- One figure (placeholder or real)
- Three mathematical equations
- Citations and bibliography (3+ references)

13.3 Exercise 3: Resume/CV

Create a professional resume with:

- Two-column layout using `minipage`
- Sections: Education, Experience, Skills
- Custom formatting for section headings
- Bulleted lists for achievements
- Professional font choices

14. Resources and Further Learning

14.1 Online Resources

- Overleaf Documentation: <https://www.overleaf.com/learn>
- LaTeX Project: <https://www.latex-project.org>
- TeX StackExchange: <https://tex.stackexchange.com>
- CTAN: <https://www.ctan.org> (package repository)
- Detexify: <https://detexify.kirelabs.org> (symbol finder)

14.2 Books and Tutorials

- Free: “The Not So Short Introduction to LaTeX2”
- Free: “LaTeX for Complete Novices” by Nicola Talbot
- Book: “LaTeX: A Document Preparation System” by Leslie Lamport
- Book: “LaTeX Beginner’s Guide” by Stefan Kottwitz
- Online Course: Overleaf’s LaTeX tutorials

14.3 Cheat Sheets

- LaTeX Mathematical Symbols
- LaTeX Reference Card
- Beamer Quick Start

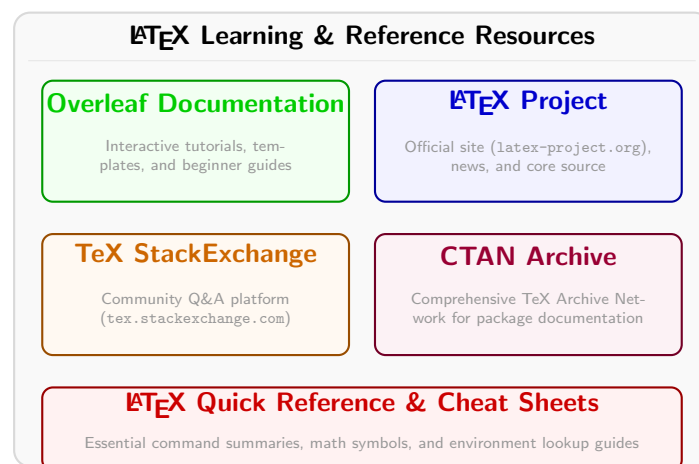


Figure 14.1: Key L^AT_EX learning resources and reference material

15. Best Practices

15.1 Document Organization

- Use folders: Separate for images, chapters, bibliography
- Version control: Use Git with .gitignore for LaTeX files
- Modular structure: Use `\input` for chapters
- Comments: Document complex code with `%`
- Backup: Regular backups (cloud or version control)

15.2 Efficiency Tips

1. Learn keyboard shortcuts in your editor
2. Use templates for common document types
3. Create custom commands for frequent formatting
4. Use build automation (Makefile, scripts)
5. Keep a personal .tex file of useful snippets

15.3 Common Pitfalls

- Spaces in filenames can cause problems
- Forgetting to compile multiple times for references
- Mixing text formatting and structure commands
- Hardcoding numbers instead of using references
- Ignoring compiler warnings

16. Complete Example Document

```
\documentclass[12pt,a4paper]{article}

% Packages
\usepackage[utf8]{inputenc}
\usepackage{amsmath, amssymb}
\usepackage{graphicx}
\usepackage{booktabs}
\usepackage{natbib}
\usepackage{hyperref}
\usepackage{cleveref}

% Hyperref setup
\hypersetup{
  colorlinks=true,
  linkcolor=blue,
  citecolor=green,
  urlcolor=red,
  pdftitle={LaTeX Example Document},
  pdfauthor={Student Name}
}

% Custom commands
\newcommand{\R}{\mathbb{R}}
\newcommand{\N}{\mathbb{N}}
\newcommand{\Var}{\operatorname{Var}}

% Document information
\title{Complete LaTeX Example: \\\
Analysis of Student Performance Data}
\author{Student Name \\\
Department of Computer Science \\\
University Name \\\
\href{mailto:student@university.edu}{student@university.edu}}
\date{\today}

\begin{document}

% Title page
\maketitle

% Abstract
```

```
\begin{abstract}
This document serves as a comprehensive example of LaTeX usage,
demonstrating various features including sections, figures, tables,
mathematical equations, and citations. The content focuses on a
hypothetical analysis of student performance data, showcasing how
LaTeX can be used for academic writing and technical documentation.
All elements are properly labeled and cross-referenced to illustrate
best practices in document preparation.
\end{abstract}

% Table of contents
\tableofcontents
\newpage

% Main content
\section{Introduction}
\label{sec:introduction}

LaTeX \cite{knuth1984} has become the standard typesetting system
for academic and scientific documents due to its superior handling
of mathematical notation and automatic formatting.

\subsection{Background}
Educational data analysis has gained importance in recent years,
with institutions using data-driven approaches to improve learning
outcomes.

\subsection{Objectives}
The main objectives of this example document are:
\begin{enumerate}
\item Demonstrate proper LaTeX document structure
\item Showcase mathematical typesetting capabilities
\item Illustrate table and figure creation
\item Provide examples of citations and references
\end{enumerate}

\section{Methodology}
\label{sec:methodology}

\subsection{Data Collection}
Hypothetical data was collected from 100 students across three courses:
Mathematics, Physics, and Computer Science.

\subsection{Statistical Methods}
The analysis employs several statistical techniques:

\subsubsection{Descriptive Statistics}
Basic descriptive statistics including mean, standard deviation, and range.

\subsubsection{Regression Analysis}
Linear regression models to examine relationships between variables:
```

```

\begin{equation}
\label{eq:regression}
Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \epsilon_i
\end{equation}
where  $Y_i$  is the post-test score for student  $i$ ,  $X_{i1}$  is the
pre-test score,  $X_{i2}$  is the study hours, and  $\epsilon$  is the
error term.

\section{Results}
\label{sec:results}

\subsection{Descriptive Statistics}
Table~\ref{tab:descriptive} presents descriptive statistics for the
collected data.

\begin{table}[h!]
\centering
\caption{Descriptive Statistics of Student Performance Data}
\label{tab:descriptive}
\begin{tabular}{lcccc}
\toprule
Variable & Mean & Std. Dev. & Min & Max \\
\midrule
Pre-test & 65.4 & 12.3 & 42 & 91 \\
Post-test & 72.8 & 14.5 & 45 & 98 \\
Study Hours & 12.5 & 5.2 & 3 & 25 \\
Attendance & 85.6 & 10.1 & 55 & 100 \\
\bottomrule
\end{tabular}
\end{table}

\subsection{Graphical Representation}
Figure~\ref{fig:scatter} shows the relationship between study hours
and post-test scores.

\begin{figure}[h!]
\centering
\includegraphics[width=0.8\textwidth]{example-scatter-plot.pdf}
\caption{Scatter plot showing relationship between study hours and
post-test scores. The positive correlation ( $r = 0.71$ ) suggests
that increased study time is associated with higher scores.}
\label{fig:scatter}
\end{figure}

\subsection{Regression Results}
The regression analysis produced the following model:
\begin{equation}
\label{eq:final-model}
\text{Post-test} = 45.2 + 0.85(\text{Pre-test}) + 1.2(\text{Study Hours})
\end{equation>

```

```
\section{Discussion}
\label{sec:discussion}
```

The results presented in Section~\ref{sec:results} indicate strong positive relationships between study habits and academic performance. The regression model in Equation~\ref{eq:final-model} provides a quantitative framework for predicting student outcomes based on measurable inputs.

```
\subsection{Limitations}
\begin{itemize}
\item The data is hypothetical and for demonstration purposes only
\item Real-world educational data may have additional confounding variables
\item The linear model assumes constant effects across all score ranges
\end{itemize}
```

```
\section{Conclusion}
\label{sec:conclusion}
```

This document has demonstrated the comprehensive capabilities of LaTeX for creating professional academic documents. From mathematical typesetting to data presentation, LaTeX provides consistent, high-quality output suitable for publication.

```
% Bibliography
\bibliographystyle{plainnat}
\bibliography{references}
```

```
% Appendix
\appendix
\section{Data Collection Instrument}
\section{Additional Analysis}

\end{document}
```

Key Features Demonstrated

1. Document Structure
2. Mathematical Typesetting
3. Tables and Figures
4. References and Citations
5. Code Quality

Compilation Instructions

To compile this document:

1. Save the code as `complete-example.tex`

2. Create a `references.bib` file with the cited references
3. Add any image files referenced (or use placeholders)
4. Compile with:
 - (a) `pdflatex complete-example.tex`
 - (b) `bibtex complete-example`
 - (c) `pdflatex complete-example.tex`
 - (d) `pdflatex complete-example.tex`

17. Final Notes

17.1 Getting Help

- Read error messages carefully: They often contain the solution
- Search online: Include “LaTeX” and the error message
- Ask on TeX StackExchange: Provide a minimal working example
- Check package documentation: `texdoc packagename`

17.2 Continuous Learning

- Practice regularly with different document types
- Explore new packages and features
- Contribute to LaTeX communities
- Share your knowledge with others

This document is provided for educational purposes. Please cite the original source if using in your own materials. For questions about this guide, email: matsalimselamat@uitm.edu.my

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