

Using $\text{\LaTeX}$ for Research Writing

A Hands-on Faculty Development Programme

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Introduction to $\text{\LaTeX}$

Why $\text{\LaTeX}$ for Research Writing

$\text{\LaTeX}$ is a professional typesetting system built for scientific and technical documents.

Widely used in

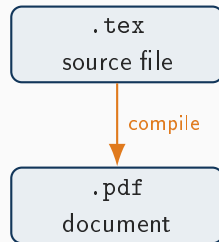
- Electrical Engineering
- Computer Science
- Mathematics
- Physics

Excellent at handling

- Mathematical equations
- Citations & references
- Figures
- Tables

Your First L^AT_EX Document

```
\documentclass{article}
\begin{document}
\section{Introduction}
This is my first LaTeX document.
\end{document}
```



Creating a Research Document

Every document is built from three parts:

1. **Document class** – defines the overall document type
2. **Preamble** – setup before the content begins
 - Packages
 - Author information
 - Formatting options
3. **Document body** – the actual content, inside document

Why Researchers Prefer $\text{\LaTeX}$

Everyday advantages

- Consistent, professional formatting
- Automatic numbering of sections, figures, tables, equations
- Easy collaboration on Overleaf
- Accepted by every major journal / conference

For maths-heavy research

- High-quality equation typesetting
- Automatic equation numbering & referencing
- Standard in IEEE, Springer, Elsevier journals

Mathematical Expressions

Writing Mathematical Expressions

Inline equation: appears within the text, e.g. $E = mc^2$.

Display equations: centred on their own line.

$$a^2 + b^2 = c^2 \qquad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Key idea

$\text{\LaTeX}$ gives every equation precise, publication-quality formatting.

Inline equation: $E = mc^2$

Display equation (quadratic formula):

```
\[  
  x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}  
\]
```

Important Mathematical Environments

Inline

$$x + y = z$$

Display

$$\int_0^1 x^2 dx = \frac{1}{3}$$

Multiple, aligned equations

$$a + b = c$$

$$x + y = z$$

(the `align` environment numbers and aligns each line)

```
\[  
A =  
\begin{bmatrix}  
  1 & 2 \\  
  3 & 4  
\end{bmatrix}  
\]
```

Output

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$

- Signal processing

$$y(t) = x(t) * h(t)$$

- Machine learning cost functions

$$J(\theta) = \frac{1}{m} \sum_{i=1}^m (h_{\theta}(x_i) - y_i)^2$$

- Algorithm complexity

$$T(n) = O(n \log n)$$

Figures, Tables & Code

Figures present

- Experimental results
- System architecture
- Flow diagrams
- Graphs & plots
- Simulation results

$\text{\LaTeX}$ provides

- Automatic numbering
- Captions
- Cross references

Including & Referencing Figures

```
\begin{figure}  
  \centering  
  \includegraphics[width=0.6\linewidth]{architecture.png}  
  \caption{System Architecture}  
  \label{fig:system}  
\end{figure}
```

Figure \ref{fig:system} shows the proposed architecture.

Supported formats & advantages

PNG, JPEG, PDF • no manual numbering • numbers update automatically

Figure Example: A Research Workflow

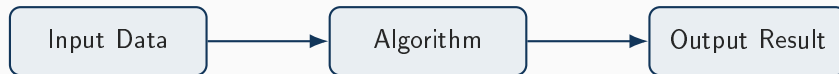


Figure: Example Research Workflow

Creating & Displaying Tables

```
\begin{table}
\centering
\begin{tabular}{ccc}
\toprule
Method & Accuracy & Time\\
\midrule
A & 95\% & 10s\\
B & 97\% & 8s\\
\bottomrule
\end{tabular}
\caption{Performance Comparison}
\end{table}
```

Output

Method	Accuracy	Time
A	95%	10s
B	97%	8s

Table 1: Performance Comparison

Tables are used for

- Experimental results
- Comparison of algorithms
- Simulation parameters
- Performance evaluation
- Statistical analysis

Professional journals expect clear, well-formatted tables – booktabs rules (`\toprule`, `\midrule`, `\bottomrule`) give a clean, publication-style look.

For Computer Science papers, $\text{\LaTeX}$ typesets algorithms, program listings, pseudocode, and experimental code with syntax highlighting.

```
for (i = 0; i < n; i++)  
{  
    sum = sum + a[i];  
}
```

Writing Research Papers

A typical engineering research paper contains:

1. Title
2. Abstract
3. Keywords
4. Introduction
5. Related Work / Literature Review
6. Methodology
7. Experimental Results
8. Conclusion
9. References

Major publisher templates	Advantages
• IEEE Conference Template • IEEE Transactions Template • Springer Lecture Notes Template • Elsevier CAS Template	• Correct formatting • Required margins • Reference style • Section organisation

IEEE Paper Template Structure

```
\documentclass[conference]{IEEEtran}
\title{Research Paper Title}
\author{Author Name}

\begin{document}
\maketitle

\begin{abstract}
Paper summary
\end{abstract}

\section{Introduction}
Main content
\end{document}
```

Writing a Good Abstract

A good abstract states

- Research problem
- Proposed approach
- Major results
- Main contribution

Typical length

150–250 words

Avoid

- Citations
- Detailed equations
- Unnecessary background

$\text{\LaTeX}$ automatically manages section numbering, the table of contents, and cross references.

```
\section{Introduction}  
\subsection{Motivation}
```

Useful in Computer Science and Mathematics papers:

```
\begin{theorem}  
Every finite language is regular.  
\end{theorem}  
  
\begin{proof}  
A finite automaton can be constructed  
for finite languages.  
\end{proof}
```

Cross-References

Cross Referencing

L^AT_EX generates references automatically for:

- Equations
- Figures
- Tables
- Sections

```
See Figure \ref{fig:model} for details.
```

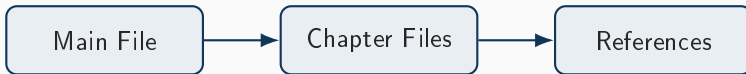
Benefit

No manual numbering – labels and references update automatically whenever the document changes.

Managing Large Research Documents

For books and theses, split the project into manageable pieces:

- Separate chapter files
- `\include` and `\input`
- A bibliography database
- Custom commands



Bibliography & Reference Management

Importance of References in Research Writing

Research papers require

- Proper acknowledgement of prior work
- Avoiding plagiarism
- Supporting research arguments
- Connecting with existing literature

$\text{\LaTeX}$ automates

- Citation numbering
- Bibliography generation
- Reference formatting

The Manual Bibliography Problem

Traditional approach

- Type references manually
- Maintain numbering manually
- Reformat for every journal

Problems

- Time consuming
- Error prone
- Hard to manage large literature

BibTeX stores references in a separate database file, `references.bib`.

Advantages

- Database of research papers
- Automatic citation generation
- Supports multiple journal styles
- Easy to reuse across different papers

BibTeX Entry Example

```
@article{chowdhary2025,  
  author = {K. R. Chowdhary},  
  title  = {Theory of Computation},  
  journal = {Springer Nature},  
  year   = {2025}  
}
```

Each reference has a unique key – here, `chowdhary2025` – used to cite it anywhere in the document.

Citing References in L^AT_EX

```
According to \cite{chowdhary2025}, automata  
theory is fundamental to computer science.
```

```
\bibliographystyle{IEEEtran}  
\bibliography{references}
```

Rendered output

“...according to [1], automata theory is fundamental ...”

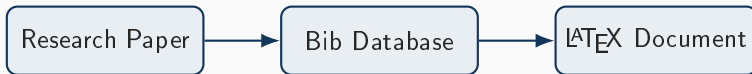
Overleaf & Reference Management Tools

Overleaf provides

- Online $\text{\LaTeX}$ editor
- Shared projects
- Version history
- Automatic compilation
- Journal templates

Great for

- Research groups
- Student-supervisor collaboration
- TeXmaker for local editing & compiling

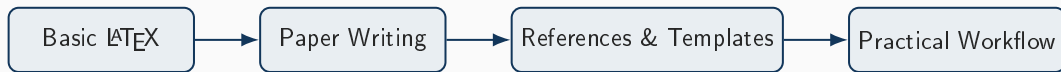


Tips for Engineering Researchers

Recommended Workflow

1. Select a journal template
2. Prepare the document structure
3. Write the content
4. Add equations and figures
5. Insert citations
6. Compile and check the PDF

Putting It All Together



This is the natural progression through the workshop – master each stage before moving to the next.

Summary

L^AT_EX helps researchers to:

- Follow publisher guidelines precisely
- Produce professional, consistently formatted papers
- Manage equations, figures, tables, and large documents with ease
- Automate citations and bibliographies with BibTeX
- Collaborate effectively using tools like Overleaf

Takeaway

L^AT_EX and BibTeX are essential skills for every engineering researcher.

Thank You

Questions & Discussion