PEOPLE's DEMOCRATIC REPUBLIC OF ALGERIA

MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH

University Mohamed Boudiaf of M'sila

Faculty of Mathematics and Computer Sciences

Department of Mathematics

Field: Mathematics and Computer Science

Branch: Mathematics

Course Material in:

LaTeX

Lecture Notes and Solved Exercises

This course is intended for all Master's specialities, particularly for the Master 1 program in

Partial Differential Equations and Applications (Semester 2)

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2026

Acknowledgements

Above all, I offer my sincere praise and gratitude to Allah the Almighty, who granted me the strength, patience, and perseverance necessary to complete this work.

I would like to express my sincere appreciation to all those who contributed, directly or indirectly, to this educational endeavor. I am particularly indebted to my students, whose engagement and feedback have been a constant source of motivation, as well as to my colleagues for their constructive discussions and professional support.

My deep gratitude also goes to the Dean of the Faculty, the Head of the Department of Mathematics, and the Head of the Scientific Committee for their guidance, encouragement, and continued confidence throughout this period.

Finally, I extend my heartfelt thanks to the members of the Scientific Committee and the Scientific Council for their dedication and valuable contributions. I am equally grateful to my family and friends for their unwavering support, understanding, and encouragement, which made this journey both possible and deeply meaningful.

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Preface

The preparation of scientific documents is an essential component of academic and research activity, particularly in mathematics, where clarity, precision, and rigor are fundamental. In this context, LaTeX has become the international standard for typesetting mathematical texts, research articles, theses, and technical reports.

This polycopy has been prepared for the LaTeX module taught in the second semester of the Master's program in *Partial Differential Equations and Applications* at the Department of Mathematics, Faculty of Mathematics and Computer Science, University Mohamed Boudiaf of M'sila. The objective of this course is to provide students with both the theoretical understanding and the practical skills necessary to produce high-quality scientific documents.

Beyond simple text formatting, LaTeX enables the structured organization of long documents, precise mathematical typesetting, automated cross-referencing, bibliography management, inclusion of graphical representations, and the preparation of professional presentations using **`beamer`**. Mastery of these tools is indispensable for writing dissertations, preparing conference papers, and publishing research articles in peer-reviewed journals.

This document combines theoretical explanations with practical examples, guided exercises, and examination questions. It is designed to serve both as a structured course support during the semester and as a reference manual that students may consult throughout their academic and research careers.

The material progresses gradually: starting from the basic structure of a LaTeX document, it moves toward more advanced features such as mathematical environments, theorem formatting, bibliographic management, graphical representations, presentation slides with Beamer, and the formatting of algorithms and pseudo-code. Particular emphasis is placed on clarity, good practices, and academic writing standards.

It is hoped that this polycopy will not only help students acquire technical competence in LaTeX but also develop a deeper awareness of scientific writing conventions and document preparation standards in mathematics.

Any suggestions or remarks that may contribute to improving the content, structure, or clarity of this document are warmly welcomed.

Notation

LaTeX	The document preparation system used for scientific typesetting.
TeX	The typesetting engine created by Donald Knuth.
MiKTeX	TeX distribution for Windows used to compile LaTeX documents.
TeXLive	Comprehensive TeX distribution for multiple operating systems.
Overleaf	An online collaborative LaTeX editor and compiler.
`\documentclass{...}`	Declares the document class (e.g., `article`, `report`, `beamer`).
`.tex`	Source file containing LaTeX code.
`.pdf`	Output file generated after compilation.
`.bib`	Bibliography database file used with BibTeX.
`\command`	A LaTeX command beginning with a backslash.
{ }	Curly braces used to delimit mandatory arguments.
[ ]	Square brackets used to delimit optional arguments.
`\usepackage{package}`	Command used to load an external package.
`\begin{...}` `\end{...}`	Define an environment.
$ . . . $	Inline mathematical mode.
`\[ ... \]` or $$ . . . $$	Displayed mathematical mode (unnumbered).
`\begin{equation} ...`	Environment used to typeset numbered displayed equations.
`\label{key}`	Command used to define a reference label.
`\ref{key}`	Command used to reference a labeled element.
`\eqref{key}`	Command (from `amsmath`) used to reference equations.
`\cite{key}`	Command used to cite a bibliographic reference.
`beamer`	Document class used to create presentation slides.
`amsmath, amsthm, ...`	Essential packages for advanced mathematical typesetting.

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Introduction

The preparation of scientific documents requires precision, clarity, and consistency. In mathematics, physics, computer science, and many other disciplines, the accurate presentation of formulas, theorems, proofs, tables, and bibliographic references is an essential part of academic work. The typesetting system LaTeX has become the international standard for the production of high-quality scientific documents.

Unlike conventional word processors, LaTeX is not based on direct visual formatting. Instead, it follows a logical structure in which the author focuses on the content, while the system automatically manages layout, numbering, cross-references, and typographical coherence. This separation between content and presentation ensures professional and consistent output, particularly for long and mathematically intensive documents.

The objective of this course is to provide students with a solid foundation in the use of LaTeX for academic writing. We begin with the basic structure of a LaTeX document, including document classes, packages, and file organization. We then study text formatting, mathematical typesetting, environments, figures, tables, and bibliographic management.

Particular attention is devoted to mathematical mode, which allows the user to typeset inline and displayed equations, aligned formulas, matrices, theorem-like environments, and cross-references. These tools are essential for students in mathematics and related fields, where clarity of notation and logical structure are fundamental.

The course also introduces advanced features such as automated numbering, labels and references, bibliographic databases, hyperlinks, and presentation slides using the `beamer` class. Practical examples and guided exercises are provided throughout the chapters in order to develop autonomy in document preparation.

Mastering LaTeX is not merely a technical skill; it is an academic competence. It enables students to write reports, projects, theses, and scientific articles according to international standards. Moreover, it encourages structured thinking, logical organization, and typographical discipline.

Finally, it is hoped that this material will assist students and instructors in producing clear, elegant, and professionally typeset scientific documents.

Chapter 1

Scientific Typesetting Using LaTeX

This document is intended as a concise yet structured introduction to LaTeX. Although the present chapter develops foundational ideas, it does not aim to exhaust the immense possibilities offered by the system. Rather, it seeks to establish sound methodological habits from the outset and to introduce the conceptual framework underlying scientific typesetting.

1.1 What is LaTeX?

Before learning how to use a tool, it is important to understand what it is and why it was created. LaTeX is both:

- A **markup language**, and
- A **document preparation system**.

More precisely, it is a structured language that allows the user to describe the logical structure of a document (sections, theorems, formulas, references, etc.), while the typesetting engine automatically determines the optimal layout [1–7].

Definition 1.1. *LaTeX is a high-level typesetting system built on top of TeX that allows the production of high-quality scientific and technical documents.*

Unlike traditional word processors, LaTeX separates *content* from *formatting*. The author focuses on logical structure, while the system ensures typographical consistency and visual harmony.

Using LaTeX requires several interacting components:

- A **distribution** (e.g., MiKTeX or TeXLive),
- A **compiler engine** (pdfLaTeX, XeLaTeX, or LuaLaTeX),
- A **text editor** (TeXstudio, TeXnicCenter, VS Code, or online platforms such as Overleaf),
- Additional **packages** extending functionality.

Why Use LaTeX in Mathematics?

LaTeX has become the de facto standard in mathematics, physics, and many scientific disciplines for several fundamental reasons.

Originally, TeX was created in 1977 by Donald E. Knuth [8] in response to declining typographical standards in mathematical publishing. In 1982, Leslie Lamport [9] developed LaTeX as a macro system built on top of TeX to simplify its use and to promote structured document preparation.

The name TeX derives from the Greek word "$\tau\acute{\varepsilon}\chi\nu\eta$" (art or craft), reflecting its emphasis on typographical precision and aesthetic quality. Since its creation, LaTeX has maintained remarkable backward compatibility, allowing documents written decades ago to be compiled today.

The widespread adoption of LaTeX in mathematics is due to several essential advantages:

- **Superior Mathematical Typesetting**: Mathematics requires precise notation, alignment of equations, scalable symbols, and consistent spacing. LaTeX was designed specifically to handle complex mathematical expressions such as

$$\int_0^{+\infty} e^{-x^2}\,dx = \frac{\sqrt{\pi}}{2}, \qquad \text{also} \qquad \frac{\partial L}{\partial q_i} - \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) = 0.$$

  Environments such as `equation` and `align` (from the `amsmath` package) allow automatic numbering and alignment of multi-line expressions.

- **Logical Structure Over Visual Editing**: In LaTeX, one writes:

```
\section{Stability Analysis}
```

  instead of manually adjusting font size or style. This structural approach ensures consistency across large documents.

- **Scalability for Large Documents**: LaTeX efficiently handles theses, books, research articles, lecture notes, and technical reports. Cross-references, numbering, and bibliographies remain automatically synchronized.

The WYSIWYG Paradigm and Its Alternative

Most users are familiar with the WYSIWYG paradigm (*What You See Is What You Get*).

LaTeX does **not** follow this model. Instead, the workflow is:

1. Write a `.tex` source file, then compile it using a typesetting engine.
2. Obtain a `.pdf` output file.

During compilation, auxiliary files such as `.aux`, `.log`, and sometimes `.toc` are generated to manage references and structure.

1.2 A Minimal Working Example

Every LaTeX document follows a basic structure:

```
\documentclass{article}
\usepackage{amsmath}

\begin{document}
 Hello, world!

\end{document}
```

This illustrates two essential ideas:

- The `preamble`, where packages and settings are declared.
- The `document` environment, containing the actual content.

Packages and Environments

One of the main strengths of LaTeX is modularity.
Additional functionality is loaded using:

```
\usepackage{package}
```

For example:

- `amsmath` for advanced mathematics,
- `amsthm` for theorem environments,
- `graphicx` for images,
- `hyperref` for hyperlinks.

Environments are defined using:

```
\begin{environment}
 ...
\end{environment}
```

Examples include `equation`, `align`, `itemize`, and `theorem`.

1.3 Installation

LaTeX belongs to a vast ecosystem. As explained in the introduction, the document production system involves several components (a language, a compilation engine, a compilation process, and supporting programs).

For this reason, in order to use LaTeX, it is necessary to install a *distribution*, which is a collection of programs that work together to produce documents.

1.3.1 Distributions

The brief description that follows is largely inspired by the presentation of Denis Bitouzé [4].

https://mt2e.univ-littoral.fr/Members/denis-bitouze/pub/latex/diapositives-cours-d/conference-n-1/view

If the instructions below are not sufficient, you are encouraged to consult the installation section of his document.

Using Windows

On Windows systems, we recommend installing the distribution **MiKTeX**:

`https://miktex.org/`

Or **TeXLive**:

`https://www.tug.org/texlive/`

Installation with Online Download

If your internet connection is stable, you may follow the online installation procedure.
First, download the file:

`install-tl-windows.exe`

available at:

`https://www.tug.org/texlive/acquire-netinstall.html`

Run this file on your system.

A dialog box may appear suggesting that you temporarily disable your antivirus software during installation. Following Denis Bitouzé's advice, we recommend:

1. Attempt the installation with the antivirus enabled by clicking "Continue".
2. If the installation fails, retry with the antivirus temporarily disabled.

Video Demonstration

The procedure is illustrated in the following video by Denis Bitouzé:

`https://www.youtube.com/watch?v=SXoErhQlkDg`

1.3.2 A Text Editor

There exists a wide variety of text editors that can be used to write LaTeX source files. Each user should choose the one that best fits their needs.

For beginners, we recommend the following.

TeXstudio

TeXstudio is an integrated development environment (IDE) specifically designed for TeX. It is dedicated to writing LaTeX documents, which offers many advantages, especially for beginners:

`https://www.texstudio.org/`

The procedure is illustrated in the following video by **Bilal Basti**:
`https://youtu.be/zK4ZxByL5uo`

Other Editors Compatible with LaTeX

Many general-purpose text editors can also be used for writing LaTeX documents. Below is a non-exhaustive list of high-quality editors.

Editor	Operating System	Type
Emacs	Multi-OS	General-purpose
Gedit	Linux	General-purpose
Nano	Linux	General-purpose
Overleaf	Web service	LaTeX
Sublime Text	Multi-OS	General-purpose
TeXmaker	Multi-OS	LaTeX
TeXnicCenter	Windows	LaTeX
TeXShop	macOS	LaTeX
Vim	Multi-OS	General-purpose
VS Code	Multi-OS	General-purpose

Each of these tools has its own advantages. Beginners may prefer dedicated LaTeX editors, while advanced users often choose powerful general-purpose editors with LaTeX extensions.

Chapter 2

First Steps to Writing with LaTeX

After this general presentation, we now begin our first steps with the typesetting system. The specific aspects introduced here will be developed in more detail in the following chapters.

2.1 Editing the First Document

We present here a minimal document that allows the production of a valid output file.

It is perfectly normal if this document does not immediately make sense to beginners. In order to understand it, we will analyze it step by step.

```
\documentclass[a4paper,12pt]{article} % document class
  \usepackage[utf8]{inputenc} % character encoding
  \usepackage[T1]{fontenc} % font encoding
  \usepackage{geometry} % page layout management
  \usepackage{mathtools,amssymb} % mathematical tools
  \usepackage{graphicx} % image management
  \usepackage{babel} % language management

\begin{document}
  Here is my first \LaTeX\ document!
\end{document}
```

Remark 2.1. *Like any programming language, LaTeX has its own commenting system. Comments are not printed in the final document. They can be very useful for adding explanations or reference notes inside the source file.*

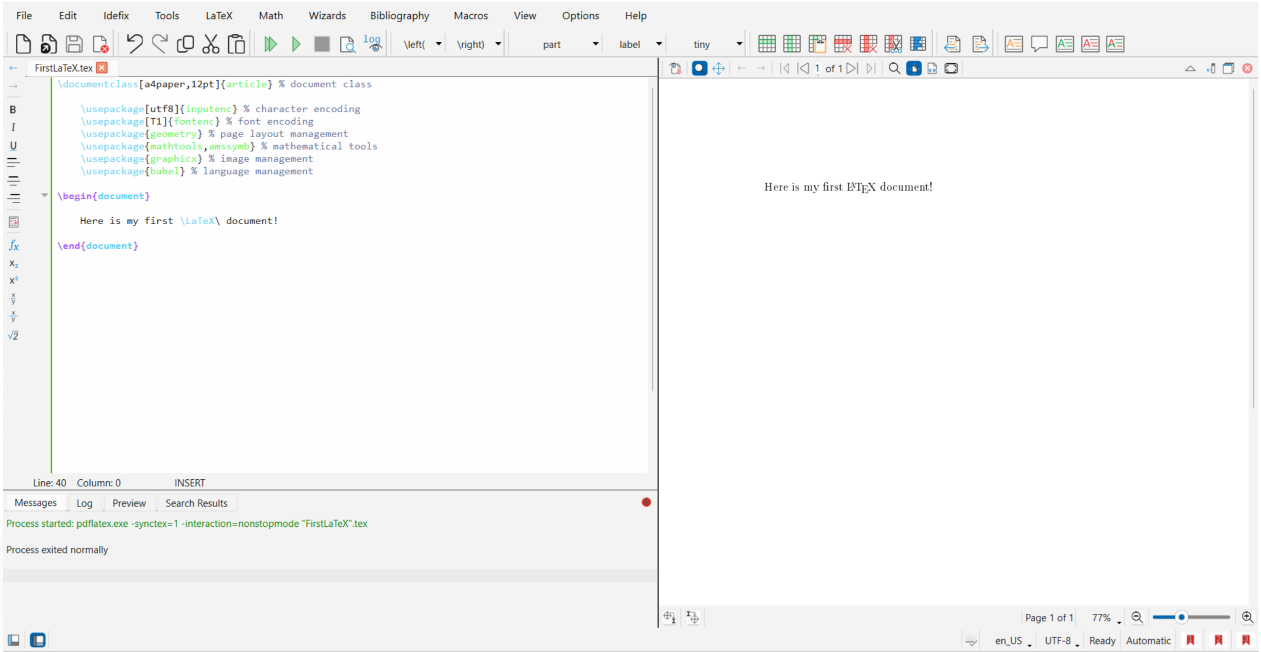
A comment begins with the symbol % and continues until the end of the line:

```
This is text. % this is a comment
More text follows.
```

From now on, suppose that this document has been saved under the name `FirstLaTeX.tex`. LaTeX source files always have the extension `.tex`.

2.2 Compilation

If you are using TeXstudio, this step simply consists of clicking the "Build and View" button (often represented by a fast-forward icon).



However, it is important to understand what happens behind this button.

Obtaining the PDF document from the `.tex` source file is done using the following command:

```
pdflatex FirstLaTeX.tex
```

This compilation produces several files. First, the file `FirstLaTeX.pdf`, which is the final document we wish to obtain, and other auxiliary files such as:

`FirstLaTeX.log`	`FirstLaTeX.aux`
`FirstLaTeX.out`	`FirstLaTeX.thm`

Without going into excessive detail, the `.log` file is particularly important. Like any log file, it contains all events that occur during the compilation process. In other words, it records compilation messages, warnings, and potential errors.

Since LaTeX is a programming language, it is composed of commands:

```
\CommandName[<optional arguments>]{<mandatory argument>}
```

A command begins with a backslash `\`, which is followed by the command name. Depending on the command definition, optional arguments may appear inside square brackets `[ ]`. Mandatory arguments appear inside curly braces `{ }`.

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For example:

- A command without argument: `\centering`.
- A command with a mandatory argument: `\section{Introduction}`.
- Finally, with an optional argument: `\includegraphics[width=10cm]{myimage.pdf}`.

Throughout this document, we will explore several LaTeX commands and their behavior.

2.3 Explanation of the Document

2.3.1 The Document Class

The file `FirstLaTeX.tex` begins with the command:

```
\documentclass[<options>]{article}
```

It is essential to remember that every LaTeX document begins with this command.

The Mandatory Argument

The mandatory argument (here `article`) defines the *document class*. The main classes are:

- **article**: Intended for relatively short documents (lab work, exercise sheets, short articles, etc.).
- **report**: Used for longer documents that may be divided into chapters. The `article` class does not support chapters.
- **book**: Designed for writing books. In practice, there are only minor differences between the `book` and `report` classes.

Class Options

Classes accept options (which may vary depending on the chosen class).
Among the most important:

- `11pt`: Sets the font size to 11 points (a typographical unit of measurement). The option `12pt` is also available. The default size is `10pt`.
- `twocolumn`: Typesets the document in two columns.
- `twoside`: Adjusts margins for double-sided printing. In this case, the inner margin differs from the outer margin.

Some options are given to the class but are actually passed to packages loaded later. For example:

- `french`: Through the `babel` package, this loads French typographical conventions.
- `a4paper`: Through the `geometry` package, this adjusts the page layout for A4 format.

2.3.2 The Preamble

The *preamble* of a LaTeX document is everything located between:

```
\documentclass
```

and

```
\begin{document}
```

In the simple case of the file `FirstLaTeX.tex`, the preamble is mainly used to load packages (also called extensions).

What Is a Package?

LaTeX already provides a large number of built-in commands. However, over time, new needs have emerged (languages, page formats, modern fonts, advanced mathematics, etc.).

A **package** extends LaTeX by redefining certain default behaviors, or adding new commands and environments. Packages are loaded using the command: `\usepackage{packagename}`

Let us briefly review the packages used in `FirstLaTeX.tex`.

Basic Packages

- **inputenc**: Specifies the encoding of the source file. With modern operating systems, UTF-8 is the standard, specified by the option `utf8`.
- **fontenc**: With the option `T1`, this specifies the encoding of characters in the produced document (PDF). It improves handling of accented characters.
- **geometry**: Manages page dimensions and margins.
- **mathtools, amssymb**: These packages provide extensive mathematical symbols and tools.
- **graphicx**: Enables image management and inclusion of image files (jpg, png, pdf, eps, etc.).
- **babel**: Manages languages and their associated typographical rules.
- **ntheorem, thmtools**: Provide tools for typesetting theorems, definitions, propositions, and customizing their appearance.
- **hyperref**: Adds navigation features to the PDF document, including clickable cross-references, bibliography links, hyperlinks and URLs, a navigable table of contents.

We recommend loading these packages in most mathematical documents.

Important note: The order in which packages are loaded may matter. The order presented here is functional.

There exist thousands of packages extending LaTeX capabilities. The official catalogue is CTAN (Comprehensive TeX Archive Network):

https://www.ctan.org/

The amount of available information online is enormous. Although it may sometimes be difficult to navigate, most answers to common LaTeX questions can be found there.

2.3.3 The Document Content

The actual content to be typeset by LaTeX is located between:

```
\begin{document}
```

and

```
\end{document}
```

Any text placed after `\end{document}` is ignored.
In the file `FirstLaTeX.tex`, the content is short and simple:

```
Here is my first \LaTeX{} document!
```

This concludes the minimal structure of a valid LaTeX document:

1. The document class declaration,
2. The preamble (packages and configuration),
3. The document body.

Understanding this tripartite structure is fundamental before moving on to advanced features.

2.4 The Structure of Documents

2.4.1 Words and Paragraphs

The basic building block of a LaTeX document is the *word*. Words are separated by spaces or punctuation marks.

A simple line break in the source code is treated as a space. Moreover, multiple consecutive spaces are interpreted as a single space. Thus, the following inputs produce identical output:

```
Here is a text written
with line breaks.

Here is a text written with line breaks.
```

A document is composed of *paragraphs*, which are created by inserting at least one empty line in the source code.

```
First paragraph.


Second paragraph.
```

This produces two distinct paragraphs in the output.

Multiple empty lines have the same effect as a single empty line. Vertical spacing between paragraphs is controlled automatically by LaTeX and should not be adjusted manually.

Commands such as

```
\smallskip
\medskip
\bigskip
```

introduce additional vertical space. They should be used sparingly, as the philosophy of LaTeX prioritizes structural clarity over manual formatting.

2.4.2 Document Organization

In all standard classes, a document can be divided into sections, subsections, subsubsections, and so on. These are numbered automatically.

The commands are:

```
\section{<section title>}
\subsection{<subsection title>}
\subsubsection{<subsubsection title>}
```

After these come paragraph-level divisions, which are not numbered:

```
\paragraph{<paragraph title>}
\subparagraph{<subparagraph title>}
```

The `book` and `report` classes allow further structural division.

A document may be divided into parts using:

```
\part{<part title>}
```

and parts may be divided into chapters using:

```
\chapter{<chapter title>}
```

Remark 2.2. *There exist "starred" versions of these commands that do not generate numbering:*

```
\part* \chapter* \section* ...
```

The Table of Contents

Once the document is structured using these commands, it becomes very easy to generate a table of contents.

This is done with:

```
\tableofcontents
```

Depending on the document class, this command generates either a section or a chapter dedicated to the table of contents. This section or chapter is not numbered.

Remark 2.3. *Sections, chapters, or parts created with starred commands (e.g.,* `\section*`*) do not appear in the table of contents.*

2.5 Special Characters in LaTeX

In the source code, certain characters have a special meaning.

For example:

- The character % begins a comment.
- The character \ introduces a command.

In total, there are ten special characters in LaTeX:

```
$ & % # _ { } ~ ^ \
```

These characters cannot be printed directly in normal text.

For seven of them, they can be printed by preceding them with a backslash:

```
\$ \& \% \# \_ \{ \}
```

which produces:
$ & % # _ { }

For the remaining three characters, specific commands must be used:

```
\textasciitilde
\textasciicircum
\textbackslash
```

which produce:
~ ^ \

Understanding these special characters is essential, since improper use of them is a frequent source of compilation errors.

2.6 Changing Style

It is often desirable to vary the style of typesetting (bold, italic, slanted, etc.) in order to create hierarchy or emphasize certain elements.

The main style-changing commands are summarized below.

Command	**Result**	**Meaning**
`\textup{upright}`	upright	upright
`\textit{italic}`	*italic*	italic
`\textsl{slanted}`	*slanted*	slanted
`\textsc{Small Caps}`	Small Caps	small caps
`\textmd{medium}`	medium	medium weight
`\textbf{bold}`	**bold**	boldface
`\textrm{roman}`	roman	roman family
`\textsf{sans serif}`	sans serif	sans serif
`\texttt{typewriter}`	`typewriter`	typewriter

Of course, style modifications can be combined. For example, one may produce bold italic text:

```
\textit{What exactly is \textbf{this}?}
```

Produces:
*What exactly is **this**?*

2.6.1 Emphasis

A particularly useful command for highlighting words is:

```
\emph{<word(s)>}
```

This command has the advantage of adapting to the current style.
If the surrounding text is in roman (upright) style, `\emph` switches to italic.
If the surrounding text is already italic, `\emph` switches back to upright.
This makes it preferable to manual italic formatting when emphasizing text.

2.7 Changing Font Size

LaTeX naturally allows changes in font size. We have already seen how to change the general font size of the entire document via class options (e.g., 10pt, 11pt, 12pt).

The commands that modify font size locally should be used sparingly, since abrupt changes in size within a paragraph may reduce readability. They are better reserved for: title pages, general layout customization, drawings, tables, quotations.

The size declarations are summarized below.

`\tiny`	tiny
`\scriptsize`	scriptsize
`\footnotesize`	footnotesize
`\small`	small
`\normalsize`	normalsize (default)
`\large`	large
`\Large`	Large
`\LARGE`	LARGE
`\huge`	huge
`\Huge`	Huge

2.8 Structuring Environments

LaTeX provides a set of environments that help structure a document. Without being exhaustive, we describe here some of the most useful ones.

2.8.1 Dissecting an Environment

First, it is important to understand what an environment is.

Definition 2.1. *An environment is a portion of the source document delimited by the commands:*

```
\begin{<environment name>}
\end{<environment name>}
```

Like commands, environments may take optional arguments and mandatory arguments. Options and arguments are specified in the opening command:

```
\begin{<environment>}[<options>]{<arguments>}
```

2.8.2 `center`, `flushleft`, and `flushright`

These environments allow alignment control:

- `center` — centers text;
- `flushleft` — aligns text to the left;
- `flushright` — aligns text to the right.

Here is centered text. LaTeX automatically breaks lines appropriately.
You can force a line break using the command `\\`.

Left-aligned composition is sometimes called *ragged right*.
All lines are aligned on the left margin.

Paragraphs can also be aligned to the right.
This is less common but can be useful in certain documents.

2.8.3 The `verbatim` Environment

When typesetting computer code (LaTeX, C++, Python, etc.), the `verbatim` environment prints text in typewriter style. No commands or special characters are interpreted.

2.8.4 Lists: `itemize`, `enumerate`, and `description`

Lists are extremely useful for structuring documents. LaTeX provides three main types.

The `itemize` Environment

A simple list is created using:

```
\begin{itemize}
 \item structures content;
 \item improves readability;
 \item adds visual clarity.
\end{itemize}
```

- structures content;
- improves readability;
- adds visual clarity.

Each element begins with the command `\item`.

The `enumerate` Environment

The `enumerate` environment works like `itemize`, but items are numbered:

1. First element:
   (a) sub-element;
   (b) sub-element;
2. Second element.

The code was:

```
\begin{enumerate}
\item First element:
\begin{enumerate}
 \item sub-element;
 \item sub-element;
\end{enumerate}
\item Second element.
\end{enumerate}
```

The `description` Environment

The `description` environment allows you to define custom labels:

```
\begin{description}
 \item[i.] for simple lists;
 \item[ii.] for numbered lists;
 \item[iii.] for labeled lists.
\end{description}
```

i. for simple lists;

ii. for numbered lists;

iii. for labeled lists.

2.9 Tables

Tables are created using the `tabular` environment. Although sometimes challenging, it is very powerful.

Basic Example

```
\begin{tabular}{lcr}
 Left column & Centered column & Right aligned \\
 Row 1 & here & there \\
 Row 2 & over there & elsewhere
\end{tabular}
```

Left column	Centered column	Right aligned
Row 1	here	there
Row 2	over there	elsewhere

The argument `lcr` specifies three columns:

- `l` — left aligned;
- `c` — centered;
- `r` — right aligned.

Columns are separated with `&` and rows end with `\\`.

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Vertical and Horizontal Lines

```
\begin{tabular}{|c|r|}
 \hline
 Centered & Right \\
 \hline
 Data 1 & Data 2 \\
 \hline
\end{tabular}
```

Centered	Right
Data 1	Data 2

Vertical lines are created with `|` and horizontal lines are created with `\hline`.

Paragraph Columns

The column type `p{<width>}` creates a column of fixed width:

```
\begin{tabular}{|p{4cm}|c|}
 \hline
 Long text automatically wraps in this column & 10 \\
 \hline
\end{tabular}
```

Long text automatically wraps in this column	10

Repeating Column Formats

For large tables, the command

```
*{<number>}{<format>}
```

allows repetition of column styles.

Example:

```
\begin{tabular}{|p{4cm}|*{2}{c|}}
 \hline
 Product & Price & Quantity \\
 \hline
```

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```
  Boards & 180€ & 3 \\
  Chalk (x50) & 10€ & 5 \\
  Brushes & 5€ & 3 \\
  \hline
\end{tabular}
```

Product	Price	Quantity
Boards	180€	3
Chalk (x50)	10€	5
Brushes	5€	3

Well-formatted Tables

Below is an example of a well-formatted table.

Table 2.1: Student Grades in Simple Table

Name	**Math**	**Physics**	**Chemistry**
Ali	85	90	88
Fatima	78	82	80
Oussama	92	88	85

To present it, we should write the following LaTeXcode:

```
\begin{table}[!ht]
 \centering
 \caption{Student Grades in Simple Table}
 \label{tabgrades1}
 \begin{tabular}{|l|c|c|c|}
  \hline
  \textbf{Name} & \textbf{Math} & \textbf{Physics} & \textbf{Chemistry} \\
  \hline
  Ali & 85 & 90 & 88 \\
  \hline
  Fatima & 78 & 82 & 80 \\
  \hline
  Oussama & 92 & 88 & 85 \\
  \hline
 \end{tabular}
\end{table}
```

Professional Tables

Table 2.2: Student Grades in Professional Table

Name	**Math**	**Physics**	**Chemistry**
Ali	85	90	88
Fatima	78	82	80
Oussama	92	88	85

To present it, we should write the following LaTeX code:

```
\begin{table}[!ht]
 \centering
 \caption{Student Grades in Professional Table}
 \label{tabgrades2}
 \begin{tabularx}{0.8\textwidth}{Xccc}
  \toprule
  \textbf{Name} & \textbf{Math} & \textbf{Physics} & \textbf{Chemistry} \\
  \midrule
  Ali & 85 & 90 & 88 \\
  Fatima & 78 & 82 & 80 \\
  Oussama & 92 & 88 & 85 \\
  \bottomrule
 \end{tabularx}
\end{table}
```

In Table 2.2, we can see the grades of three students in different subjects. The table is formatted using the `tabularx` and `booktabs` packages for better readability.

2.10 Including Images

In the preambles presented in this document, we load the package `graphicx`. This package provides the essential command:

```
\includegraphics[<options>]{<image name>}
```

which allows the inclusion of images in formats such as PDF, PNG, and JPEG (when compiling with `pdflatex`). For complete details, refer to the official documentation of the `graphicx` package.

Note that this package offers more functionality than simple image inclusion.

2.10.1 Basic Inclusion

Suppose the file `logo.png` is located in the root directory of your working document.[1] Then the image can be included simply as follows:

```
\includegraphics{Msila-Logo.png}
```

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2.10.2 Common Options

The command `\includegraphics` accepts several options. Options are written in the form `key=value`.

Below are the most commonly used options:

- `angle` — rotation angle in degrees;
- `width` — desired width (with unit). The height is adjusted proportionally;
- `height` — desired height (with unit). The width is adjusted proportionally;
- `scale` — scaling factor;
- `page` — page number to include (for multi-page PDF files).

[1]It is good practice to organize your project directory, for example by creating a subfolder dedicated to images.

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2.10.3 Using `\linewidth`

The command

```
\linewidth
```

represents the width of the text area (the composition width of the page). Example:

```
\includegraphics[width=0.5\linewidth,angle=90]{Msila-Logo.png}
```

This produces an image rotated by 90 degrees and scaled so that its width is half the width of the text area.

Example in context:

2.10.4 Alignment Within Text

When an image is inserted directly within a paragraph, it is aligned on the baseline of the text, as illustrated below:

```
Text showing the alignment of the image~
\includegraphics[scale=0.2]{Msila-Logo.png}.
```

Text showing the alignment of the image

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2.10.5 Using the **`figure`** Environment

In practice, images are most often included inside the `figure` environment (described in Section 4.3). This environment allows:

- adding a caption,
- labeling the figure,
- referencing it elsewhere in the document.

Example:

```
\begin{figure}[h]
 \centering
 \includegraphics[width=0.5\textwidth]{Msila-Logo.png}
 \caption{Example logo}
 \label{fig1}
\end{figure}
```

You can then reference the figure using:

```
See Figure~\ref{fig1}.
```

It results

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Figure 2.1: Example logo of M'sila.

See Figure 2.1.

CHAPTER 3

FLOATS, CROSS-REFERENCES, BIBLIOGRAPHIES, AND INDEXES

This chapter introduces one of the most powerful features of LaTeX: automatic management of references, floating objects, bibliographies, and indexes. By using structured labels, it becomes possible to refer to sections, figures, tables, equations, and other elements without manually updating numbers or page references.

All numbering and links are handled automatically during compilation, ensuring consistency even after major restructuring of the document.

3.1 Cross-References

LaTeX provides a mechanism for referring to:

- sections and chapters,
- equations, figures and tables,
- theorems and other numbered environments.

Basic Principle

Cross-referencing relies on two commands:

1. Place `\label{key}` inside or immediately after a numbered element.
2. Use `\ref{key}` elsewhere to print its number.

Example

```
\section{Section Title}\label{sec:example}
See Section~\ref{sec:example}.
```

```
\begin{equation}\label{eq:integral}
 \int_{0}^{1} x^2\,\mathrm{d}x
\end{equation}

Compute the integral~\ref{eq:integral}.
```

It produces

1.1 Section Title

See Section 1.1.

$$\int_0^1 x^2\,\mathrm{d}x \tag{3.1}$$

Compute the integral (3.1).

Compilation

References are resolved during compilation. It is therefore necessary to compile the document twice. After the first compilation, unresolved references may appear as `??`; this is normal.

Referencing Page Numbers

The command

```
\pageref{key}
```

prints the page number on which the labeled element appears.

Major Advantage

Even after moving content or restructuring the document, all references remain correct after recompilation. This ensures internal coherence in both small and very large documents.

3.2 Floats: `table` and `figure`

The insertion of certain objects such as tables and figures may create layout difficulties: pages should have a satisfactory fill ratio, page breaks should occur at appropriate locations, and large objects should not disrupt the flow of text.

To solve these issues, LaTeX introduces the concept of *floats*. A float is an object whose exact position may vary, but which is referenced in the main text.

We present here two floating environments:

- `table` — for tables,
- `figure` — for figures and images.

These environments allow:

- automatic numbering,
- adding captions,
- cross-referencing.

Basic Example: The `table` Environment

Let us analyze a simple example:

```
\begin{table}[!htbp]
 \centering
 \begin{tabular}{||l|l||}
  \hline
  Element 1 & Element 2 \\
  \hline
  Element 3 & Element 4 \\
  \hline
 \end{tabular}
 \caption{Example of the table environment}
 \label{tab:example}
\end{table}
```

This produces Table 3.1.

Element 1	Element 2
Element 3	Element 4

Table 3.1: Example of the table environment

Placement Options

The optional argument in square brackets determines the preferred placement of the float:

- `h` (here) — place here if possible;
- `t` (top) — at the top of a page;
- `b` (bottom) — at the bottom of a page;
- `p` (page of floats) — on a special page containing only floats;
- `!` — instructs LaTeX to try harder to respect the specified order.

The default placement preference is `tbp`.

Explanation of the Code

Let us comment on the previous example:

- `\centering` centers the table. It is preferable here to the `center` environment, since that environment would add unwanted vertical spacing.
- `\caption{}` provides the caption and automatically numbers the table.
- `\label{}` must be placed *after* the `\caption{}` in order to reference the correct number.

Although beginners often wish to control the exact position of floats, it is generally better to reference them in the text and let LaTeX's layout algorithm optimize the page composition.

The `figure` Environment

The `figure` environment works in exactly the same way.
Example:

```
\begin{figure}[htbp]
 \centering
 \includegraphics[width=0.5\linewidth]{example-image}
 \caption{Example of the figure environment}
 \label{fig:example}
\end{figure}
```

Figures can then be referenced using:

```
See Figure~\ref{fig:example}.
```

3.2.1 Lists of Tables and Figures

It is possible to generate:

- a list of tables with `\listoftables`,
- a list of figures with `\listoffigures`.

Like cross-references, these lists rely on auxiliary files. Therefore, two successive compilations are necessary for them to be up to date.

The auxiliary files used are:

- `.lot` (list of tables),
- `.lof` (list of figures).

3.3 Bibliography – **biblatex**

Scientific writing relies on precise bibliographic references. In LaTeX, bibliography management is handled efficiently using the `biblatex` package together with an external backend `biber`.

We present here the essential principles. So you can write directly

```
\begin{thebibliography}{99}
 \bibitem{Basti} B. Basti, \textit{Introduction to \LaTeX},
 University Mohamed Boudiaf, 2026.

 \bibitem{SecendRef} Secend Reference.
\end{thebibliography}
```

which gives

Bibliography

[1] B. Basti, *Introduction to LaTeX*, University Mohamed Boudiaf of M'sila, 2026.

[2] Secend Reference.

3.3.1 The Bibliographic Database

Bibliographic entries are stored in a file with extension .bib, for example:

```
mybibliography.bib
```

An entry has the general form:

```
@book{Orwell1984,
 author    = {Orwell, George},
 title     = {1984},
 year      = {1950},
 publisher = {Tandem Library}
}
```

Each entry consists of:

- a type (e.g. @book, @article, @thesis),
- a citation key (here Orwell1984),
- fields of the form field = {value}.

For multiple authors, separate names with and and use the format LastName, FirstName. Institutional authors should be enclosed in braces.

3.3.2 Loading the Package

In the preamble, write:

```
\usepackage[backend=biber]{biblatex}
\addbibresource{mybibliography.bib}
```

The style can be chosen via options, for example:

```
\usepackage[style=authoryear]{biblatex}
```

3.3.3 Citing References

The basic citation command is \cite{key}. But there is an optional arguments allow additional text or page numbers:

```
\verb|\cite[see][49]{key}|
```

For most purposes, `\autocite` is recommended, as it adapts automatically to the chosen style. Multiple works may be cited simultaneously

```
\cites{key1}{key2}
```

Other useful commands include `\citeauthor`, `\citetitle`, `\citeyear`, `\fullcite`, and `\nocite{*}` (to include all entries in the bibliography).

3.4 Index

LaTeX provides tools for generating document indexes. To create an index, load the `makeidx` package and add `\makeindex` in the preamble. Insert `\printindex` where the index should appear (usually at the end of the document).

```
\usepackage{makeidx}
\makeindex
...
\printindex
```

Index entries are created with:

```
\index{<entry>}
```

Example:

```
A word\index{word} in the text.
```

The command produces no visible output at its location in the text. Entries may contain spaces:

```
\index{Lax theorem}
```

Subentries are created using the separator `!`:

```
\index{index!subentry}
```

To display text different from the sorting key, use `@`:

```
\index{LaTeX@\LaTeX}
```

This is especially useful for symbols:

```
$\beta$\index{beta@$\beta$}
```

The symbol is sorted under "beta" while displaying β.

Chapter 4

Mathematics

One of the many advantages of using LaTeX is the typesetting of mathematical formulas. Indeed, its creator, D. E. Knuth, being himself a mathematician, developed a language particularly well suited to mathematics.

Here, in order to remain as simple and concise as possible, we will assume that we load the packages `mathtools` (an extension of the `amsmath` package) and `amssymb`. These packages add many very useful features to the basic LaTeX mathematical capabilities.

4.1 Mathematical Modes

Typesetting mathematics is radically different from typesetting ordinary text. Therefore, it is necessary to tell the typesetting engine — namely `pdfLaTeX` — that we wish to typeset mathematics. To do so, LaTeX provides two mathematical modes:

- The first is used to typeset mathematical formulas within the body of the text. This is *math mode*, which is entered and exited using the character `$`. Thus, we write our mathematical commands between two dollar signs, as shown below.[1]

```
We typeset mathematics in the text using dollars
$f(x)=x^2$.
```

  This produces inline mathematics such as $f(x) = x^2$.

- The second mode is used to typeset formulas displayed on their own line, separate from the text. This is *display math mode*, which is entered using the mechanism `$$f(x)=x^{2}$$` or `\[ ... \]`, as shown below.[2]

```
The same example in displaymath mode:
\[
f(x)=x^{2}
\]
```

[1] In reality, the dollar signs are a shortcut for the environment `\begin{math} ... \end{math}`.

[2] Again, this is a shortcut for the environment `\begin{displaymath} ... \end{displaymath}`.

This produces:

$$f(x) = x^2$$

Mathematical mode differs from text mode in several ways:

- Letters are typeset in mathematical italics.
- Spacing follows mathematical rules.
- Spaces typed in the source file are ignored.

For example:

```
\[
f x t e
\]
```

produces

$$fxte$$

The spaces in the source have no effect.

4.2 Basic Mathematical Structures

4.2.1 Subscripts and Superscripts

Subscripts are produced using _ and superscripts using ^. For example `$$ x_i \quad x^2 $$`.

$$x_i \quad x^2$$

If no braces are used, only the next character is taken as argument. For multi-character expressions, grouping with braces is required: `$$ a_{ij}, \quad x^{y^{z}}, \quad (x+y)^n $$`

$$a_{ij}, \quad x^{y^{z}}, \quad (x+y)^n.$$

4.2.2 Spacing in Math Mode

Manual spacing can be introduced when necessary. Common commands include:

`\,` small space	`\!` negative small space
`\:` medium space	`\quad` large space
`\;` large space	`\qquad` very large space

Example:

```
\newcommand\Dx{\,\mathrm{d}x}

\[
\forall x \in \mathbb{R},\quad
\int_{0}^{x}\!f(x)\Dx = F(x)-F(0).
\]
```

It results

$$\forall x \in \mathbb{R},\quad \int_{0}^{x}\!f(x)\,\mathrm{d}x = F(x)-F(0).$$

Spacing commands should be used sparingly. If a spacing pattern is structural (such as the differential), it is preferable to define a dedicated macro.

4.2.3 Text Inside a Formula

Especially in display math mode, it is often useful to include text. This can be done with the command `\text{...}`.

```
\[
f_{[x_i,x_{i+1}]}
\text{ is increasing for all }
i \in \{1,\dots,N\}
\]
```

That gives

$$f_{[x_i,x_{i+1}]} \text{ is increasing for all } i \in \{1,\dots,N\}$$

Text as Subscript or Superscript: The object produced by `\text{...}` can also be used as a subscript or superscript:

```
\[
\sum F_{\text{ext}} = \vec{a}
\]
```

That gives

$$\sum F_{\text{ext}} = \vec{a}$$

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4.2.4 Binary Operator Symbols

It is often necessary to use binary operators other than the simple + or − directly accessible from the keyboard. LaTeX provides many such operators.

Some common examples include:

Symbol	Code	Symbol	Code
$\pm$	`\pm`	$\mp$	`\mp`
$\times$	`\times`	$\div$	`\div`
$\ast$	`\ast`	$\star$	`\star`
$\cup$	`\cup`	$\cap$	`\cap`
$\sqcup$	`\sqcup`	$\sqcap$	`\sqcap`
$\vee$	`\vee`	$\wedge$	`\wedge`
$\oplus$	`\oplus`	$\ominus$	`\ominus`
$\otimes$	`\otimes`	$\odot$	`\odot`
$\bigcirc$	`\bigcirc`		

These commands allow access to a wide variety of binary operator symbols.

4.2.5 Useful Symbols, Letters, and Operators

In this section, we present, for reference, collections of mathematical symbols, letters, and operators that are useful for mathematicians.

Greek Letters Greek letters are widely used in mathematics.

Lowercase examples:

Symbol	Code	Symbol	Code
α	`\alpha`	β	`\beta`
γ	`\gamma`	δ	`\delta`
ϵ	`\epsilon`	ε	`\varepsilon`
θ	`\theta`	ϑ	`\vartheta`
λ	`\lambda`	μ	`\mu`
π	`\pi`	ϖ	`\varpi`
ρ	`\rho`	ϱ	`\varrho`
σ	`\sigma`	ς	`\varsigma`
ϕ	`\phi`	φ	`\varphi`
ψ	`\psi`	ω	`\omega`

Uppercase examples:

Symbol	Code	Symbol	Code
Γ	`\Gamma`	Δ	`\Delta`
Θ	`\Theta`	Λ	`\Lambda`
Ξ	`\Xi`	Π	`\Pi`
Σ	`\Sigma`	Υ	`\Upsilon`
Φ	`\Phi`	Ψ	`\Psi`
Ω	`\Omega`		

Binary Relation Symbols LaTeX also provides many binary relation symbols, such as order relations and inclusion relations:

Symbol	Code	Symbol	Code
$\leq$	`\leq`	$\geq$	`\geq`
$\neq$	`\neq`	$\equiv$	`\equiv`
$\sim$	`\sim`	$\simeq$	`\simeq`
$\subset$	`\subset`	$\subseteq$	`\subseteq`
$\supset$	`\supset`	$\supseteq$	`\supseteq`
$\in$	`\in`	$\ni$	`\ni`
$\parallel$	`\parallel`	$\perp$	`\perp`

Negations can be formed using `\not`, for example `$$ x \notin F $$`:

$$x \notin F$$

Arrows Arrows are extremely useful in mathematics. LaTeX offers a wide range:

Symbol	Code	Symbol	Code
$\leftarrow$	`\leftarrow`	$\rightarrow$	`\rightarrow`
$\leftrightarrow$	`\leftrightarrow`	$\Leftarrow$	`\Leftarrow`
$\Rightarrow$	`\Rightarrow`	$\Leftrightarrow$	`\Leftrightarrow`
$\longleftarrow$	`\longleftarrow`	$\longrightarrow$	`\longrightarrow`
$\longleftrightarrow$	`\longleftrightarrow`	$\mapsto$	`\mapsto`
$\longmapsto$	`\longmapsto`	$\uparrow$	`\uparrow`
$\downarrow$	`\downarrow`	$\updownarrow$	`\updownarrow`

Various Symbols Many other useful symbols are available:

Symbol	Code	Symbol	Code
$\forall$	`\forall`	$\exists$	`\exists`
∞	`\infty`	∇	`\nabla`
∂	`\partial`	$\aleph$	`\aleph`
$\hbar$	`\hbar`	ℓ	`\ell`
$\Re$	`\Re`	$\Im$	`\Im`
$\emptyset$	`\emptyset`	$\angle$	`\angle`
$\top$	`\top`	$\bot$	`\bot`
$\dots$	`\dots`	$\cdots$	`\cdots`
$\vdots$	`\vdots`		

4.2.6 Accents

In mathematics, accents are frequently used to extend the number of available symbols or to denote transformations. Some common accent commands (used in math mode) are:

Symbol	Code	Symbol	Code
$\hat{a}$	`\hat{a}`	$\bar{a}$	`\bar{a}`
$\tilde{a}$	`\tilde{a}`	$\dot{a}$	`\dot{a}`
$\ddot{a}$	`\ddot{a}`	$\vec{a}$	`\vec{a}`
$\check{a}$	`\check{a}`	$\breve{a}$	`\breve{a}`

Note that the letters `i` and `j` have a special status because of their dots. When adding an accent, the dot must disappear. For this purpose, LaTeX provides the commands `\imath` and `\jmath`:

$$\hat{\imath} \quad \tilde{\jmath}$$

To place a wide hat or tilde over several characters, use:

`\widehat{xyz}` for $\widehat{xyz}$ and `\widetilde{xyz}` for $\widetilde{xyz}$

To draw long arrows over symbols, use:

`\overrightarrow{AB}` for $\overrightarrow{AB}$ and `\overleftarrow{BA}` for $\overleftarrow{BA}$

The commands `\overline` and `\underline` allow overlining and underlining:

$$\overline{z+1} = \bar{z} + 1 \qquad \text{and} \qquad \underline{\alpha + \beta}$$

Finally, the commands `\overbrace` and `\underbrace` place braces above or below expressions. A comment can be added as a superscript (for `\overbrace`) or a subscript (for `\underbrace`):

$$a^n = \overbrace{a \times a \times \cdots \times a}^{n \text{ times}}$$

4.2.7 Superimposing Two Symbols

It is possible to superimpose two symbols using the command:

```
\stackrel{<above>}{<below>}
```

For example: `$ x \stackrel{f}{\longmapsto} f(x) $`, which gives $x \stackrel{f}{\longmapsto} f(x)$

4.2.8 Style Modifications

Sets One can typeset the symbols used for the usual number sets. Historically, these sets were printed in bold letters. This can be achieved with the command `\mathbf`:

```
\[
\mathbf{N},\quad \mathbf{R},\quad \mathbf{C}
\]
```

The result:

$$\mathbf{N},\quad \mathbf{R},\quad \mathbf{C}$$

With the development of teaching, these notations had to be written on blackboards. It then became customary to typeset number sets in a special "blackboard bold" font. In LaTeX, this is obtained with the command `\mathbb`:

```
\[
\mathbb{N},\quad \mathbb{R},\quad \mathbb{C}
\]
```

$$\mathbb{N},\quad \mathbb{R},\quad \mathbb{C}$$

It is often useful to typeset uppercase letters in a calligraphic style. This is done with the command `\mathcal`:

```
\[
\mathcal{N},\quad \mathcal{R},\quad \mathcal{C}
\]
```

$$\mathcal{N},\quad \mathcal{R},\quad \mathcal{C}$$

You may also write:

```
\[
\mathcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}
\]
```

$$\mathcal{ABCDEFGHIJKLMNOPQRSTUVWXYZ}$$

4.2.9 Fractions and Roots

Fractions are typeset with the command: `\frac{<numerator>}{<denominator>}`
For example:

```
\[
\frac{1+x^{2}}{1-x^{2}} = ?
\]
```

$$\frac{1+x^{2}}{1-x^{2}} = ?$$

Roots are typeset with the command: `\sqrt[<order>]{<argument>}`
For example:

```
\[
\sqrt{x^{2}+y^{2}},\quad \sqrt[n]{a_{i}}
\]
```

$$\sqrt{x^{2}+y^{2}},\quad \sqrt[n]{a_{i}}$$

4.2.10 Delimiters

One of the very useful mechanisms in LaTeX is that of delimiters. In mathematics, parts of equations are grouped using parentheses, brackets, braces, etc. These elements must adapt their size to the content they enclose.

Examples:

Symbol	Code
$\left(\frac{1}{1+x}\right)$	`$\left(\frac{1}{1+x}\right)$`
$\left(\frac{1}{1+x}\right]$	`$\left(\frac{1}{1+x}\right]$`

If nothing should appear on one side, use the special delimiter `.` :

```
\[ f(x)=
\left\{
\begin{array}{rl}
 x & \text{if } x \geq 0 \\
 -x & \text{if } x < 0
\end{array}
\right. \]
```

$$f(x)=\left\{\begin{array}{rl} x & \text{if } x \geq 0 \\ -x & \text{if } x < 0 \end{array}\right.$$

4.2.11 Symbols with Variable Size

The symbols listed below have variable size: they are smaller in inline math mode and larger in display math mode. This prevents disturbing line spacing in normal text.

Symbol	Code	Symbol	Code
$\sum$	`\sum`	$\prod$	`\prod`
$\coprod$	`\coprod`	$\int$	`\int`
$\oint$	`\oint`	$\bigcap$	`\bigcap`
$\bigcup$	`\bigcup`	$\bigsqcup$	`\bigsqcup`
$\bigvee$	`\bigvee`	$\bigwedge$	`\bigwedge`
$\bigodot$	`\bigodot`	$\bigotimes$	`\bigotimes`
$\bigoplus$	`\bigoplus`	$\biguplus$	`\biguplus`

For these symbols, the bounds are positioned differently in inline and display modes.

```
$\sum_{i=1}^{+\infty} x_i \quad \int_{0}^{+\infty} f(x)\,\mathrm{d}x$

\displaystyle
\sum_{i=1}^{+\infty} x_i \quad \int_{0}^{+\infty} f(x)\,\mathrm{d}x$

\[
\sum_{i=1}^{+\infty} x_i
\quad
\int_{0}^{+\infty} f(x)\,\mathrm{d}x
\]
```

Inline: $\sum_{i=1}^{+\infty} x_i \quad \int_{0}^{+\infty} f(x)\,\mathrm{d}x$ and with `\displaystyle`: $\displaystyle\sum_{i=1}^{+\infty} x_i \quad \int_{0}^{+\infty} f(x)\,\mathrm{d}x$

The second is centered in the full display:

$$\sum_{i=1}^{+\infty} x_i \quad \int_{0}^{+\infty} f(x)\,\mathrm{d}x$$

4.2.12 Functions and Operators

There are specific typographical conventions for mathematical operators and functions. LaTeX provides predefined operators to typeset them properly:

```
\[ \lim_{x\to+\infty} \ln x = +\infty. \]
```

$$\lim_{x\to+\infty} \ln x = +\infty.$$

Several operators are predefined, such as:

$$\sin \quad \cos \quad \tan \quad \log \quad \ln \quad \exp \quad \det \quad \ker \quad \dim \quad \hom$$

$$\lim \quad \limsup \quad \liminf \quad \max \quad \min \quad \sup \quad \inf \quad \gcd \quad \deg$$

Declaring New Operators To create new operators, the `mathtools` package provides two commands:

```
\DeclareMathOperator{\<command name>}{<text to display>}
\DeclareMathOperator*{\<command name>}{<text to display>}
```

Example:

```
\DeclareMathOperator{\Real}{Re}
\DeclareMathOperator*{\Tot}{Toto}

\[ \Real z \]

\[ \Tot_{x=3}^{N} \]
```

gives:

$$\operatorname{Re} z$$

$$\operatorname*{Toto}_{x=3}^{N}$$

4.2.13 Matrices

The `mathtools` package makes it easy to typeset matrices. Several environments are available for this purpose.

Result	Code

$\mathcal A = \begin{matrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{matrix}$	`\[`
	`\mathcal A =`
	`\begin{matrix}`
	`a_{11} & a_{12} & a_{13} \\`
	`a_{21} & a_{22} & a_{23} \\`
	`a_{31} & a_{32} & a_{33}`
	`\end{matrix}`
	`\]`

Delimiters can also be placed around the matrix:

```
\[
\mathcal A =
\begin{pmatrix}
 a_{11} & a_{12} & a_{13} \\
 a_{21} & a_{22} & a_{23}
\end{pmatrix}
=
\begin{bmatrix}
 a_{11} & a_{12} & a_{13} \\
 a_{21} & a_{22} & a_{23}
\end{bmatrix}
\]
```

The code shows

$$\mathcal A = \begin{pmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \end{pmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \end{bmatrix}$$

4.3 Numbered Equations and References

It is often necessary to refer to equations throughout the text, instead of using simple display math mode with `\[ ... \]`, one must use the environment:

```
\begin{equation}
 ...
\end{equation}
```

This environment numbers the equation and allows a label to be added for referencing. Since equation numbers appear in parentheses, it is preferable to use `\eqref` instead of `\ref` when referring to them. **Example**:

```
\begin{equation}\label{EulerEq}
 \mathrm{e}^{\mathrm{i}\pi}+1=0
\end{equation}

We refer to this beautiful equation~\eqref{EulerEq}.
```

It produces:

$$\mathrm{e}^{\mathrm{i}\pi}+1=0 \tag{4.1}$$

We refer to this beautiful equation (4.1).

4.3.1 Aligned Equations

During proofs, it is often necessary to align several equations with respect to a symbol. The `mathtools` package provides the `align` environment, which aligns and numbers equations.

Example:

```
\begin{align}
 \int_{1}^{2} x^{2}\,\mathrm{d}x
 &= \left[\frac{x^{3}}{3}\right]_{1}^{2}
 \label{eq:firststep} \\
 &= \frac{2^{3}}{3} - \frac{1^{3}}{3}
 \nonumber \\
 &= \frac{8}{3} - \frac{1}{3}
 \nonumber \\
 &= \frac{7}{3}
 \label{eq:last}
\end{align}

We go from~\eqref{eq:firststep} to~\eqref{eq:last}
by simple calculation.
```

$$\begin{aligned}
\int_{1}^{2} x^{2}\,\mathrm{d}x &= \left[\frac{x^{3}}{3}\right]_{1}^{2} && (4.2)\\
&= \frac{2^{3}}{3} - \frac{1^{3}}{3}\\
&= \frac{8}{3} - \frac{1}{3}\\
&= \frac{7}{3} && (4.3)
\end{aligned}$$

We go from (4.2) to (4.3) by simple calculation.

To align equations without numbering them, we use the starred version of the environment:

```
\begin{align*}
 \ln(xy) &= \ln x + \ln y, \\
 \exp(x+y) &= \exp(x)\exp(y).
\end{align*}
```

$$\begin{aligned}
\ln(xy) &= \ln x + \ln y,\\
\exp(x+y) &= \exp(x)\exp(y).
\end{aligned}$$

4.4 Theorems, Definitions, etc.

To typeset theorems, definitions, ..., that can be referenced and have typography distinguishing them from the rest of the text, LaTeX provides a mechanism allowing the definition of new environments.

```
\newtheorem{<environment name>}{<Printed text>}
```

For example, one may define the environment `Theorem` as follows:

```
\newtheorem{Theorem}{Theorem}

\begin{Theorem}[Title of the Theorem]\label{thm:test}
   Here is a beautiful theorem!
\end{Theorem}
```

Theorem 1 (Title of the Theorem)**.** *Here is a beautiful theorem!*

Then we can even refer to Theorem 1, using `Theorem~\ref{thm:test}`.

The environment created by the command `\newtheorem` performs the following actions:

1. It prints the *Printed text* (the second argument of the command `\newtheorem`);

2. It prints a number (each created environment is associated with a dedicated counter that is incremented each time the environment is used);

3. It prints, optionally, its optional argument in parentheses;

4. Finally, it prints its content, automatically formatted in italics.

One may therefore create as many environments as necessary: one for theorems, one for definitions, one for lemmas, one for hypotheses, etc., each having its own counter.

Of course, the appearance of theorem environments is fully customizable, but this goes beyond the scope of this brief introduction.

Chapter 5

Presentation Slides with Beamer

Beamer [2–7] is a LaTeX class specifically designed to create presentations intended for projection. It is very useful and often more practical when delivering mathematical talks.

Indeed:

- All the classical LaTeX tools presented in this document are available, in particular for typesetting mathematics, managing bibliographies, creating tables of contents, etc.
- Presentations produced with Beamer are portable: one generates a PDF that is displayed in the same way regardless of the computer used.
- This class allows the creation of dynamic presentations with some simple animations.
- There are many predefined themes, and it is very easy to find one that suits your needs.
- Different versions of a presentation can be managed very easily.

In this chapter, we will only provide a brief introduction. It will be necessary to complement this with the many examples available in the official documentation or online.

This introduction to Beamer is largely inspired by the website:

`https://open-freax.fr/initiation-beamer/`

5.1 Preparing the Document: The Preamble

Here, one needs to load the `beamer` class and choose a theme.

```
\documentclass[options]{beamer}
\usetheme{theme}                % choose a theme (optional)
\usecolortheme{color}           % choose a color theme (optional)
\usefonttheme{font}             % choose a font theme (optional)
```

To choose a theme, consult the official documentation or the following website:

`https://hartwork.org/beamer-theme-matrix/`

You should also check the documentation for available color themes and font themes.

5.1.1 Document Information

The title slide of the presentation is generated using the information provided in the preamble. The following fields can be filled:

```
\title[short title]{title}
\subtitle[short subtitle]{subtitle}
\author[short author(s)]{author(s)}
\institute[short institute]{institute}
\date[short date]{date}
\titlegraphic{\includegraphics{file}}
\subject{subject}
\keywords{keyword(s)}
```

5.2 Slides

A projected presentation necessarily consists of a sequence of slides. The syntax uses the `frame` environment. To structure the presentation, use `\section`, `\subsection`, etc., as in a standard LaTeX document. However, they should not appear inside `frame` environments.

The slide title is defined using the commands:

`\frametitle` and `\framesubtitle`.

Here is an example:

```
\section{My Section}
\subsection{A Subsection}

\begin{frame}
 \frametitle{\insertsection}
 \framesubtitle{\insertsubsection}
 Content
\end{frame}

\begin{frame}
 \frametitle{A Completely Different Title}
 \framesubtitle{A Particular Subtitle}
 Content
\end{frame}
```

A slide is divided into several areas as: a header and a footer; a left and right margin; navigation bars; navigation symbols; a space for a logo; a frame title and subtitle; a background; a content area.

With some work and careful reading of the documentation, all these areas can be customized, although the default settings are often sufficient.

5.3 Table of Contents

Beamer allows automatic generation of a table of contents, which can be inserted at the beginning of a presentation or between sections to indicate progress.

```
\tableofcontents[<options>]
```

Useful options include:

- `currentsection` or `currentsubsection` — highlight the current part;
- `hideothersubsections` — show only the current subsection;
- `hideallsubsections` — hide all subsections.

A typical slide:

```
\begin{frame}
 \frametitle{Table of Contents}
 \tableofcontents
\end{frame}
```

5.4 Blocks

Beamer provides structured content containers called *blocks*. There are three main types:

- `block`
- `alertblock`
- `exampleblock`

Syntax:

```
\begin{block}{Title}
 Content
\end{block}
```

The visual appearance depends on the chosen theme.

5.5 Overlays

Overlays allow progressive display of elements in a frame. Each overlay produces a PDF slide.

Using `\pause`

The simplest method uses `\pause`:

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

Each `\pause` creates a new overlay.

Overlay Specifications

Instead of `\pause`, it is often preferable to use overlay specifications directly on list items:

```
\begin{itemize}
 \item<1-> First item
 \item<2-> Second item
 \item<3-> Third item
\end{itemize}
```

Here:

- `<1->` means: from overlay 1 onward;
- `<2->` means: from overlay 2 onward.

Alerting Items

Items can be emphasized dynamically using `\alert`:

```
\begin{itemize}
 \item<1-> First item
 \item<2-> \alert{Important point}
 \item<3-> Third item
\end{itemize}
```

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CHAPTER 6

USEFUL PACKAGES

In this chapter, we present several packages that are useful for mathematical writing in general: reports, lecture notes, research articles, and other scientific documents.

We do not present these packages exhaustively. Instead, we illustrate their usefulness through selected examples, encouraging readers to explore their documentation further.

LaTeX is free software supported by a large and active community. Thanks to its package mechanism, numerous extensions of the base system have been developed. For most common needs, it is very likely that someone has already encountered the same requirement and created a package providing an appropriate solution.

6.1 Color Management with `xcolor`

The `xcolor` package allows colors to be defined and used easily.

A common way to define a color is:

```
\definecolor{<name>}{<model>}{<coordinates>}
```

This command assigns a <name> to a color, specifies the <model> (such as `rgb`, `RGB`, `cmyk`, `hsb`, `HTML`, etc.), and provides the corresponding <coordinates> (depending on the chosen model).

Examples:

```
\definecolor{myred}{rgb}{0.7,0.1,0.1}
\definecolor{definition}{RGB}{56,97,146}
\definecolor{newcolor}{HTML}{38924E}
```

6.1.1 Using Colors

Once defined, colors can be used in various ways. Common commands include:

```
\textcolor{<color>}{<text>}
```

This prints text in the specified color.

Text can also be placed inside colored boxes:

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```
\colorbox{<color>}{<text>}
\fcolorbox{<frame color>}{<background color>}{<text>}
```

It is also possible to change the current text color until the next change using:

```
\color{<color>}
```

Similarly, the page background color can be changed with:

```
\pagecolor{<color>}
```

6.1.2 Loading Predefined Color Sets

When loading the `xcolor` package, predefined color sets can be activated.

Some basic colors are always available:

```
black, blue, brown, cyan, darkgray, gray, green,
lightgray, lime, magenta, olive, orange, pink,
purple, red, teal, violet, white, yellow
```

Additional sets such as:

- `dvipsnames`
- `svgnames`
- `x11names`

can be enabled when loading the package, for example:

```
\usepackage[svgnames]{xcolor}
```

6.2 Customizing Lists with `enumitem`

The package `enumitem` allows customization of list environments: `enumerate`, `itemize`, and `description`.

Again, the package is very rich in features, and only a brief overview is provided here. It is loaded in the preamble as follows:

```
\usepackage{enumitem}
```

The examples below demonstrate local modifications (i.e., changes applied only to a specific list), although global customization is also possible in the preamble.

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6.2.1 Customizing itemize

The customization of `itemize` mainly consists in changing the bullet symbol.

```
\begin{itemize}[label=$\heartsuit$]
 \item the answer D;
 \item do not overuse it;
 \item 42.
\end{itemize}
```

This produces a list using a heart symbol as bullet:

- ♡ the answer D;
- ♡ do not overuse it;
- ♡ 42.

6.2.2 Customizing enumerate

To change the numbering style, simply modify the label. Several styles are available:

- `\Roman*` produces I, II, III, . . . and `\roman*` produces i, ii, iii, . . .
- `\Alph*` produces A, B, C, . . .
- `\alph*` produces a, b, c, . . .
- `\arabic*` produces 1, 2, 3, . . .

Example:

```
\begin{enumerate}[label=\Roman*]
 \item this is the first;
 \item the second;
 \item etc.
\end{enumerate}
```

This results:

I this is the first;

II the second;

III etc.

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If one wishes to add additional formatting around the number, this can also be done:

```
\begin{enumerate}[label=(\arabic*) -- ]
 \item my first is \dots
 \item my second is \dots
 \item my whole is \dots
\end{enumerate}
```

This produces:

(1) – my first is ...

(2) – my second is ...

(3) – my whole is ...

6.2.3 Customizing `description`

To modify the style of a `description` list, one may use the `font` key (which is also available in `enumerate` and `itemize`). For example:

```
\begin{description}[font=\scshape\bfseries]
 \item[*Test*] This is a text.
\end{description}
```

This displays the label in small caps and boldface:

TEST This is a text.

6.3 Beautiful Framed Boxes with `tcolorbox`

Documents composed with LaTeX tend to have a naturally sober and minimalistic appearance. It may, however, be desirable to highlight certain elements of a document using framed boxes and colors. Numerous packages allow this. Here we present, through a simple example, the use of the `tcolorbox` package.

It is loaded in the preamble as follows:

```
\usepackage{tcolorbox}
```

There are hundreds of options, possible modifications, and customizations. The package documentation is extensive but very well written. We restrict ourselves to two simple examples: the default behavior and a small customization example.

Default Usage

```
\begin{tcolorbox}
 Content of the box.
\end{tcolorbox}
```

Content of the box.

```
\begin{tcolorbox}[title=Box Title]
 Content of the box.
\end{tcolorbox}
```

Box Title

Content of the box.

Customized Example

Using the package options, nearly every aspect of the box can be modified, as illustrated below:

```
\begin{tcolorbox}[
 rightrule=3mm,
 colback=red!5!white,
 colframe=red!75!black,
 arc=0mm,
 after title={\hfill\colorbox{white}{\color{black}approved}},
 title={\bfseries Box Title}
 ]
 This is a \textbf{tcolorbox}.
\end{tcolorbox}
```

Box Title **approved**

This is a **tcolorbox**.

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6.4 Facilitating Mathematical Typesetting with **tdsfrmath**

According to its documentation, the `tdsfrmath` package provides ready-to-use macros for mathematics teachers who wish to use LaTeX without advanced programming.

It is also useful for university students, as it offers numerous commands that simplify common mathematical constructions. It is loaded in the preamble as follows:

```
\usepackage{tdsfrmath}
```

Below is a brief selection of available commands.

Tuples

One can easily typeset n-tuples: `$$\nuplet{a c s d}$$`, which produces:

$$(a,\, c,\, s,\, d)$$

Subsets of $\mathbb{R}$

For subsets of $\mathbb{R}$ (and other sets), several options are available: `$$\R[*+]\quad \R[-m][Y]$$`, which produces:

$$\mathbb{R}_+^* \quad \mathbb{R}_m[Y]$$

Intervals

Intervals can be written simply: `$$\interof{x y}$$`, which produces:

$$]x,\, y]$$

Integrals and Derivatives

They are also simplified by using also `\usepackage{derivative}`. For example:

```
\[
\intgen{2}{5}{\dfrac{\D x}{x^{2}}}, \qquad
\pdv[order={2,3,1}]{f(x,y,z)}{x,y,z} \qquad
\odv{f(x)}{x}
\]
```

which produces:

$$\int_2^5 \frac{\mathrm{d}x}{x^2}, \qquad \frac{\partial^6 f(x,y,z)}{\partial x^2\, \partial y^3\, \partial z}, \qquad \frac{\mathrm{d}f(x)}{\mathrm{d}x}$$

6.5 Customizing Theorems with **thmtools**

The package thmtools allows users to define and customize environments for the typesetting of theorems, definitions, propositions, remarks, and similar structures.

Its possibilities are extensive; here we present only a few examples, mainly inspired by the documentation. The package is loaded as follows:

```
\usepackage{amsthm} % not needed if mathtools is loaded
\usepackage{thmtools}
```

Theorem environments can then be defined in the preamble:

```
\declaretheorem[numberwithin=section,name=Theorem]{theoremS}
```

Example:

```
\begin{theoremS}[Euclid]
 For every prime $p$, there exists a prime $p' > p$.
 In particular, there are infinitely many primes.
\end{theoremS}
```

This produces a theorem numbered within the current section:

Theorem 6.5.1 (Euclid). *For every prime p, there exists a prime $p' > p$. In particular, there are infinitely many primes.*

Custom Styles

Nearly every aspect of the layout can be customized. For instance, one may define a style in the preamble:

```
\declaretheoremstyle[
spaceabove=6pt, spacebelow=6pt,
headfont=\normalfont\bfseries\color{red},
notefont=\mdseries,
notebraces={(}{)},
bodyfont=\itshape,
postheadspace=1em,
qed=\qedsymbol
]{mystyle}

\declaretheorem[style=mystyle,name=Theorem]{styledtheorem}
```

This allows:

```
\begin{styledtheorem}[Euclid]
 For every prime $p$ \dots
\end{styledtheorem}
```

Theorem 1 (Euclid). *For every prime p ...* □

The package also simplifies referencing theorem-like environments. For additional features, consult the documentation. A list of declared theorems can be generated with: `\listoftheorems`.

6.6 Advanced Table Typesetting

We have explored only a small part of table composition in LaTeX. When tables become more complex, the basic mechanisms may no longer suffice. Several packages are particularly useful in such cases.

array

The `array` package extends the `tabular` environment, especially by allowing advanced column formatting and the definition of new column types.

tabularx

Based on `array`, the `tabularx` package provides easier column formatting and introduces the `tabularx` environment, which allows specification of the total width of a table.

longtable

The `longtable` package allows tables to span multiple pages.

booktabs

The `booktabs` package provides additional commands to improve the aesthetics of tables, particularly horizontal rules.

tabularray

The relatively recent (2021) package `tabularray` represents a major evolution in table typesetting in LaTeX. Instead of modifying internal TeX table commands (as traditional packages do), it relies on LaTeX3 functions to analyze and construct tables.

A key feature is the separation between table content and style, with styling handled entirely through a key–value system. Example:

```
\begin{tblr}{
  width=0.8\textwidth,
  colspec={l X[2] X[3] X[-1]},
  row{odd} = {bg=azure8},
  row{1} = {bg=azure3, fg=white, font=\sffamily, c},
  column{1} = {bg=purple7},
  hlines = {1pt, white}, }
 Alpha   & Beta  & Gamma   & Delta   \\
 Epsilon & Zeta  & Eta     & Theta   \\
 Iota    & Kappa & Lambda  & Mu      \\
 Nu      & Xi    & Omicron & Pi      \\
 Rho     & Sigma & Tau     & Upsilon \\
 Phi     & Chi   & Psi     & Omega   \\
\end{tblr}
```

This example illustrates the power and flexibility of the package, especially in separating structure from presentation.

Alpha	Beta	Gamma	Delta
Epsilon	Zeta	Eta	Theta
Iota	Kappa	Lambda	Mu
Nu	Xi	Omicron	Pi
Rho	Sigma	Tau	Upsilon
Phi	Chi	Psi	Omega

6.7 Creating Exercise Sheets with exesheet

When teaching mathematics, one often needs to prepare exercise sheets, examinations, and solutions. The package exesheet, developed by Antoine Missier, provides many commands that simplify the production of such documents (exercise numbering, question environments, structured enumerations, etc.).

It allows exercises and their solutions to be typeset together, with solutions displayed or hidden depending on the chosen options. It also supports grading annotations and marking schemes, as well as the creation of blank spaces for students' answers.

The package may be loaded in several ways:

```
\usepackage{exesheet}
% hides corrections

\usepackage[output=questions]{exesheet}
\usepackage[output=answers]{exesheet}
\usepackage[output=both]{exesheet}
% choose what to display

\usepackage[display=none]{exesheet}
\usepackage[display=pts]{exesheet}
\usepackage[display=notes]{exesheet}
% control grading display

\usepackage[display=notes,marginwidth=unset]{exesheet}
% prevents margin modification when displaying notes
```

The following example
(with the option `\usepackage[display=notes,marginwidth=unset]{exesheet}`)
illustrates the use of this package.

```
\exercise[\totalexe{4}] \label{totalexe}

\begin{questions}
 For each of the following statements, determine whether it is
 true or false. Justify your answer carefully.

 \begin{tablenum1}
  \item $ \int_{0}^{\sqrt{3}}\frac{1}{x+\sqrt{3}} \,\mathrm{d}x = \ln 2$,

  \item $ \int_{2}^{\mathrm{e}} \frac{1}{x\ln x} \,\mathrm{d}x = -\ln 2$,

  \item* The function $F$ defined on $\mathbf{R}$ by
  $F(x) = \int_{0}^{x}\frac{1}{t^2+t+1}\,\mathrm{d} t$
  is increasing on $\mathbf{R}$.
 \end{tablenum1}
\end{questions}
```

```
\begin{answers}
 \begin{enumerate}

  %--------------------------------
  \item \note[1]{0.5 for the anti-derivative \\
   0.5 for simplification of $\ln$}

  We compute:
  \[
  \int_{0}^{\sqrt{3}}\frac{1}{x+\sqrt{3}}\,\mathrm{d}x
  = \Big[ \ln(x+\sqrt{3}) \Big]_0^{\sqrt{3}}
  = \ln(2\sqrt{3}) - \ln(\sqrt{3})
  = \ln\left(\frac{2\sqrt{3}}{\sqrt{3}}\right)
  = \ln 2.
  \]

  \textbf{TRUE}.

  %--------------------------------
  \item \note[1.5]{1 for the anti-derivative \\
   0.5 for the integral value}

  Observe that
  \[
  \frac{1}{x\ln x}
  = \frac{\frac{1}{x}}{\ln x}
  = \frac{u'(x)}{u(x)},
  \quad \text{with } u(x)=\ln x.
  \]

  Thus
  \[
  \int_{2}^{\mathrm{e}}\frac{1}{x\ln x}\,\mathrm{d}x
  = \Big[\ln(\ln x)\Big]_{2}^{\mathrm{e}}
  = \ln(\ln \mathrm{e}) - \ln(\ln 2)
```

```
    = \ln 1 - \ln(\ln 2)
    = -\ln(\ln 2).
    \]

    Hence the proposed equality is false.

    \textbf{FALSE}.

    %--------------------------------
    \item \note*{1.5}

    The function
    \[
    F(x)=\int_{0}^{x}\frac{1}{t^2+t+1}\,\mathrm{d}t
    \]
    is differentiable on $\mathbf{R}$ and

    \[
    F'(x)=\frac{1}{x^2+x+1}.
    \]

    \note{0.5 for $F'$ \\ 1 for the sign of $F'$ and conclusion}

    The denominator is a quadratic polynomial with discriminant
    \[
    \Delta = 1 - 4 = -3 < 0,
    \]
    hence it is always positive on $\mathbf{R}$.

    Therefore $F'(x) > 0$ for all $x \in \mathbf{R}$,
    and $F$ is increasing on $\mathbf{R}$.

    \textbf{TRUE}.

  \end{enumerate}
\end{answers}
```

4 pts

Exercise 1

For each of the following statements, determine whether it is true or false. Justify your answer carefully.

1. $\int_0^{\sqrt{3}} \frac{1}{x+\sqrt{3}}\,\mathrm{d}x = \ln 2$, **2.** $\int_2^{\mathrm{e}} \frac{1}{x\ln x}\,\mathrm{d}x = -\ln 2$,

3. The function F defined on $\mathbf{R}$ by $F(x) = \int_0^x \frac{1}{t^2+t+1}\,\mathrm{d}t$ is increasing on $\mathbf{R}$.

Correction

1
0.5 for the anti-derivative
0.5 for simplification of $\ln$

1.

We compute:

$$\int_0^{\sqrt{3}} \frac{1}{x+\sqrt{3}}\,\mathrm{d}x = \left[\ln(x+\sqrt{3})\right]_0^{\sqrt{3}} = \ln(2\sqrt{3}) - \ln(\sqrt{3}) = \ln\left(\frac{2\sqrt{3}}{\sqrt{3}}\right) = \ln 2.$$

TRUE.

1.5
1 for the anti-derivative
0.5 for the integral value

2.

Observe that

$$\frac{1}{x\ln x} = \frac{\frac{1}{x}}{\ln x} = \frac{u'(x)}{u(x)}, \quad \text{with } u(x) = \ln x.$$

Thus

$$\int_2^{\mathrm{e}} \frac{1}{x\ln x}\,\mathrm{d}x = \left[\ln(\ln x)\right]_2^{\mathrm{e}} = \ln(\ln \mathrm{e}) - \ln(\ln 2) = \ln 1 - \ln(\ln 2) = -\ln(\ln 2).$$

Hence the proposed equality is false.

FALSE.

1.5

3.

The function

$$F(x) = \int_0^x \frac{1}{t^2+t+1}\,\mathrm{d}t$$

is differentiable on $\mathbf{R}$ and

$$F'(x) = \frac{1}{x^2+x+1}.$$

0.5 for F'
1 for the sign of F' and conclusion

The denominator is a quadratic polynomial with discriminant

$$\Delta = 1 - 4 = -3 < 0,$$

hence it is always positive on $\mathbf{R}$.

Therefore $F'(x) > 0$ for all $x \in \mathbf{R}$, and F is increasing on $\mathbf{R}$.

TRUE.

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6.8 Writing Computer Code with `listings`

To use the package `listings`, it must be loaded in the preamble:

```
\usepackage{listings}
```

6.8.1 Standard Usage

Once loaded, one may use the `lstlisting` environment:

```
\begin{lstlisting}
 Code goes here.
\end{lstlisting}
```

The programming language can be specified using the option `language=<language>`. We refer to the `listings` documentation for the complete list of supported languages.
Ç For example, to typeset Python code:

```
\begin{lstlisting}[language=Python]
 def somme(a,b):
 return a+b
 c = somme(4,5)
\end{lstlisting}
```

This produces a formatted block of Python code:

```
def somme(a,b):
return a+b
c = somme(4,5)
```

It is also possible to include code from an external file using:

```
\lstinputlisting[language=Python]{script.py}
```

The command `\lstinputlisting` allows selecting specific lines using the options:

```
firstline=<number>, endline=<number>
```

For example:

```
\lstinputlisting[language=Python,firstline=5,endline=20]{script.py}
```

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6.8.2 Customization

The default formatting is often rather plain. Modern code presentation typically includes monospaced fonts, syntax highlighting, line numbers, and background color.

To configure the default language and style, use `\lstset`. Here, an example of customization:

```
\usepackage{xcolor}

\definecolor{codegreen}{rgb}{0,0.6,0}
\definecolor{codegray}{rgb}{0.5,0.5,0.5}
\definecolor{codepurple}{rgb}{0.58,0,0.82}
\definecolor{backcolour}{rgb}{0.95,0.95,0.92}

\lstset{
 backgroundcolor=\color{backcolour},
 commentstyle=\color{codegreen},
 keywordstyle=\color{magenta},
 numberstyle=\tiny\color{codegray},
 stringstyle=\color{codepurple},
 basicstyle=\ttfamily\footnotesize,
 breakatwhitespace=false,
 breaklines=true,
 numbers=left,
 numbersep=5pt,
 language=Python,
}
```

Then:

```
\begin{lstlisting}
 def somme(a,b):
 return a+b
 c = somme(4,5)
\end{lstlisting}
```

It results the following:

```
def somme(a,b):
return a+b
c = somme(4,5)
```

6.9 Formatting Pseudo-codes

Several packages in LaTeX allow formatting pseudo-code. We describe the main approaches below.

6.9.1 Early Approach: `algorithms`

In 1994, the `algorithms` package [6] provided two environments: `algorithm` and `algorithmic`.

- `algorithm` allows creating floating environments (different from `figure` or `table`, see Sections 2.9 and 2.10) for pseudo-code.
- `algorithmic` generates the actual pseudo-code inside the floating environment.

To use only the floating environment, write `\usepackage{algorithm}`.

6.9.2 Modern Approach: `algorithmicx` and `algpseudocodex`

- The `algorithmic` environment standardized the commands and layout for pseudo-code.
- `algorithmicx` [6] extends its functionality.
- `algpseudocodex` [6] further improves it; it is recommended even though it does not provide French keywords by default.

Example: Euclid's Algorithm

Let's compile the following LaTeX code:

```
\begin{algorithm}
 \begin{algorithmic}[1]
  \Procedure{Euclide}{$a,b$} \Comment{Compute gcd of $a$ and $b$}
  \State $r \gets a \bmod b$
  \While{$r \neq 0$} \Comment{Loop while remainder is not zero}
  \State $a \gets b$
  \State $b \gets r$
  \State $r \gets a \bmod b$
  \EndWhile \label{euclidendwhile}
  \State \Return $b$ \Comment{gcd is $b$}
  \EndProcedure
 \end{algorithmic}
 \caption{Euclid's Algorithm}\label{euclid}
```

```
\end{algorithm}
```

The result:

Algorithm 1 Euclid's Algorithm

procedure EUCLIDE(a, b) ▷ *Compute gcd of a and b*

  $r \leftarrow a \bmod b$

  while $r \neq 0$ **do** ▷ *Loop while remainder is not zero*

    $a \leftarrow b$

    $b \leftarrow r$

    $r \leftarrow a \bmod b$

  return b ▷ *gcd is b*

Using French Keywords

To adapt the pseudo-code keywords to French, add the following in the preamble:

```
\usepackage{algorithm, algpseudocodex}
\algrenewcommand\algorithmicend{\textbf{fin}}
\algrenewcommand\algorithmicdo{\textbf{faire}}
\algrenewcommand\algorithmicwhile{\textbf{tant que}}
\algrenewcommand\algorithmicfor{\textbf{pour}}
\algrenewcommand\algorithmicforall{\textbf{pour tous}}
\algrenewcommand\algorithmicprocedure{\textbf{procédure}}
\algrenewcommand\algorithmicif{\textbf{si}}
\algrenewcommand\algorithmicthen{\textbf{alors}}
\algrenewcommand\algorithmicelse{\textbf{sinon}}
\algrenewcommand\algorithmicreturn{\textbf{retourner}}
```

The result:

Algorithm 2 Algorithme d'Euclide

procédure EUCLIDE(a, b) ▷ *Calculer le PGCD de a et b*

  $r \leftarrow a \bmod b$

  tant que $r \neq 0$ **faire** ▷ *Boucler tant que le reste est différent de zéro*

    $a \leftarrow b$

    $b \leftarrow r$

    $r \leftarrow a \bmod b$

  retourner b ▷ *Le PGCD est b*

CHAPTER 7

PRACTICAL WORKS AND EXAMS

In this chapter, we offer several practical works and exams designed to help students apply the concepts learned throughout the course.

7.1 Practical Works

Practical Work 1: First Lesson in LaTeX

Author: Your Name **Date:** `\today`.

1. What is LaTeX?

LaTeX is a software system for document preparation widely used for high-quality typesetting, particularly in academic and technical fields.

2. Installation Components

LaTeX is composed of two main components:

- **Distribution**: A core system containing compilers, packages, and tools (e.g., MiKTeX for Windows, TeXLive for Linux/macOS).
- **Editor/IDE**: Software to write and compile LaTeX code (e.g., TeXstudio, TeXnicCenter, or Overleaf for online editing).

3. Simple Application

Write the following code and compile your first LaTeX document.

```
\documentclass{article}
\begin{document}
 \title{First Lesson in \LaTeX}
 \maketitle

 Hello Master 1 PDEs and Applications!
\end{document}
```

Practical Work 2: Text Formatting in LaTeX

Author: Your Name
Date: `\today`.

1. Accents and Special Characters

Exercise 1

Write the following accented characters in LaTeX.

```
\'e   \`e   \^e   \"e   \c{c}   \~n
```

Output: é è ê ë ç ñ

2. Font Styles

LaTeX provides several commands to modify text style.

Command	Result
\textbf{text}	**Bold text**
\textit{text}	*Italic text*
\texttt{text}	`Typewriter text`
\underline{text}	Underlined text
\textsc{text}	SMALL CAPS

Exercise 2

Write a paragraph with bold, italic, typewriter, and underlined words.

3. Font Sizes

LaTeXallows different text sizes.

Command	Example
\tiny	Tiny text
\small	Small text
\large	Large text
\Large	Larger text
\huge	Huge text
\Huge	Huge text

Exercise 3

Write the same sentence using three different font sizes.

4. Horizontal and Vertical Spacing

LaTeX automatically manages spacing, but it is sometimes useful to control it manually.

Examples:

```
Hello\quad world
Hello\qquad world
Hello\hspace{1cm}world
```

Output:

Hello $\quad$ world
Hello $\qquad$ world
Hello $\hspace{1cm}$ world

Vertical spacing:

```
First line
\vspace{1cm}
Second line
```

Exercise 4

Write two paragraphs separated by a vertical space of 1 cm.

5. Title, Author, and Date

Exercise 5

Create a document with:

- a title, (using `\title{Introduction to LaTeX}`),
- your name as author, (using `\author{Your Name}`),
- today's date, (using `\date{\today}`).

Then make them in your paper using `\maketitle`.

6. Sections

LaTeXautomatically numbers sections. Example:

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

Exercise 6

Write a short document containing:

- one section,
- two subsections.

Practical Work 3: My First Mathematical Paper Using LaTeX

Author: Your Name

Date: \today.

1. Introduction

In this lesson, we explore some fundamental laws in mathematics and physics and learn how to write these equations in LaTeX.

2. Mathematical Equations

How do we write an equation in LaTeX?
In 1902, Einstein created the energy law:

$$E = mc^2$$

Also, Newton formulated his second law of motion:

$$\sum F = ma$$

We can also write:

$$\sum_{i=1}^{n} i = \frac{n(n+1)}{2}. \tag{7.1}$$

3. Using Symbols

LaTeX provides a variety of symbols for mathematical notation.

- Letters: α, β, γ, π, and ρ.
- Functions: φ, ϕ, and ψ.

4. Using Operators

- Summation:

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$$

- Integral:

$$\int_a^b x^2\,dx = \left[\frac{x^3}{3}\right]_a^b = \frac{b^3}{3} - \frac{a^3}{3}.$$

5. Displaying LaTeX Code

Here is the LaTeX code used in this document.

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

\usepackage[utf8]{inputenc}
\usepackage[T1]{fontenc}
\usepackage{amsmath, amssymb}

\begin{document}

 \title{My First Paper Using \LaTeX}
 \author{Your Name}
 \date{\today}
 \maketitle

 \section{Introduction}

 In this lesson, we will explore some fundamental laws in mathematics and
 physics. We will also learn how to write these equations in \LaTeX.

 \section{Mathematical Equations}

 How do I write an equation in \LaTeX?

 In 1902, Einstein created the energy law: $E = mc^2 $

 Also, Newton formulated his second law of motion: $\sum F = ma $

 We can mention that:
 \begin{equation}
  \sum_{i=1}^{n} i = \frac{n(n+1)}{2}.
 \end{equation}

 \subsection{Using Symbols}

 LaTeX provides a variety of symbols for mathematical notation. Here are
 some commonly used symbols:

 \begin{itemize}
  \item Letters: $\alpha$, $\beta$, $\gamma$, $\pi$, and $\rho$.
```

```
  \item Functions: $\varphi$, $\phi$, and $\psi$.
 \end{itemize}

 \subsection{Using Operators}

 \begin{itemize}
  \item Summation: $\sum_{i=1}^{\infty }\frac{1}{n^{2}}=\frac{\pi^{2}}{6}$.
  % For sum limits we use \displaystyle

  \item Integral:
  \begin{equation*}
   \int_{a}^{b} x^2 \, dx = \left[ \frac{x^3}{3}
   \right]_{a}^{b}=\frac{b^3}{3}-\frac{a^3}{3}.
  \end{equation*}
 \end{itemize}

\end{document}
```

Practical Work 4: Document Structure and Formatting

Author: Your Name

Date: `\today`.

1. Introduction

This document demonstrates the structure and formatting capabilities of LaTeX.

To add a table of contents, we write after `\begin{document}` and `\maketitle` the command `\tableofcontents`.

2. Text Formatting

Here are some examples of text formatting:

- **Bold text** using `\textbf`.
- *Italic text* using `\textit`.
- Underlined text using `\underline`.
- `Monospaced text` using `\texttt`.

3. Lists

LaTeX supports both ordered and unordered lists.

Unordered List

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

Ordered List

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

4. Table of Contents Example

The following example shows a document containing mathematical content and a table of contents.

4.1 Introduction

This document introduces some fundamental **mathematical concepts** and demonstrates how to typeset them using LaTeX. We will cover basic *algebra*, *calculus*, and *geometry*, along with examples of how to format mathematical expressions.

4.2 Basic Algebra

Algebra is the branch of mathematics that deals with symbols and the rules for manipulating them.

4.2.1 Linear Equations

A linear equation in one variable is an equation of the form:

$$ax + b = 0 \tag{7.2}$$

where a and b are constants, and x is the variable. The solution is:

$$x = -\frac{b}{a} \tag{7.3}$$

4.2.2 Quadratic Equations

A **quadratic equation** is of the form:

$$ax^2 + bx + c = 0 \tag{7.4}$$

The solutions are given by the quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \tag{7.5}$$

4.3 Calculus

Calculus is the study of change and motion. It has two main branches: `differential calculus` and `integral calculus`.

4.3.1 Derivatives

1. The derivative of a function $f(x)$ with respect to x is defined as:

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h} \tag{7.6}$$

2. For example, the derivative of $f(x) = x^2$ is:

$$f'(x) = 2x \tag{7.7}$$

4.3.2 Integrals

The integral of a function $f(x)$ represents the area under its curve.

- The definite integral from a to b is:

$$\int_a^b f(x)dx = F(b) - F(a). \tag{7.8}$$

- For example, the integral of $f(x) = x^2$ is:

$$\int x^2\, dx = \frac{x^3}{3} + C \tag{7.9}$$

  where C is the constant of integration.

4.4 Geometry

Geometry is the study of shapes, sizes, and properties of space.

4.4.1 Pythagorean Theorem

In a right-angled triangle, the square of the hypotenuse (c) is equal to the sum of the squares of the other two sides (a and b):

$$c^2 = a^2 + b^2 \tag{7.10}$$

4.4.2 Area of a Circle

The area A of a circle with radius r is:

$$A = \pi r^2. \tag{7.11}$$

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5. Displaying LaTeX Code

Here is the LaTeX code used in this document.

```
\documentclass[a4paper,11pt]{article}

\usepackage[utf8]{inputenc}
\usepackage{amsmath, amssymb}
\usepackage{geometry}
\geometry{a4paper, top=2cm, bottom=2cm, left=3cm, right=3cm}

\title{Document Structure and Formatting}
\author{Your Name}
\date{\today}

\begin{document}

 \maketitle
 \tableofcontents % Add a table of contents

 \section{Introduction}
 This document introduces some fundamental \textbf{mathematical concepts}
 and demonstrates how to typeset them using \LaTeX. We will cover basic
 \textit{algebra}, \textit{calculus}, and \textit{geometry}, along with
 examples of how to format mathematical expressions.

 \section{Basic Algebra}
 Algebra is the branch of mathematics that deals with symbols and the rules
 for manipulating them.

 \subsection{Linear Equations}
 A linear equation in one variable is an equation of the form:
 \begin{equation}
  ax + b = 0
 \end{equation}
 where $ a $ and $ b $ are constants, and $ x $ is the variable. The solution is:
 \begin{equation}
  x = -\frac{b}{a}
 \end{equation}

 \subsection{Quadratic Equations}
 A \textbf{quadratic equation} is of the form:
```

```
\begin{equation}
 ax^2 + bx + c = 0
\end{equation}
The solutions are given by the quadratic formula:
\begin{equation}
 x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}
\end{equation}

\section{Calculus}
\underline{Calculus} is the study of change and motion. It has two main branches:
\texttt{differential calculus} and \texttt{integral calculus}.

\subsection{Derivatives}
\begin{enumerate}
 \item The derivative of a function $ f(x) $ with respect to $ x $ is defined as:
 \begin{equation}
  f’(x) = \lim_{h \to 0} \frac{f(x + h) - f(x)}{h}
 \end{equation}
 \item For example, the derivative of $ f(x) = x^2 $ is:
 \begin{equation}
  f^{\prime}(x) = 2x
 \end{equation}
\end{enumerate}

\subsection{Integrals}
The integral of a function $ f(x) $ represents the area under its curve.
\begin{itemize}
 \item The definite integral from $ a $ to $ b $ is:
 \begin{equation}
  \int_a^b f(x) dx = F(b)-F(a).\,
 \end{equation}
 \item For example, the integral of $ f(x) = x^2 $ is:
 \begin{equation}
  \int x^2 \, dx = \frac{x^3}{3} + C
 \end{equation}
 where $ C $ is the constant of integration.
\end{itemize}

\section{Geometry}
Geometry is the study of shapes, sizes, and properties of space.
```

```
\subsection{Pythagorean Theorem}
In a right-angled triangle, the square of the hypotenuse ($ c $) is equal
to the sum of the squares of the other two sides ($ a $ and $ b $):
\begin{equation}
 c^2 = a^2 + b^2
\end{equation}

\subsection{Area of a Circle}
The area $ A $ of a circle with radius $ r $ is:
\begin{equation}
 A = \pi r^2.
\end{equation}

\end{document}
```

Practical Work 5: Advanced Document Structure

Author: Your Name
Date: \today.

Lesson

Write the following commands in LaTeX, then explain each line:

```
\documentclass[a4paper,11pt]{article}
\usepackage[utf8]{inputenc}
\usepackage{amsmath, amssymb,geometry}
\geometry{a4paper, top=2cm, bottom=2cm, left=3cm, right=3cm}
\begin{document}

 \title{Advanced Document Structure}
 \author{Your Name}
 \date{\today}
 \maketitle
 \tableofcontents

 \section{Introduction}
 ...
 ...
\end{document}
```

See what the difference is between:

```
\begin{equation}
 x+y=2025.
\end{equation}
```

and

```
\begin{equation*}
 x+y=2025.
\end{equation*}
```

Also, `$$x+y=2025$$.` **and** `$x+y=2025$.`

Finally,

```
a_1, a_11, a_{11}.
```

Try to write:

```
\begin{equation*}
 \begin{bmatrix}
  a & b \\
  c & d
 \end{bmatrix}
\end{equation*}
```

Also:

```
\begin{equation*}
 \left[
 \begin{array}{cc}
  a & b \\
  c & d
 \end{array}
 \right]
\end{equation*}
```

Finally,

```
\begin{equation*}
 \begin{cases}
  2x+3y=5, \\
  4x-y=3.
 \end{cases}
\end{equation*}
```

and

```
\begin{equation*}
 \left\{
 \begin{array}{ll}
  2x+3y=5, \\
  4x-y=3.
 \end{array}
 \right.
\end{equation*}
```

Now, we will learn how to name an equation and then call it using the command **\label{key}**

Write the following:

```
\begin{equation}
 (x-1)(x-2) = 0.
 \label{eq}
\end{equation}
Equation (\ref{eq}) admits two solutions: $(x_1;x_2)=(1;2)$.
```

PW On Matrix

This document builds on the previous lesson and introduces more advanced features of LaTeX, including matrices and systems of equations.

1. Text Formatting

Here are some examples of text formatting:
Bold text, *Italic text*, <u>Underlined text</u>, and `Monospaced text`.

2. Mathematical Equations

Here are some examples of mathematical equations:

2.1 Linear Algebra

A system of linear equations can be written in matrix form:

$$\begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

2.2 System of Equations

Solve the following system of equations:

$$\begin{cases} 2x + 3y = 5 \\ 4x - y = 3 \end{cases} \tag{7.12}$$

This can be written in matrix form as:

$$\begin{bmatrix} 2 & 3 \\ 4 & -1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 5 \\ 3 \end{bmatrix}$$

The solution is:

$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 2 & 3 \\ 4 & -1 \end{bmatrix}^{-1} \begin{bmatrix} 5 \\ 3 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

Then, the solution of (7.12) is given by $(x; y) = (1; 1)$.

3. Displaying LaTeX Code

Here is the LaTeX code used in this document.

```
\documentclass[a4paper,10pt]{article}
\usepackage[utf8]{inputenc}
\usepackage{amsmath, amssymb}
\usepackage{geometry}
\geometry{a4paper, top=2cm, bottom=2cm, left=3cm, right=3cm}

\begin{document}

 \title{Advanced Document Structure}
 \author{Your Name}
 \date{\today}
 \maketitle
 \tableofcontents

 \section{Introduction}

 This document builds on the previous lesson and introduces more advanced
 features of \LaTeX, including matrices and systems of equations.

 \section{Text Formatting}

 Here are some examples of text formatting:
```

```
\textbf{Bold text}, \textit{Italic text}, \underline{Underlined text}, and
\texttt{Monospaced text}.

\section{Mathematical Equations}

Here are some examples of mathematical equations:

\subsection{Linear Algebra}

A system of linear equations can be written in matrix form:
\begin{equation*}
 \left[
 \begin{array}{ccc}
  a_{11} & a_{12} & a_{13} \\
  a_{21} & a_{22} & a_{23} \\
  a_{31} & a_{32} & a_{33}%
 \end{array}
 \right]
 \begin{bmatrix}
  x_{1} \\
  x_{2} \\
  x_{3}%
 \end{bmatrix}%
 =%
 \begin{bmatrix}
  b_{1} \\
  b_{2} \\
  b_{3}%
 \end{bmatrix}%
\end{equation*}

\subsection{System of Equations}

Solve the following system of equations:%
\begin{equation}
 \begin{cases}
  2x+3y=5 \\
  4x-y=3%
 \end{cases}
 \label{eq1}
\end{equation}%
```

```
  This can be written in matrix form as:
  \begin{equation*}
   \begin{bmatrix}
    2 & 3 \\
    4 & -1%
   \end{bmatrix}%
   \begin{bmatrix}
    x \\
    y%
   \end{bmatrix}%
   =%
   \begin{bmatrix}
    5 \\
    3%
   \end{bmatrix}%
  \end{equation*}%
  The solution is:
  \begin{equation*}
   \begin{bmatrix}
    x \\
    y%
   \end{bmatrix}%
   =%
   \begin{bmatrix}
    2 & 3 \\
    4 & -1%
   \end{bmatrix}%
   ^{-1}%
   \begin{bmatrix}
    5 \\
    3%
   \end{bmatrix}%
   =%
   \begin{bmatrix}
    1 \\
    1%
   \end{bmatrix}%
  \end{equation*}%
  Then, the solution of (\ref{eq1}) is given by $\left( x;y\right) =\left(
  1;1\right) .$
\end{document}
```

Practical Work 6: Advanced Document Features

Author: Your Name

Date: `\today`.

Lesson

Write the following commands in LaTeX, then explain each line:

```
\documentclass[a4paper,10pt]{article}
\usepackage[utf8]{inputenc}
\usepackage{amsmath, amssymb, geometry}
\geometry{a4paper, top=2cm, bottom=2cm, left=3cm, right=3cm}
\usepackage{graphicx} % For including images
\usepackage{tabularx} % For better table control
\usepackage{booktabs} % For professional-looking tables

\title{Advanced Document Features}
\author{Your Name} \date{\today} \maketitle
\tableofcontents

\section{Introduction}
...
\end{document}
```

1. Introduction

This document introduces advanced features of LaTeX, including tables, figures, cross-referencing, and bibliographies. These tools are essential for creating academic and technical documents.

2. Tables

2.1 Simple Table

Table 7.1: Student Grades in Simple Table

Name	Math	Physics	Chemistry
Ali	85	90	88
Fatima	78	82	80
Oussama	92	88	85

To present it, we should write the following LaTeXcode:

```
\begin{table}[!ht]
 \centering
 \caption{Student Grades in Simple Table}
 \label{tabgrades11}
 \begin{tabular}{|l|c|c|c|}
  \hline
  \textbf{Name} & \textbf{Math} & \textbf{Physics} & \textbf{Chemistry} \\
  \hline
  Ali & 85 & 90 & 88 \\
  \hline
  Fatima & 78 & 82 & 80 \\
  \hline
  Oussama & 92 & 88 & 85 \\
  \hline
 \end{tabular}
\end{table}
```

2.2 Professional Table

Table 7.2: Student Grades in Professional Table

Name	**Math**	**Physics**	**Chemistry**
Ali	85	90	88
Fatima	78	82	80
Oussama	92	88	85

To present it, we should write the following LaTeX code:

```
\begin{table}[!ht]
 \centering
 \caption{Student Grades in Professional Table}
 \label{tabgrades22}
 \begin{tabularx}{0.8\textwidth}{Xccc}
  \toprule
  \textbf{Name} & \textbf{Math} & \textbf{Physics} & \textbf{Chemistry} \\
  \midrule
  Ali & 85 & 90 & 88 \\
  Fatima & 78 & 82 & 80 \\
  Oussama & 92 & 88 & 85 \\
  \bottomrule
```


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```
 \end{tabularx}
\end{table}
```

In Table 7.2, we can see the grades of three students in different subjects. The table is formatted using the `tabularx` and `booktabs` packages for better readability.

3. Figures

Figures are essential for visualizing data. Below is an example of how to include and reference a figure.

```
\begin{figure}[!ht]
 \centering
 \includegraphics[width=0.8\textwidth]{example-image} % Replace with your image file
 \caption{Example Figure: A placeholder image}
 \label{figexample}
\end{figure}
```

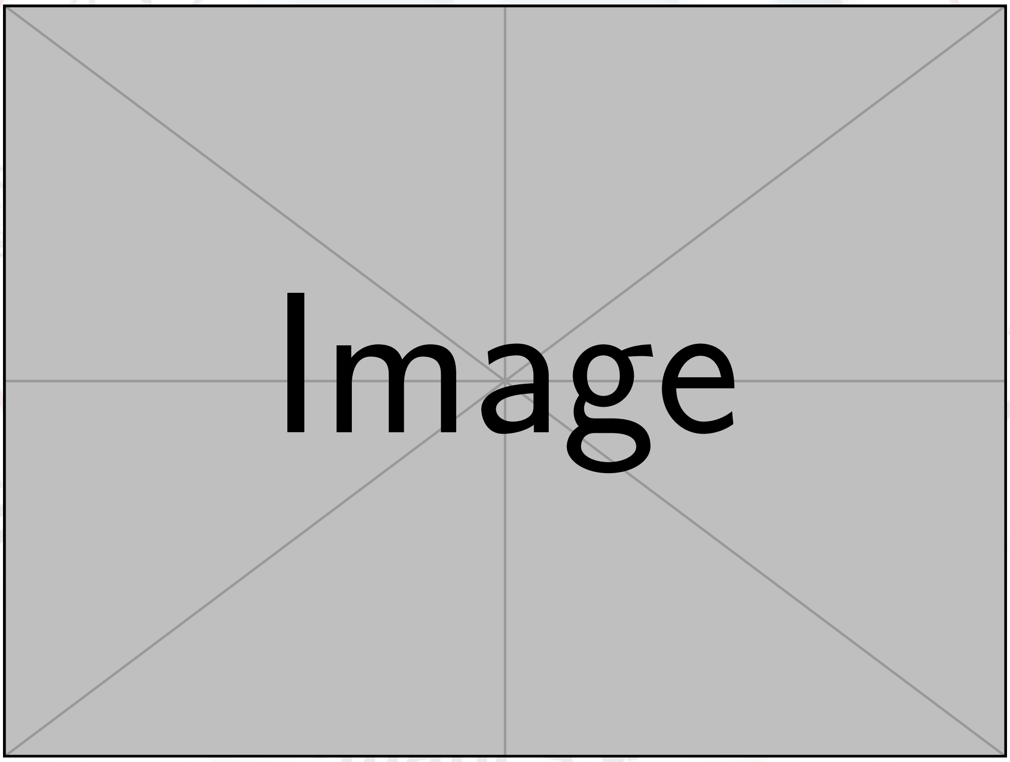

Figure 7.1: Example Figure: A placeholder image

Figure 7.1 shows a placeholder image. You can replace it with any image file (e.g., `.png`, `.jpg`, or `.pdf`) by specifying the file name in the `\includegraphics` command

(For more details see [1]).

Bibliography

[1] B. Basti, *Course in LaTeX*, University Mohamed Boudiaf of M'sila, 2026.

Practical Exercises

Exercise 1: Create a Table

Create a table that lists the following data about books:

- Title: "Introduction to Algorithms", Author: "Cormen et al.", Year: 2009
- Title: "The Art of Computer Programming", Author: "Donald Knuth", Year: 1968
- Title: "Clean Code", Author: "Robert C. Martin", Year: 2008

Include a caption, cite references, and label the table as 'tabbooks'.

Exercise 2: Add a Bibliography

Create a bibliography with the following references:

- A book: "Introduction to Algorithms" by Cormen et al., published in 2009.
- An article: "The Art of Computer Programming" by Donald Knuth, published in 1968.

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Practical Work 7: Advanced Document Features 2

Author: Your Name

Date: `\today`.

1. Triangle Inequality

For any two vectors (or real numbers) x and y, the following holds:

$$\|x+y\| \leq \|x\| + \|y\| .$$

This inequality is a fundamental property of norms and absolute values.

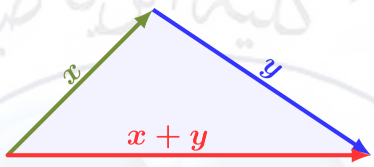

Figure 7.2: Visual representation of the triangle inequality in vector space

2. The Heat Equation

Consider the IVP for the heat equation on a bounded domain $\Omega \subset \mathbb{R}^n$:

$$\begin{cases} \dfrac{\partial u}{\partial t} = \Delta u + f(x,t) & \text{in } \Omega \times (0,T], \\ u(x,0) = u_0(x) & \text{for } x \in \Omega, \\ u(x,t) = 0 & \text{on } \partial\Omega \times [0,T] \end{cases}$$

where:

- $u(x,t)$ represents the temperature distribution
- $f(x,t)$ is a heat source term
- $u_0(x)$ is the initial temperature distribution
- Δ is the Laplacian operator

Theorem 7.1 (Existence and Uniqueness). *For $u_0 \in L^2(\Omega)$ and $f \in L^2(0,T;H^{-1}(\Omega))$, there exists a unique weak solution:*

$$u \in L^2(0,T;H_0^1(\Omega)) \cap C([0,T];L^2(\Omega))$$

with $\dfrac{\partial u}{\partial t} \in L^2(0,T;H^{-1}(\Omega))$.

For more resources on LaTeX, visit `https://www.latex-project.org/` or the Overleaf documentation here.

Bibliography

[1] L. C. Evans, *Partial Differential Equations*, AMS, Providence, RI, 2010.

[2] A. Sengouga, *Course on Measure and Integration*, Univ. of M'sila, 2012.

Good LaTeX Practice!

Displaying LaTeX Code

Here is the LaTeX code used in this document.

```
\documentclass[a4paper,11pt]{article}
\usepackage[utf8]{inputenc}
\usepackage{amsmath, amssymb, geometry}
\geometry{a4paper, top=1cm, bottom=1.9cm, left=3cm, right=3cm}
\usepackage{graphicx}
\usepackage{hyperref} % For clickable links

\newtheorem{theorem}{Theorem}

\begin{document}

 \title{TP 06: Advanced Document Features}
 \author{Your Name}    \date{\today}
 \maketitle

 \section{Triangle Inequality}
 For any two vectors (or real numbers) $x$
 and $y$, the following holds:
 \begin{equation*}
  \left\Vert x+y\right\Vert \leq \left\Vert x\right\Vert +\left\Vert y\right\Vert.
 \end{equation*}
 This inequality is a fundamental property of norms and absolute values.%
 \begin{figure}[h]
  \centering
  \includegraphics[width=0.3\textwidth]{triangle_inequality.png}
  \caption{Visual representation of the triangle inequality in vector space}
  \label{fig11}
 \end{figure}
```

```
\section{The Heat Equation}
Consider the IVP for the heat equation on a bounded domain
$\Omega \subset \mathbb{R}^n$:

\begin{equation*}
 \begin{cases}
  \dfrac{\partial u}{\partial t} = \Delta u + f(x,t) & \text{in }%
  \Omega \times (0,T], \\
  u(x,0) = u_0(x) & \text{for } x \in \Omega, \\
  u(x,t) = 0 & \text{on } \partial\Omega \times [0,T]
 \end{cases}
\end{equation*}
where:
\begin{itemize}
 \item $u(x,t)$ represents the temperature distribution
 \item $f(x,t)$ is a heat source term
 \item $u_0(x)$ is the initial temperature distribution
 \item $\Delta$ is the Laplacian operator
\end{itemize}

\begin{theorem}[Existence and Uniqueness]
 For $u_0 \in L^2(\Omega)$ and $f \in L^2(0,T;H^{-1}(\Omega))$, there exists a
 unique weak solution:
 \begin{equation*}
  u \in L^2(0,T;H^1_0(\Omega)) \cap C([0,T];L^2(\Omega))
 \end{equation*}
 with $\dfrac{\partial u}{\partial t} \in L^2(0,T;H^{-1}(\Omega))$.
\end{theorem}

For more resources on \LaTeX, visit \url{https://www.latex-project.org/}
or the Overleaf documentation \href{https://www.overleaf.com/learn}{here}.

\begin{thebibliography}{9}
 \bibitem{Evans} L. C. Evans, \textit{Partial Differential Equations}, AMS,
 Providence, RI, 2010.
 \bibitem{Sengouga} A. Sengouga, \textit{Course on Measure and Integration},
 Univ. of M'sila, 2012.
\end{thebibliography}

\begin{flushright}
 Good \LaTeX\ Practice!
\end{flushright}
\end{document}
```

Practical Work 8: Theorems and Proofs in Functional Analysis

Author: $\mathfrak{B}$. $\mathfrak{B}$**asti** (Master PDEs and Applications)

Date: `\today`.

1. The Fourier Transform

Definition 7.1 (Fourier Transform). *For $f \in L^1(\mathbb{R}^n)$, the Fourier transform $\hat{f}$ is defined as*

$$\hat{f}(\xi) = \int_{\mathbb{R}^n} f(x) e^{-2\pi i x \cdot \xi} \, dx.$$

Remark 7.1. *The Fourier transform converts differentiation into multiplication. More precisely, if f is sufficiently smooth, then*

$$\widehat{\partial_{x_j} f}(\xi) = 2\pi i \xi_j \hat{f}(\xi).$$

This property makes the Fourier transform extremely useful for solving linear partial differential equations.

Theorem 7.2 (Plancherel's Theorem). *The Fourier transform extends uniquely to a unitary operator on $L^2(\mathbb{R}^n)$ and satisfies*

$$\left\|\hat{f}\right\|_{L^2} = \|f\|_{L^2}.$$

Proof. One first proves the identity for Schwartz functions. The result then extends to all of $L^2(\mathbb{R}^n)$ by density, since $\mathcal{S}(\mathbb{R}^n)$ is dense in $L^2(\mathbb{R}^n)$ (see [3]). □

2. Sobolev Spaces

Definition 7.2 (Sobolev Space [2]). *For $k \in \mathbb{N}$ and $1 \leq p \leq \infty$, the Sobolev space $W^{k,p}(\Omega)$ consists of all functions $u \in L^p(\Omega)$ whose weak derivatives up to order k also belong to $L^p(\Omega)$.*

Remark 7.2. *Sobolev spaces generalize the notion of classical differentiability. Even functions that are not differentiable in the classical sense may possess weak derivatives and therefore belong to a Sobolev space.*

Theorem 7.3 (Sobolev Embedding [1]). *Let $\Omega \subset \mathbb{R}^n$ be a bounded domain with smooth boundary. If $kp > n$, then we have the continuous embedding*

$$W^{k,p}(\Omega) \hookrightarrow C^0\left(\overline{\Omega}\right).$$

Lemma 7.1 (Rellich–Kondrachov [1,2]). *If Ω is bounded with Lipschitz boundary, the embedding*

$$W^{1,p}(\Omega) \hookrightarrow L^q(\Omega)$$

is compact for $1 \leq q < p^*$, where

$$p^* = \frac{np}{n-p}.$$

3. Hilbert Space Theory

Theorem 7.4 (Projection Theorem). *Let H be a Hilbert space and $K \subset H$ a closed convex subset. For any $x \in H$, there exists a unique $y \in K$ such that*

$$\|x - y\| = \inf_{z \in K} \|x - z\|.$$

Corollary 7.1. *Every closed subspace M of a Hilbert space H admits an orthogonal complement $M^\perp$ such that*

$$H = M \oplus M^\perp.$$

Remark 7.3. *This decomposition allows every element $x \in H$ to be written uniquely as $x = m + m^\perp$ with $m \in M$ and $m^\perp \in M^\perp$. Such orthogonal decompositions are fundamental in approximation theory and spectral analysis (see [1]).*

Bibliography

[1] H. Brezis, *Functional Analysis, Sobolev Spaces and Partial Differential Equations*, Springer, 2011.

[2] L. C. Evans, *Partial Differential Equations*, AMS, 2010.

[3] E. M. Stein and R. Shakarchi, *Fourier Analysis: An Introduction*, Princeton University Press, 2003.

Happy LaTeX. Enjoy!

Displaying LaTeX Code

Here is the LaTeX code used in this document.

```
\documentclass[a4paper,11pt]{article}
\usepackage{amsfonts} \usepackage[utf8]{inputenc}
\usepackage{amsmath, amssymb} \usepackage{graphicx}
\usepackage{geometry} \usepackage{hyperref}
\usepackage{amsthm}

\geometry{a4paper, top=1cm, bottom=1.9cm, left=2.8cm, right=2.6cm}
\def\baselinestretch{1.3}
\newtheorem{theorem}{Theorem}[section]
\newtheorem{lemma}[theorem]{Lemma}
\newtheorem{corollary}[theorem]{Corollary}
\newtheorem{definition}[theorem]{Definition}

\begin{document}

 \title{\textbf{PW 7: Theorems and Proofs in Functional Analysis}}
 \author{\textbf{$\mathfrak{B}.$ $\mathfrak{B}$asti} (Master PDEs and Applications)}
 \date{\today}
 \maketitle

 \section{The Fourier Transform}

 \begin{definition}[Fourier Transform]
  For $f\in L^{1}\left( \mathbb{R}^{n}\right) $, the Fourier transform $\hat{f}$
  is defined as
  \begin{equation*}
   \hat{f}\left( \xi \right)
```

```
  =
  \int_{\mathbb{R}^{n}} f(x)e^{-2\pi i x\cdot \xi}\,dx .
 \end{equation*}
\end{definition}

\begin{remark}
 The Fourier transform converts differentiation into multiplication.
 More precisely, if $f$ is sufficiently smooth, then
 \[
 \widehat{\partial_{x_j}f}(\xi)=2\pi i \xi_j\,\hat f(\xi).
 \]
 This property makes the Fourier transform extremely useful for solving
 linear partial differential equations.
\end{remark}

\begin{theorem}[Plancherel's Theorem]
 The Fourier transform extends uniquely to a unitary operator on
 $L^{2}\left( \mathbb{R}^{n}\right)$ and satisfies
 \begin{equation*}
  \left\Vert \hat{f}\right\Vert _{L^{2}}
  =
  \left\Vert f\right\Vert _{L^{2}}.
 \end{equation*}
\end{theorem}

\begin{proof}
 One first proves the identity for Schwartz functions. The result then
 extends to all of $L^{2}(\mathbb{R}^{n})$ by density, since
 $\mathcal{S}(\mathbb{R}^n)$ is dense in $L^2(\mathbb{R}^n)$
 (see \cite{SteinShakarchi}).
\end{proof}

\section{Sobolev Spaces}

\begin{definition}[Sobolev Space \cite{Evans}]
 For $k\in \mathbb{N}$ and $1\leq p\leq \infty $, the Sobolev space
 $W^{k,p}\left( \Omega \right)$ consists of all functions
 $u\in L^{p}\left(\Omega\right)$ whose weak derivatives up to order $k$
 also belong to $L^{p}\left(\Omega\right)$.
\end{definition}

\begin{remark}
 Sobolev spaces generalize the notion of classical differentiability.
 Even functions that are not differentiable in the classical sense may
 possess weak derivatives and therefore belong to a Sobolev space.
```

```
\end{remark}

\begin{theorem}[Sobolev Embedding \cite{Brezis}]
 Let $\Omega \subset \mathbb{R}^{n}$ be a bounded domain with smooth
 boundary. If $kp>n$, then we have the continuous embedding
 \begin{equation*}
  W^{k,p}\left(\Omega\right)
  \hookrightarrow
  C^{0}\left(\overline{\Omega}\right).
 \end{equation*}
\end{theorem}

\begin{lemma}[Rellich--Kondrachov \cite{Brezis,Evans}]
 If $\Omega$ is bounded with Lipschitz boundary, the embedding
 \[
 W^{1,p}\left(\Omega\right)
 \hookrightarrow
 L^{q}\left(\Omega\right)
 \]
 is compact for $1\le q<p^\ast$, where
 \[
 p^\ast=\frac{np}{n-p}.
 \]
\end{lemma}

\section{Hilbert Space Theory}

\begin{theorem}[Projection Theorem]
 Let $H$ be a Hilbert space and $K\subset H$ a closed convex subset.
 For any $x\in H$, there exists a unique $y\in K$ such that
 \begin{equation*}
  \left\Vert x-y\right\Vert
  =
  \inf_{z\in K}\left\Vert x-z\right\Vert .
 \end{equation*}
\end{theorem}

\begin{corollary}
 Every closed subspace $M$ of a Hilbert space $H$ admits an orthogonal
 complement $M^\perp$ such that
 \[
 H = M \oplus M^\perp .
 \]
\end{corollary}
```

```
 \begin{remark}
  This decomposition allows every element $x\in H$ to be written uniquely
  as $x = m + m^\perp$ with $m\in M$ and $m^\perp\in M^\perp$.
  Such orthogonal decompositions are fundamental in approximation theory
  and spectral analysis (see \cite{Brezis}).
 \end{remark}

 \begin{thebibliography}{9}

  \bibitem{Brezis}
  H. Brezis,
  \textit{Functional Analysis, Sobolev Spaces and Partial Differential Equations},
  Springer, 2011.

  \bibitem{Evans}
  L. C. Evans,
  \textit{Partial Differential Equations},
  AMS, 2010.

  \bibitem{SteinShakarchi}
  E. M. Stein and R. Shakarchi,
  \textit{Fourier Analysis: An Introduction},
  Princeton University Press, 2003.

 \end{thebibliography}

 \begin{flushright}
  Happy \LaTeX. Enjoy!
 \end{flushright}
\end{document}
```

Faculty of Mathematics and Computer Sciences

Practical Work 9: Creating Presentations with Beamer

Author: Your Name   **Date:** `\today`

1. Introduction

The `beamer` class allows users to create professional presentations directly in LaTeX. It is widely used in academic contexts for lectures, seminars, and conference talks.

A Beamer presentation is composed of **frames**, each corresponding to a slide. The structure is similar to a normal LaTeX document but uses the document class:

```
\documentclass{beamer}
```

2. Itemize with Alerts

Beamer allows the progressive display of list items using **overlay specifications**. The notation `<1->`, `<2->`, etc., determines when an element appears.

- `<1->`: appears from slide step 1 onward
- `<2->`: appears from slide step 2 onward
- `\alert`: highlights important elements

3. Example: Alerted Items

The following frame demonstrates how to highlight items progressively.

```
\begin{frame}
 \begin{itemize}
  \item<1-> Normal item
  \item<2-> \alert<2>{Alerted item}
  \item<3-> Another normal item
 \end{itemize}
\end{frame}
```

4. Transparent Covered Items

Inactive items can be displayed with reduced opacity using:

```
\setbeamercovered{transparent=30}
```

Example:

```
\begin{frame}
 \setbeamercovered{transparent=30}

 \begin{itemize}[<+-| alert@+>]
  \item First item (alerted first)
  \item Second item (alerted next)
```

```
  \item Third item (alerted last)
 \end{itemize}

\end{frame}
```

5. Blocks and Alert Blocks

Beamer provides special environments to highlight content:

- `block` for standard statements
- `alertblock` for important results
- `exampleblock` for examples

Example:

```
\begin{frame}

 \begin{block}{Definition}
  This appears with red borders on Definition 1
 \end{block}

 \begin{alertblock}{Important Theorem 1}<2->
  This appears with red borders on Theorem 1
 \end{alertblock}

 \begin{alertblock}{Important Theorem 2}<3->
  This appears with red borders on Theorem 2
 \end{alertblock}

\end{frame}
```

6. Mathematical Example

Beamer is especially useful for mathematical presentations. The following slide illustrates the progressive discussion of a theorem.

```
\begin{frame}{Sobolev Embedding Theorem}

 \setbeamercovered{transparent=30}

 \begin{theorem}<1->
  W^{k,p}(\Omega) \hookrightarrow
  C^0(\overline{\Omega}) when kp > n
 \end{theorem}

 \begin{itemize}[<+-| alert@+>]
  \item Key idea: Morrey’s inequality
```

```
  \item Critical case: kp = n
  \item Counterexample when kp < n
 \end{itemize}

 \begin{alertblock}{Application}<4->
  Proving regularity for PDE solutions
 \end{alertblock}

\end{frame}
```

7. Exercises

Exercise 1. Create a simple Beamer presentation containing:

- A title page using `\title`, `\author` and `\date`.
- One slide introducing the topic of your presentation.
- One slide containing a short itemized list.

Exercise 2. Create a slide with a progressive list using overlay specifications:

- Each item should appear one after another using `<1->`, `<2->`, and `<3->`.
- Highlight one of the items using the command `\alert`.

Exercise 3. Produce a slide containing mathematical content. For example, present the quadratic formula:

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

Use a `block` or `alertblock` to emphasize the formula.

Exercise 4. Create a slide explaining the **Sobolev Embedding Theorem**. Your slide should contain:

- A theorem environment displaying the embedding

$$W^{k,p}(\Omega) \hookrightarrow C^0(\overline{\Omega}) \quad \text{when } kp > n.$$

- A progressive list explaining the main ideas behind the theorem.
- An `alertblock` highlighting an application to partial differential equations.

Exercise 5. Create a small presentation of three slides about a mathematical topic of your choice (for example Fourier transform, Hilbert spaces, or linear algebra). Your presentation should contain:

- A title slide.
- A slide with progressive itemization.
- A slide containing a theorem or important formula highlighted using a block.

7.2 Final Exam: LaTeX for Master 1 PDEs and Applications

Duration: 2 Hours **Date:** May 13^{th}, 2025

Instructions

Prepare the following document using LaTeX and compile it with `TeXStudio`. The document must:

- Use the class `article` with the options `a4paper` and `11pt`.
- Include the packages `amsmath`, `amssymb`, `amsfonts`, and `geometry`.
- Use the page margins: top $= 2\,\text{cm}$, bottom $= 2\,\text{cm}$, left $= 3\,\text{cm}$, right $= 2.8\,\text{cm}$.
- Contain a title, an abstract, a table of contents, sections, theorem environments, and references.

Your final document should be approximately **two pages** long.

Exercise 1: Document Structure

Create a title page containing:

- The title: **Exam in LaTeX, Master 1 PDEs and Applications**
- Your full name as the author
- A footnote indicating your department
- The date of the exam

Add a table of contents and an abstract describing the purpose of the document.

Exercise 2: Document Content

1. Create a section entitled **Sobolev Spaces**. Inside this section, define the following concept.

Definition 7.3 (Sobolev Space [3]). *For $k \in \mathbb{N}$ and $1 \leq p \leq \infty$, the Sobolev space $W^{k,p}(\Omega)$ consists of all functions $u \in L^p(\Omega)$ whose weak derivatives up to order k also belong to $L^p(\Omega)$.*

Definition 7.4 (Weak Solution). *Let $\Omega \subset \mathbb{R}^n$ be an open domain. A function $u \in W_0^{1,2}(\Omega)$ is called a weak solution of*

$$-\Delta u = f \quad \text{in } \Omega$$

if

$$\int_\Omega \nabla u \cdot \nabla v \, dx = \int_\Omega f v \, dx \quad \text{for all } v \in W_0^{1,2}(\Omega).$$

2. Create a subsection entitled **Lax–Milgram Theorem**, and insert its principle.

Theorem 7.5 (Lax–Milgram Theorem). *Let V be a Hilbert space, $a(\cdot,\cdot)$ a continuous and coercive bilinear form on $V \times V$, and L a continuous linear functional on V. Then there exists a unique $u \in V$ such that*

$$a(u,v) = L(v) \quad \text{for all } v \in V.$$

Proof. Define the operator $A : V \to V^*$ by

$$(Au)(v) = a(u,v), \qquad v \in V.$$

The continuity of a implies that A is bounded, while coercivity yields $\langle Au, u\rangle \geq \alpha \|u\|_V^2$ for some $\alpha > 0$, hence A is invertible. Therefore, for any $L \in V^*$ there exists a unique $u \in V$ such that $Au = L$, which is equivalent to $a(u,v) = L(v)$ for all $v \in V$ (see [1, 2]). $\square$

Exercise 3: Document Completing

Create a new section entitled **Galerkin approximation**. Then write:
Let $\{\phi_1, \phi_2, \dots\}$ be a basis of $W_0^{1,2}(\Omega)$. Then the Galerkin approximation:

$$u_n = \sum_{i=1}^{n} c_i \phi_i$$

satisfying

$$\int_\Omega \nabla u_n \cdot \nabla \phi_j \, dx = \int_\Omega f \phi_j \, dx, \quad j = 1, \dots, n.$$

Exercise 4: Bibliography

Create a bibliography using the following references:

[1] H. Brezis, *Functional Analysis, Sobolev Spaces and Partial Differential Equations*, Springer, 2011.

[2] L. C. Evans, *Partial Differential Equations*, AMS, 2010.

[3] R. A. Adams and J. J. Fournier, *Sobolev Spaces*, 2nd ed., Academic Press, 2003.

Good Luck in the LaTeX Exam!

Faculty of Mathematics and Computer Sciences

Bibliography

[1] Jacques André, *Petites leçons de typographie*, 2017.
URL: http://jacques-andre.fr/faqtypo/lessons.pdf.

[2] Marc Baudoin, *Apprends LaTeX!*, 2012.
URL: https://www.ctan.org/texarchive/info/apprends-latex/.

[3] Claudio Beccari et Enrico Gregorio, *The imakeidx package. A package for producing multiple indexes*, Version 1.3e, 15 Oct. 2016. URL: https://ctan.org/pkg/imakeidx.

[4] Denis Bitouzé, *Conférence 1 : les bases de LaTeX*, 2020. URL: https://mt2e.univ-littoral.fr/Members/denis-bitouze/pub/latex/diapositives-cours-d/conference-n-1/view.

[5] Denis Bitouzé and Jean-Côme Charpentier, *Introduction à LaTeX*, Pearson, July 2010, ISBN: 2-7440-7451-9. URL: http://www.pearson.fr/livre/?GCOI=27440100259650.

[6] Maxime Chupin, *Très courte initiation à LaTeX*, 2020.
URL: https://www.ceremade.dauphine.fr/ chupin/LaTeX/initLaTeX.pdf.

[7] Aissa Djeriou, *Polycopie de "TP de Langage LaTeX"*, University Mohamed Boudiaf M'sila, 2024.
URL: https://depot.univ-msila.dz/handle/123456789/43473.

[8] Donald E. Knuth, *Le TeXbook : composition informatique*, Trad. par Jean-Côme Charpentier. Vuibert informatique, Vuibert, 2003.

[9] Leslie Lamport, *LaTeX: a document preparation system*, Addison-Wesley, 1994.
URL: http://www.informit.com/store/product.aspx?isbn=0201529831.

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