

Research Methodology in Computer Science (AI800)

Lecture 10

Research Tools and Software: LaTeX



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Outlines

- Learning Outcomes
- Overview
- What is LaTeX?
- Why Use LaTeX?
- Installing LaTeX
- LaTeX document structure



Learning Outcomes

- To introduce participants to the basics of LaTeX and its benefits.
- To provide hands-on experience in creating professional-looking documents.
- To learn how to format text, create tables and figures, manage references and citations, and customize document layouts.



What is LaTeX?

- LaTeX is a method for preparing documents for typesetting of superior quality.
- LaTeX may be used for nearly any type of publishing, while it is most used to create technical or scientific texts.

L^AT_EX



Why Use LaTeX?

- Expertly designed preset layouts give a paper the authentic "printed" look.
- Equations and mathematical symbols may be combined with ease.
- Simple to create even intricate structures like table of contents, footnotes, and references.
- Makes the author concentrate on the document's logical structure rather than its visual appeal.
- Produces more good-looking papers. It's affordable (or free), lightweight, compatible, adaptable, and versatile.



Installing LaTeX



Texmaker



TeXstudio



Overleaf



TeXworks



TeXnicCenter



LyX



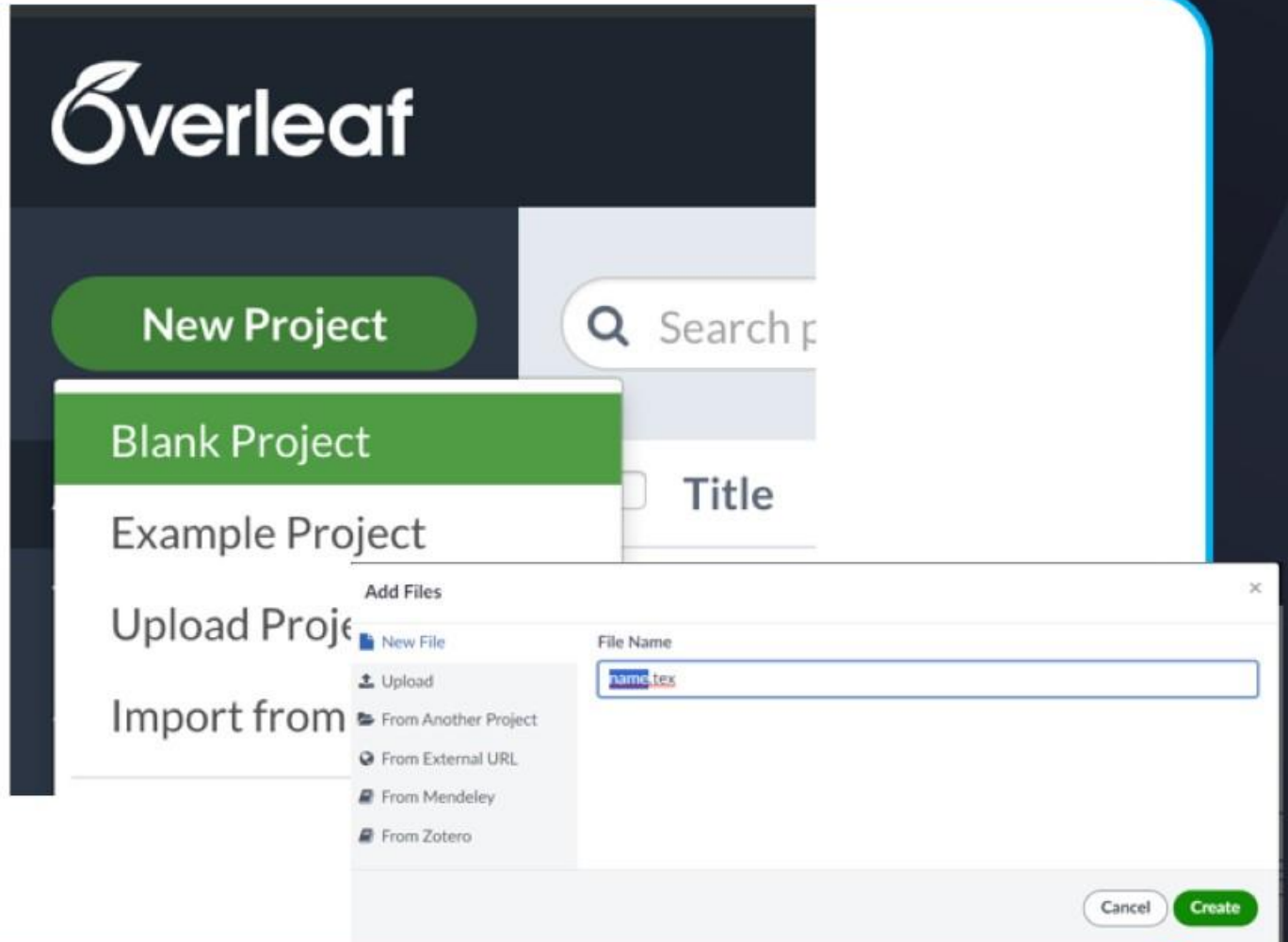
Start using Overleaf

Go to : www.overleaf.com.

Register

Login

Starting a new project





LaTeX document structure

```
1 \documentclass{article}
2 \usepackage[T1]{fontenc}
3
4 \begin{document}
5 Hey world!
6
7 This is a first document.
8 \end{document}
```

You specify your document class.

- Document classes: letter, article, report, book, slides(beamer, prosper)
 - ✓ `\documentclass{article}`
 - ✓ Backslash – at the beginning of text markup command.
- Packages: numerous packages are available
 - ✓ `\usepackage[margin=1in]{geometry}`
 - ✓ `\usepackage{setspace}`
 - ✓ `\usepackage{harvard}`



Writing your first piece of LATEX

Menu

Home

Simplest working example LaTeX document

Review

Share

Submit

History

Layout

Chat

Source

Rich Text

Ω

Recompile

↓

main.tex

```
1 \documentclass{article}
2 \begin{document}
3 First document. This is a simple
  example, with no extra parameters or
  packages included. Now I have added
  more text and need to recompile the
  document.
4 \end{document}
5
```

File outline

We can't find any sections or subsections in this file. [Find out more about](#)

Auto Compile

On

✓ Off

Compile Mode

✓ Normal

Fast [draft]

Syntax Checks

✓ Check syntax before compile

Don't check syntax

Compile Error Handling

Stop on first error

✓ Try to compile despite errors

Stop compilation

Recompile from scratch

Select the downward-facing arrow

Set "Auto Compile" to "On" or "Off"



Writing your first piece of LATEX

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

Output

The screenshot shows a web-based LaTeX editor interface. At the top, there is a dark blue header bar with several buttons: 'Code Editor' (highlighted in green), 'Visual Editor', a circular arrow icon, 'Normal text' with a dropdown arrow, 'B' and 'I' for bold and italic, a search icon, a green 'Recompile' button with a circular arrow icon, a red notification badge with the number '2', and a download icon. Below the header, the interface is split into two main panels. The left panel is the 'Code Editor', which contains five lines of LaTeX code: `1 \documentclass{article}`, `2 \begin{document}`, `3 Start LaTeX ..... Hello World !`, `4` (an empty line), and `5 \end{document}`. The right panel is the 'Output' area, which displays the rendered result of the code: 'Start LaTeX Hello World !'.



Changing Your Margins

The default margins for a LaTeX article are rather large. You can alter them to whatever you want in the following way. Add the command:

```
\usepackage{geometry}
```

```
\geometry{left=1in,right=1in,top=1in,bottom=1in}
```

Create a document using A4-sized paper with a text area which shouldn't exceed 6 inches wide and 8 inches high.

```
\usepackage[a4paper, total={6in, 8in}]{geometry}
```



Examples of LaTeX Coding (cont.)

```
\documentclass{article}
\usepackage{blindtext}
\usepackage[a4paper, total={6in, 8in}]{geometry}
\begin{document}
\section{Introduction}
This is a test document which uses A4-sized paper and the user-
defined text area. \end{document}
```

Output

1 Introduction

This is a test document which uses A4-sized paper and the user-defined text area.



Including title, author and date information

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

```
\title{My first LaTeX document}\author
```

```
{Dr.Mohammed Anbar
```

```
\thanks{Funded by the Overleaf team.}}
```

```
\date{November 2023}\begin{document}
```

```
\maketitle
```

We have now added a title, author and date to our first

```
\LaTeX{} document!
```

```
\end{document}
```



Output

```
1 \documentclass[12pt, letterpaper]{article}
2 \title{My first LaTeX document}
3 \author{Dr.Mohammed Anbar\thanks{Funded by the Overleaf
team.}}
4 \date{November 2023}
5 \begin{document}
6 \maketitle
7 We have now added a title, author and date to our first
\LaTeX{} document!
8 \end{document}
```

My first LaTeX document

Dr.Mohammed Anbar*

November 2023

We have now added a title, author and date to our first $\text{\LaTeX}$ document!



In the Body (section and subsection)

- To begin a new section

`\section{}`

Similarly, `\subsection{}`, `\subsubsection{}`,
`\subsubsubsection{}`

LaTeX does automatic numbering. If you don't like it,
use `section*{}`



Bold, italics and underlining

Bold: bold text in LaTeX is typeset using :

`\textbf{...}` command.

Italics: italicised text is produced using :

`\textit{...}` command.

Underline: to underline text use :

`\underline{...}` command.



Bold, italics and underlining (cont.)

Code EditorVisual Editor↺↻Normal textB I...QRecompile2↓

```
1 \documentclass[12pt, letterpaper]{article}
2 \title{My first LaTeX document}
3 \author{Dr.Mohammed Anbar\thanks{Funded by the Overleaf
team.}}
4 \date{November 2023}
5 \begin{document}
6 \maketitle
7 We have \underline{now added} a \textbf{title} ,
  \textbf{\textit{author}} and date to our first \LaTeX{}
document!
8
9 \end{document}
```

My first LaTeX document

Dr.Mohammed Anbar*

November 2023

We have now added a **title** , *author* and date to our first $\LaTeX$ document!



Enumeration in LaTeX

```
\begin{itemize}  
  \item One  
  \item Two  
  \item Three  
\end{itemize}
```

```
\begin{enumerate}  
  \item One  
  \item Two  
  \item Three  
\end{enumerate}
```



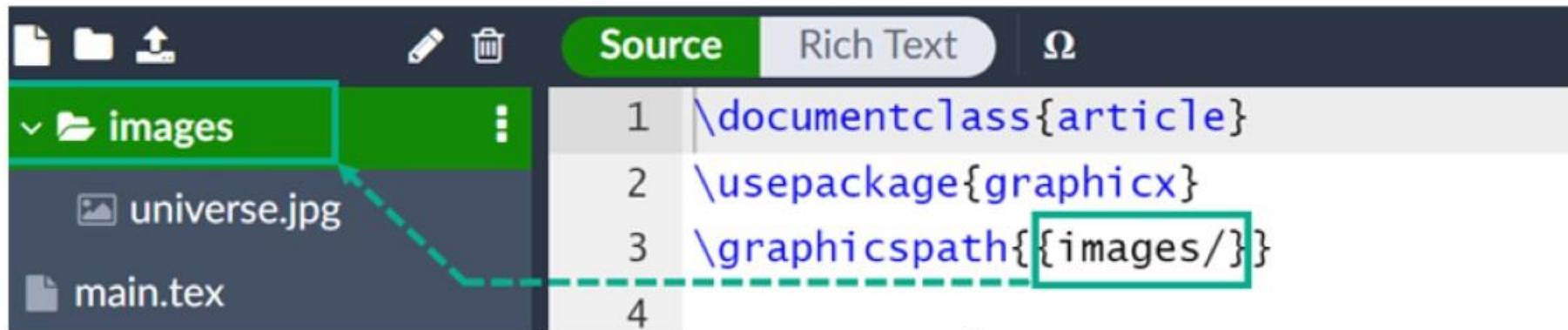
Images

Upload images to your Overleaf project.

Add the command:

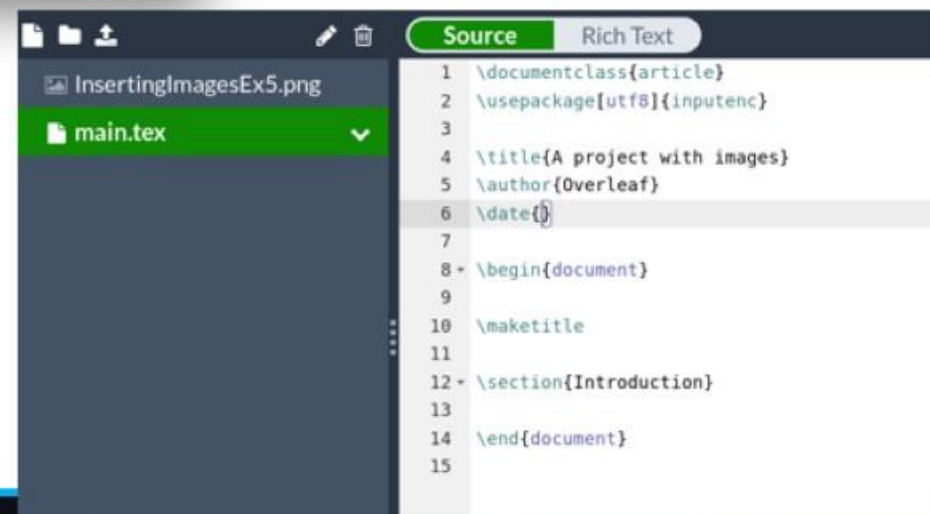
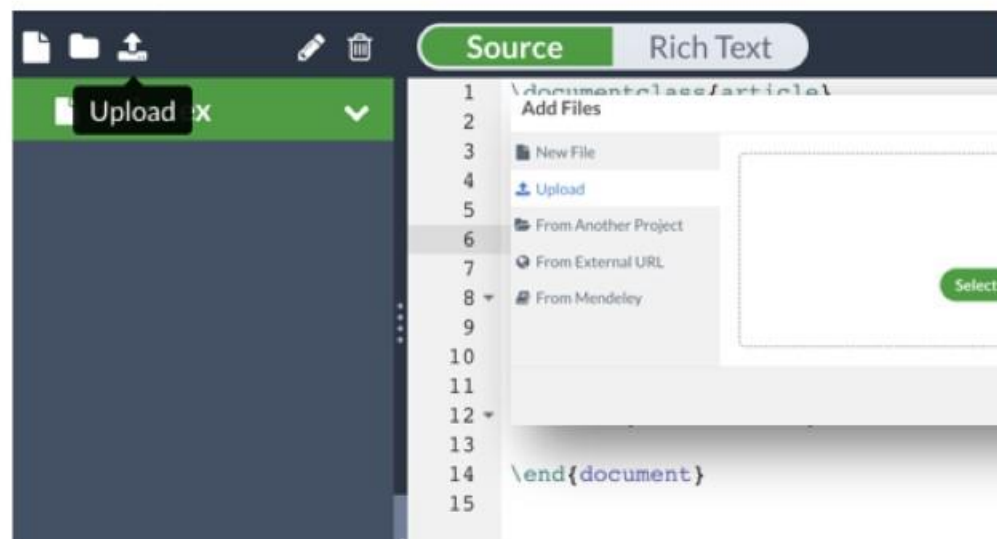
```
\usepackage{graphicx} %LaTeX package to import graphics
```

```
\graphicspath{{images/}} %configuring the graphicx package
```





Upload images





Use images within LATEX file

Code Editor Visual Editor

Recompile

```
2 \usepackage[utf8]{inputenc}
3 \usepackage{graphicx}
4 \title{My first LaTeX document}
5 \author{Dr.Mohammed Anbar\thanks{Funded by the Overleaf
team.}}
6 \date{November 2023}
7 \begin{document}
8 \maketitle
9 We have \underline{now added} a \textbf{title} ,
\textbf{\textit{author}} and date to our first \LaTeX{}
document!
10 \begin{figure}[htp]
11 \centering
12 \includegraphics[width=15cm]{image.jpg}
13 \caption{An image of Overleaf Logo}
14 \label{fig:Overleaf}
15 \end{figure}
16
17 \end{document}
```

```
\begin{figure}[htp] \centering
\includegraphics[width=15cm]{image.jpg}
\caption{An image of Overleaf Logo}
\label{fig:Overleaf}\end{figure}
```

My first LaTeX document

Dr.Mohammed Anbar*

November 2023

We have now added a **title** , ***author*** and date to our first $\text{\LaTeX}$ document!



Figure 1: An image of Overleaf Logo



Creating a Table

- Add numbered table
 - `\begin{table} \caption{}`
- Creating a table
- Simple tables can be produced by
 - `\begin{tabular}[pos]{tablespec}`
 - Within the `{tablespec}` section, one details the number of columns, the alignment, and the number of vertical lines of the table.
 - `{lrc}`, `{||r|c}`
 - Then type in from left to right, the values for each cell with `&` in between.
 - Put “`\\`” at the end of each row, then input another row of values if needed.



Creating a 3*4 Table

```
\begin{table}[h]
\caption{Creating a simple table in \LaTeX{}}
\begin{tabular}{|l|l|l|l|}
\hline
& Col1 & Col2 & Col3 \\
\hline
Row1 cell1 & Row1 cell2 & Row1 cell3 & Row1 cell4 \\
Row2 cell1 & Row2 cell2 & Row2 cell3 & Row2 cell4 \\
\hline
\end{tabular}
\end{table}
```

Output

Table 1: Creating a simple table in $\LaTeX$

Col1	Col2	Col3	
Row1 cell1	Row1 cell2	Row1 cell3	Row1 cell4
Row2 cell1	Row2 cell2	Row2 cell3	Row2 cell4



Creating a 3*4 Table

Code Editor

Visual Editor



B

I



Recompile



```
2 \usepackage[utf8]{inputenc}
3 \usepackage{graphicx}
4 \title{My first LaTeX document}
5 \author{Dr. Mohammed Anbar \thanks{Funded by the Overleaf
team.}}
6 \date{November 2023}
7 \begin{document}
8 \maketitle
9 We have \underline{now added} a \textbf{title} ,
\textbf{\textit{author}} and date to our first \LaTeX{}
document!
10 \begin{table}[h]
11 \caption{Creating a simple table in \LaTeX{} }
12 \begin{tabular}{llll}
13 \hline
14 \hline
15 & Col1 & Col2 & Col3 \\
16 \hline
17 Row1 cell1 & Row1 cell2 & Row1 cell3 & Row1 cell4 \\
18 Row2 cell1 & Row2 cell2 & Row2 cell3 & Row2 cell4 \\
19 \hline
20 \end{tabular}
21 \end{table}
22
23
24
25 \end{document}
```

My first LaTeX document

Dr. Mohammed Anbar*

November 2023

We have now added a **title** , ***author*** and date to our first $\LaTeX$ document!

Table 1: Creating a simple table in $\LaTeX$

	Col1	Col2	Col3
Row1 cell1	Row1 cell2	Row1 cell3	Row1 cell4
Row2 cell1	Row2 cell2	Row2 cell3	Row2 cell4



Combining rows and columns

```
\begin{tabular}{|p{3cm}||p{3cm}|p{3cm}|p{3cm}| }
\hline
\multicolumn{4}{|c|}{Country List} \\
\hline
Country Name or Area Name& ISO ALPHA 2 Code &ISO
ALPHA 3 Code&ISO numeric Code\\
\hline
Afghanistan & AF & AFG& 004\\
Aland Islands& AX & ALA &248\\
Albania &AL & ALB& 008\\
Algeria &DZ & DZA& 012\\
American Samoa& AS & ASM&016\\
Andorra& AD & AND &020\\
Angola& AO & AGO&024\\
\hline
\end{tabular}
```

Output

Country List			
Country Name or Area Name	ISO ALPHA 2 Code	ISO ALPHA 3 Code	ISO numeric Code
Afghanistan	AF	AFG	004
Aland Islands	AX	ALA	248
Albania	AL	ALB	008
Algeria	DZ	DZA	012
American Samoa	AS	ASM	016
Andorra	AD	AND	020
Angola	AO	AGO	024



Online Tools to Generate a latex table

- Several online tools available that can help you generate a LaTeX table easily and efficiently.
 - ✓ provide user-friendly interfaces where you can input your data and customize the table's appearance.
 - ✓ offer features like automatic column alignment, merging cells, and adding borders to make your table look professional.
 - ✓ allow you to export the generated LaTeX code directly, saving you time and effort in manually writing the code yourself.
- Online a LaTeX table Generator such as:
 - ✓ Tables Generator: <https://www.tablesgenerator.com/>
 - ✓ LaTeX Tables Editor: <https://www.latex-tables.com/>
 - ✓ LaTeX Table Editor and Generator: <https://tableconvert.com/latex-generator>



Mathematics and Matrices in LaTeX

- LaTeX is a powerful typesetting system that is widely used in academia for writing mathematical documents.
- LaTeX provides a comprehensive set of tools and commands for creating complex mathematical equations and symbols, making it particularly suitable for typesetting mathematics and matrices.
- LaTeX create matrices of any size, specify their elements, and format them according to your needs.
- LaTeX offers an efficient and flexible solution to write a research paper, a thesis, or simply need to display mathematical equations in the document,



- **Inline Math**

$6+2=8$

superscript: x^5

subscript : x_5

- **Geek letters :**

α

β

γ

δ



- Basic math functions

Formula	LaTeX-code
$\int_0^2 x^2 dx$	<code>\int_0^2 x^2 dx</code>
$\int_{x \in C} dx$	<code>\int\limits_{x \in C} dx</code>
$\sum_{i=1}^n i = \frac{n(n+1)}{2}$	<code>\sum_{i=1}^n i = \frac{n(n+1)}{2}</code>
$\lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$	<code>\lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}</code>



- Basic math functions

Formula	LaTeX-code
$(1 + \frac{1}{x})^2$	<code>(1+\frac{1}{x})^2</code>
$(1 + \frac{1}{x})^2$	<code>\left(1+\frac{1}{x}\right)^2</code>
$[-\frac{1}{x}]_1^\infty$	<code>\left[-\frac{1}{x}\right]_1^\infty</code>
$\{1, 2, 3, \dots, n\}$	<code>\{1,2,3,\ldots ,n\}</code>
$\{1, \frac{1}{2}, \frac{1}{3}, \dots, \frac{1}{n}\}$	<code>\left\{1,\frac{1}{2},\frac{1}{3},\ldots ,\frac{1}{n}\right\}</code>



- Equation on new line

```
\begin{equation}
```

```
3\cdot 5=15
```

```
\end{equation}
```

```
\begin{equation}
```

```
x=\frac{2}{3}
```

```
\end{equation}
```



Matrices in LaTeX

- A rectangular array of numbers, symbols, or phrases organized in rows and columns is called a matrix.
- A math environment for typesetting matrices can be used to construct a matrix in LaTeX.
- For generating matrix in LaTeX we have to use the package amsmath by giving the command `\usepackage{amsmath}`.

```
\begin{document}
$$
\begin{bmatrix}
a & b & c \\
c & d & d \\
e & f & g
\end{bmatrix}
\end{bmatrix}
\quad
$$
```

Output

$$\begin{bmatrix} a & b & c \\ c & d & d \\ e & f & g \end{bmatrix}$$



Matrices in LaTeX (cont.)

There can be various types of brackets to use in a matrix. Some of them are discussed below:

- ✓ `\begin{matrix}`: This command creates a matrix without brackets or boundaries.
- ✓ `\begin{pmatrix}`: This command creates a matrix with brackets or parenthesis.
- ✓ `\begin{bmatrix}`: This command creates a matrix with square brackets or boundaries.
- ✓ `\begin{Bmatrix}`: This command creates a matrix with curly brackets or boundaries.
- ✓ `\begin{vmatrix}`: This command creates a matrix with a rectangular line boundary.
- ✓ `\begin{Vmatrix}`: This command creates a matrix with double vertical bar brackets or boundaries.



- Online tools to generate mathematics and matrices are widely available and can be incredibly useful for both students and professionals.
 - ✓ Allow users to quickly and easily generate complex mathematical equations, solve equations, perform matrix operations, and visualize data in matrix form.
 - ✓ Provide a convenient way to save time and effort by automating calculations that would otherwise be time-consuming or prone to human error.
 - ✓ Offer advanced features such as graphing functions, creating 3D plots, and generating random matrices.
- Online a LaTeX Mathematics and Matrices Generator such as:
 - ✓ Latex Matrix Generator: <https://jasonwarta.github.io/latex-matrix/>
 - ✓ Equation Editor for online mathematics: <https://editor.codecogs.com/>
 - ✓ LaTeX Matrix Generator : <https://latex-matrix.netlify.app/>



Adding comments

To make a comment in LATEX, simply write a % symbol at the beginning of the line:

```
\documentclass[12pt, letterpaper]{article}
\title{My first LaTeX document}
\author{Hubert Farnsworth\thanks{Funded by the Overleaf team.}}
\date{August 2022}
\begin{document}
\maketitle
We have now added a title, author and date to our first \LaTeX{} document!
% This line here is a comment. It will not be typeset in the document.
\end{document}
```



Citations and reference using Biblatex approach

- Biblatex is a powerful tool for managing citations and references in academic writing, offering a flexible and customizable approach.
- With its extensive range of citation styles and support for various bibliographic databases, biblatex simplifies the process of generating accurate and consistent citations.
- Biblatex seamlessly integrates with LaTeX, facilitating precise document formatting and contributing to a polished and standardized presentation of citations and references in academic writing.





Citations and reference using Biblatex approach (cont.)

1. Create .bib file

The screenshot shows a dialog box titled "Add Files" with a close button (X) in the top right corner. On the left side, there is a sidebar with several options: "New File" (highlighted with a blue icon), "Upload" (with an upload icon), "From Another Project" (with a folder icon), "From External URL" (with a globe icon), "From Mendeley" (with a document icon), and "From Zotero" (with a document icon). To the right of this sidebar, there is a "File Name" label above a text input field that contains the text "ref.bib". At the bottom right of the dialog box, there are two buttons: "Cancel" and "Create" (which is green).

2. Use natbib package

```
\usepackage[square]{natbib}  
\bibliographystyle{ieeetr}  
\bibliography{ref}
```



Using journal LaTeX template

Demo



Modern Research Methodology Trends

AI-driven research methods

Reproducibility and Open Science
Movement

Big Data Research Methods

Ethical AI and Responsible
Research Frameworks



Modern Research Methodology Trends (cont.)

AI-driven research methods

- AI for Data Collection
 - Automated surveys & chatbots
 - AI-based literature retrieval
 - Web scraping with LLM-assisted interpretation
- AI for Data Analysis
 - Machine learning instead of traditional statistical tests
 - LLM-powered qualitative analysis (coding themes, sentiment extraction)
 - Predictive modeling in research questions
- AI-Assisted Writing
 - Drafting sections
 - Improving clarity
 - Avoiding plagiarism and citation errors (with ethical guidelines!)



Modern Research Methodology Trends (cont.)

Reproducibility and Open Science Movement

Major update in research ethics and methodology:

- Open Data
Sharing datasets publicly.
- Open Code
Sharing Python/R notebooks.
- Pre-registration
Researchers must register the method before collecting data.
Goal: Reduce bias and increase transparency.



Modern Research Methodology Trends (cont.)

Big Data Research Methods

Big Data Research Methods : research is shifting from small samples to large-scale datasets.

Includes tools like:

- Data mining
- Predictive analytics
- Text and sentiment analysis
- Social media analytics
- Network analysis
- New research questions emerge from big data instead of small controlled experiments.



Modern Research Methodology Trends (cont.)

Ethical AI and Responsible Research Frameworks

Ethical AI and Responsible Research Frameworks

- How to use AI ethically
- Do not be biased with machine learning models.
- Transparency in AI research
- Informed consent and anonymity in the cyber world.



References

- ☐ Leslie Lamport. 1994. LaTeX: A Document Preparation System.
- ☐ Helmut Kopta and Patrick W. Daly. 2004. Guide to LaTeX
- ☐ Frank Mittelbach et al. 2004. The LaTeX Companion
- ☐ Online Guides
 - ✓ <https://www.overleaf.com/>
 - ✓ <http://en.wikibooks.org/wiki/LaTeX>
 - ✓ <http://tobi.oetiker.ch/lshort/lshort.pdf>



Thank You