SKILLPILLS

Skill Pill: LaTeX Course

Lecture 1: The Basics of Typesetting

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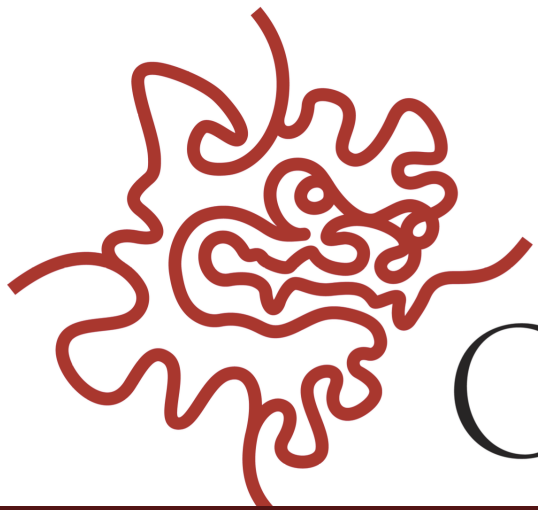
January 18, 2016



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Overleaf

If you have not installed LaTeX on your computer, you may use Overleaf, which is an online LaTeX editor.

`https://www.overleaf.com`

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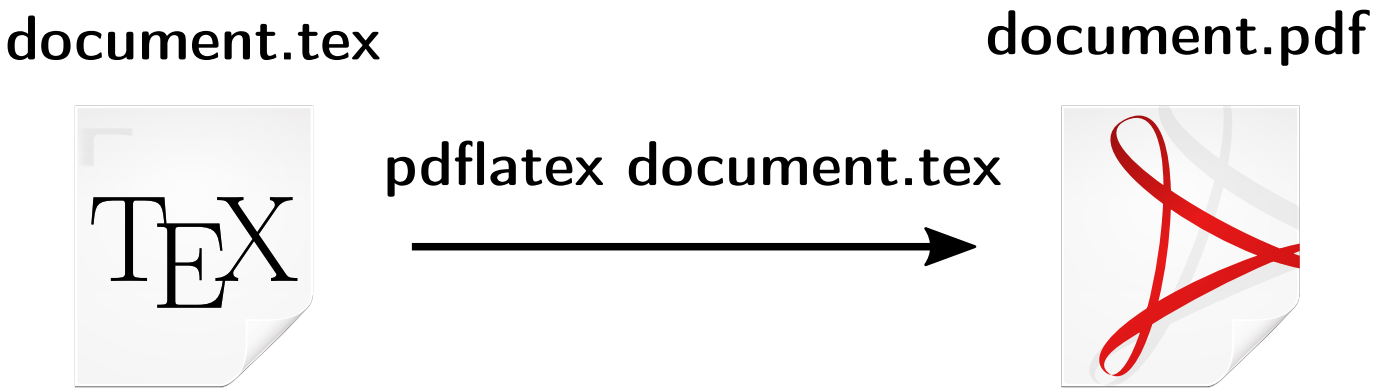
Creation of a LaTeX-document



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A First Example

```
\documentclass{scrartcl}

\usepackage[ngerman,spanish,english]{babel}
\usepackage[utf8]{inputenc}
\usepackage[T1]{fontenc}

\title{My First \LaTeX\ Document}
\author{Author}
\date{\today}

\begin{document}

\maketitle
\section{How it Began}
This is my first \LaTeX\ document!

\end{document}
```

My First LaTeX Document

Author

January 18, 2016

1 How it Began

This is my first LaTeX document!

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Structure of a LaTeX-command

- Command:

```
\command[optional argument]{argument}
```

  If there is more than one optional argument, separate them by commas.

- Environments:

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

- Comments are made using %.

The Document Classes

```
\documentclass{scrartcl}
```

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```

- possible document classes:
  - `scrartcl`, `scrreprt`, `scrbook` (`article`, `report`, `book` resp.)
  - `beamer`
  - `letter`

The Document Classes

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`\documentclass{scrartcl}`

- possible document classes:
  - `scrartcl`, `scrreprt`, `scrbook` (`article`, `report`, `book` resp.)
  - `beamer`
  - `letter`
- possible preferences:
  - Font size (e. g. `11pt`)
  - Paper format (e. g. `a4paper`)
  - Number of columns (`onecolumn` or `twocolumn`)
  - One-sided/two-sided margins (`oneside` or `twoside`)

Example: `\documentclass[a4paper, 11pt, twocolumn]{scrartcl}`

The Preamble – Including Packages

```
\usepackage[ngerman,spanish,english]{babel}
\usepackage[utf8]{inputenc}
\usepackage[T1]{fontenc}
```

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\usepackage[ngerman,spanish,english]{babel}
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Important packages:

- `babel` Definition of language(s) – important for hyphenation
- `inputenc` Input encoding – important to use special characters
- `fontenc` Font encoding – important for diacritics

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\usepackage[ngerman,spanish,english]{babel}
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Important packages:

- `babel` Definition of language(s) – important for hyphenation
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- `fontenc` Font encoding – important for diacritics

There are many more packages, useful for formatting your document.

The Preamble – \title, \author, \date

```
\title{My First \LaTeX\ Document}
\author{Author}
\date{\today}
```

The Preamble – \title, \author, \date

```
\title{My First \LaTeX\ Document}
\author{Author}
\date{\today}
```

`\title{}`, `\author{}`, `\date{}` define title, author, and date of the document

`\today` includes today's date. The formatting of the date is determined by the defined language.

`\LaTeX` creates the LaTeX-logo

The Document

```
\begin{document}

\maketitle
\section{How it Began}
This is my first \LaTeX\ document!

\end{document}
```

```
\begin{document}

\maketitle
\section{How it Began}
This is my first \LaTeX\ document!

\end{document}
```

`\begin{document}` ... `\end{document}` divides document and preamble

`\maketitle` creates the title (based on `\title`, `\author`, `\date` in the preamble)

`\section` creates a numbered section

Table of Contents

```
\section{A Section of the Document}
Text of a section.

\subsection{A Subsection}
Text of a subsection.

\subsubsection{A Subsubsection}
Further Text

\paragraph{A Paragraph}
blabla

\subparagraph{A Subparagraph}
blablabla
```

1 A Section of the Document

Text of a section.

1.1 A Subsection

Text of a subsection.

1.1.1 A Subsubsection

Further Text

A Paragraph blabla

A Subparagraph blablabla

Line Breaks and Paragraphs

Line breaks are created with `\newline` or short `\\`.

Paragraphs are created by empty lines or `\par`. To avoid the indentation, one may use `\noindent`.

Be aware of *widows* and *orphans* (*clubs*)!

Widow The last sentence of a paragraph that appears as first sentence of a new page or paragraph.

Orphan A paragraph opening that appears as the last sentence of a page or column.

This is suppressed by `\clubpenalty = 10000` `\widowpenalty = 10000`

Table of Contents

The table of contents is created by `\tableofcontents`.

The table of contents is created by `\tableofcontents`.

Contents

Emphasize

In order to emphasize words/phrases one can use `\emph{}`. The emphasized text will be *cursive* if the rest of the text is upright/print, and the other way around.

Other possibilities for highlighting are:

- `\textbf{}` – **bold**
- `\textit{}` – *cursive* (as `\emph{}`)
- `\textsc{}` – Small Capitals
- `\underline{}` – underline

Font Size

`\Huge`	Text
`\huge`	Text
`\LARGE`	Text
`\Large`	Text
`\large`	Text
`\normalsize`	Text
`\small`	Text
`\footnotesize`	Text
`\scriptsize`	Text
`\tiny`	Text

Font Size

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`\Large`	Text
`\large`	Text
`\normalsize`	Text
`\small`	Text
`\footnotesize`	Text
`\scriptsize`	Text
`\tiny`	Text

The listed examples are declarations (switches), which means they change the way the text to follow is printed. Another way to implement this is using it within an environment or braces. For example:

```
\begin{Large} ... \end{Large}
```

Listing

- There are three different listing environments:
  - `itemize` for unnumbered lists
  - `enumerate` for numbered lists
  - `description` for lists based on keywords (as it is in a dictionary)

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Listing

- There are three different listing environments:
  - `itemize` for unnumbered lists
  - `enumerate` for numbered lists
  - `description` for lists based on keywords (as it is in a dictionary)
- all three environments may be nested (even in combination)
- the structure of the environments is similar: a new item is created with `\item`.

The itemize-Environment

```
\begin{itemize}
\item first
\item second
\begin{itemize}
\item three
\item nested
\item items
\begin{itemize}
\item further
\item nesting
\end{itemize}
\end{itemize}
\item third
\end{itemize}
```

The itemize-Environment

- first
- second
  - three
  - nested
  - items
    - further
    - nesting
- third

The enumerate-Environment

```
\begin{enumerate}
\item first
\item second
\begin{enumerate}
\item different
\item level
\item[x)] customized
\item continued
\item counting
\end{enumerate}
\item third
\end{enumerate}
```

The enumerate-Environment

1. first
2. second
    a) different
    b) level
    x) customized
    c) continued
    d) counting
3. third

The description-Environment

```
\begin{description}
\item[First Term] Description of term.
\item[Second Term] Description of term.
\begin{description}
\item[First Minor Term] Description of term.
\item[Second Minor Term] Description of term.
\item[Third Minor Term] Description of term.
\end{description}
\end{description}
```

The description-Environment

First Term Description of term.

Second Term Description of term.

- **First Minor Term** Description of term.
- **Second Minor Term** Description of term.
- **Third Minor Term** Description of term.

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Character	Code	Result
Single Quotation Marks	`‘Example’`	‘Example’
Quotation Marks	`‘‘Example’’`	“Example”
Apostrophe	`’`	’
Hyphen	`-`	-
En dash	`--`	–
Em dash	`---`	—
Ellipsis	`\dots`	…

Character	Code	Result
Enforced space	`\Mr.\ Smith`	Mr. Smith
Non-breaking space	`Fig.~1`	Fig. 1
Small non-breaking space	`10\,%`	10 %

The *non-breaking space* prevents LaTeX from breaking the text at this point.

Special Characters

For some characters a preceding \ is necessary:

Code	\%	_	\$	\&	\#	\{	\}
Result	%	_	$	&	#	{	}

Backslash is created with `\textbackslash`.

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Equations

One of the great advantages of LaTeX is the typesetting of equations. Equations can be placed directly in the text, such as $\mathrm{e}^{\mathrm{i}\pi} + 1 = 0$, or they can be set separate from the text:

$$\mathrm{e}^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} \,.$$

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Equations in the text are created with \$ ... \$, separate equations with \$\$ ... \$\$.

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$$\mathrm{e}^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} \,.$$

Equations in the text are created with `$ ... $`, separate equations with `$$ ... $$`.

It is recommended to use the $\mathcal{AMS}$-packages, since those extend the whole equation typesetting enormously. Those packages are included via

```
\usepackage{amsmath, amssymb}
```

.

Equations

- Variables are set cursive, while functions are set upright, e. g. `$\sin(x)$` creates $\sin(x)$

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- In order to set letters upright you can use `\mathrm{}`:

  `$\int \mathrm{d}x$` creates $\int \mathrm{d}x$

Equations

- For superscript use `^`: `$x^2$`, which creates x^2.

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`X_12`	creates	X_12
`X_{12}`	creates	X_{12}

Equations

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`X_12`	creates	X_12
`X_{12}`	creates	X_{12}

- Super- and subscript can be combined and nested:

`X^3_{n_i^2}` creates $X^3_{n_i^2}$

Equations

- Letters, numbers and symbols such as + - * / = < > , . ( ) [ ] may be directly used in math mode. For many other symbols one needs to use special commands (see separate list), e. g. for multiplication:

`2 \cdot 3=6` creates $2 \cdot 3 = 6$

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- Fractions are created with `\frac{}{}`:

  `\frac{x+y}{2}` creates $\frac{x+y}{2}$

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- Fractions are created with `\frac{}{}`:

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- Vector arrows are created using `\vec`:

  `\vec{a}` creates $\vec{a}$

- Limits of summation/integration (and similar structures) are created with `\limit`:

`\int_0^1` creates $\int_0^1$

`\int\limits_0^1` creates $\int\limits_0^1$

- Brackets, which are created with `\left` and `\right` are adopted to the heights of the content:

`( \frac{x+y}{2} )` creates $(\frac{x+y}{2})$

`\left( \frac{x+y}{2} \right)` creates $\left(\frac{x+y}{2} \right)$

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- more brackets: `[...]`, `\{...\}`, `|...|`, `\|...\|`, `\langle...\rangle`, ...

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- more brackets: `[...]`, `\{...\}`, `|...|`, `\|...\|`, `\langle...\rangle`, ...
- Brackets can be combined in any way:

  `\left[ ... \right)`

- The dot represents (if used with `\left` or `\right`) an invisible bracket:

  `\left( ... \right.`

Equation

- The amsmath-packages provides additional environments in order to enumerate and/or vertically align equations:

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$$\partial_\mu F^{\mu\nu} = j^\nu \tag{1}$$
$$\partial_{[\mu} F_{\nu\lambda]} = 0 \tag{2}$$

```
\begin{align}
\partial_\mu F^{\mu\nu} &= j^\nu \\
\partial_{[\mu}F_{\nu\lambda]} &= 0
\end{align}
```

- The amsmath-packages provides additional environments in order to enumerate and/or vertically align equations:

$$R_{\mu\nu[\lambda\sigma,\rho]} = 0 \tag{3}$$

```
\begin{equation}
R_{\mu\nu[\lambda\sigma,\rho]} = 0
\end{equation}
```

1 Canonical Quantization

For the quantization of the electromagnetic field you just need to make a mode expansion of $\vec{A}$, which leads to

$$\hat{\vec{A}}(x) = \sum_J \sum_{\lambda=1}^{2} \frac{1}{\sqrt{\omega_J}} \vec{\varepsilon}_{J,\lambda} \left(\mathrm{e}^{-\mathrm{i}\omega_J t} \tilde{\mathcal{A}}_{J,\lambda}(\vec{r})\, \hat{a}_{J,\lambda} + \mathrm{e}^{\mathrm{i}\omega_J t} \tilde{\mathcal{A}}^*_{J,\lambda}(\vec{r})\, \hat{a}^\dagger_{J,\lambda} \right) .$$

2 Integral Theorems

The *Gauß-Ostrogradski* and *Green* theorem are shown below:

$$\int_V \operatorname{div} \vec{F}\, \mathrm{d}^n V = \oint_S \vec{F} \cdot \vec{n}\, \mathrm{d}^{n-1} S\,, \tag{1}$$

$$\iint_D \left(\frac{\partial g}{\partial x}(x,y) - \frac{\partial f}{\partial y}(x,y) \right) \mathrm{d}x\, \mathrm{d}y = \oint_C \left(f(x,y)\, \mathrm{d}x + g(x,y)\, \mathrm{d}y \right) \tag{2}$$

A detailed list about symbols and the corresponding packages may be found at the following link:

`http://ftp.jaist.ac.jp/pub/CTAN/info/symbols/comprehensive/symbols-a4.pdf`

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The tabular-Environment

The tabular-environment is used to create tables.

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```
\begin{tabular}{l|cr}
flush left & centered & flush right\\
\hline
text & more text & even more text
\end{tabular}
```

flush left	centered	flush right
text	more text	even more text

The tabular-Environment

```
\begin{tabular}{l|cr}
flush left & centered & flush right\\
\hline
text & more text & even more text
\end{tabular}
```

The tabular-Environment

```
\begin{tabular}{l|cr}
flush left & centered & flush right\\
\hline
text & more text & even more text
\end{tabular}
```

- `l` left aligned column (as wide as the widest entry)
- `c` centered column
- `r` right aligned column
- `p{1cm}` justified (with the value of the column width)
- `|` division of the columns with a vertical line (more than one possible)

The tabular-Environment

```
\begin{tabular}{l|cr}
flush left & centered & flush right\\
\hline
text & more text & even more text
\end{tabular}
```

`&` separates the columns

`\\` separates the rows

`\hline` horizontal line over the whole width of the table (more than one possible)

`\cline{1-2}` horizontal line from column 1 to column 2

Nature

Nature amazes us with its wonders!

Mountains	Rivers	Lakes	Beaches and Deserts
rough	fast	standing	sandy

The table was centered with the `center` environment. (`\begin{center} ... \end{center}`)

The \multicolumn command

The texttt\multicolumn command connects the entries of several columns of one row.

```
\multicolumn{Number}{Alignment}{Content}
```

The \multicolumn command

The texttt\multicolumn command connects the entries of several columns of one row.

```
\multicolumn{Number}{Alignment}{Content}
```

- **Number** Number of columns to be connected.
- **Alignment** Alignment of text in the created cell (`l`, `c`, `r` as needed, with succeeding `|`)
- **Content** Content of the created cell.

The \multicolumn command – Example

```
\begin{tabular}{|l|l|l|}
\hline
Atoms & \multicolumn{2}{c|}{Ions} \\
& Cations & Anions \\
\hline
H, Ne & Na$^+$ & Cl$^-$ \\
\hline
\end{tabular}
```

Atoms	Ions	
	Cations	Anions
H, Ne	Na^+	Cl^-

The \multirow Command

Similar to the \multicolumn command, the \multirow command is used to connect the entries of several rows of one column. In order to use it you need to add the multirow package:

```
\usepackage{multirow}
```

The syntax is simply:

```
\multirow{Number}{Width}{Content}
```

The \multirow Command

Similar to the \multicolumn command, the \multirow command is used to connect the entries of several rows of one column. In order to use it you need to add the multirow package:

```
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```

The syntax is simply:

```
\multirow{Number}{Width}{Content}
```

Number Number of columns to be connected.

Width With of the box in which the text will be set. (* automatically adjusts the width to the column-width)

Content Content of the created cell.

The \multirow Command – Example

```
\begin{tabular}{|l|l|l|}
\hline
Atoms & \multicolumn{2}{c|}{Ions} \\
& Cations & Anions \\
\hline
H, Ne & Na$^+$ & Cl$^-$ \\
\hline
\end{tabular}
```

Atoms	Ions	
	Cations	Anions
H, Ne	Na^+	Cl^-

The \multirow Command – Example

```
\begin{tabular}{|l|l|l|}
\hline
\multirow{2}{*}{Atoms} & \multicolumn{2}{c|}{Ions} \\
& Cations & Anions \\
\hline
H, Ne & Na$^+$ & Cl$^-$ \\
\hline
\end{tabular}
```

Atoms	Ions	
	Cations	Anions
H, Ne	Na^+	Cl^-

Tables and Matrices in Math Mode

- Similar to the `tabular` environment in text mode there exists the `array` environment in math mode with alike syntax.

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- Moreover the `amsmath` package offers various tools for the formatting of vectors and matrices.

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- Moreover the `amsmath` package offers various tools for the formatting of vectors and matrices.

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

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

Tables and Matrices in Math Mode

```
B=\begin{bmatrix}
1 & 2\\
3 & 4
\end{bmatrix}
```

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

```
C=\begin{Bmatrix}
1 & 2\\
3 & 4
\end{Bmatrix}
```

$$C = \begin{Bmatrix} 1 & 2 \\ 3 & 4 \end{Bmatrix}$$

```
D=\begin{vmatrix}
1 & 2\\
3 & 4
\end{vmatrix}
```

$$D = \begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix}$$

```
E=\begin{Vmatrix}
1 & 2\\
3 & 4
\end{Vmatrix}
```

$$E = \begin{Vmatrix} 1 & 2 \\ 3 & 4 \end{Vmatrix}$$

Tables and Matrices in Math Mode

- In case you do not need brackets or you want to set them yourself with `\left ... \right` you can use the `matrix` environment:

```
\begin{matrix}
1 & 2\\
3 & 4
\end{matrix}
```

$$\begin{matrix}
1 & 2\\
3 & 4
\end{matrix}$$

- In case you do not need brackets or you want to set them yourself with `\left ... \right` you can use the `matrix` environment:

```
\begin{matrix}
1 & 2\\
3 & 4
\end{matrix}
```

$$\begin{matrix}
1 & 2\\
3 & 4
\end{matrix}$$

- For smaller matrices in-line you can use the `smallmatrix` environment.

```
\begin{smallmatrix}
1 & 2\\
3 & 4
\end{smallmatrix}
```

$\begin{smallmatrix} 1 & 2\\ 3 & 4 \end{smallmatrix}$

- For case definitions you can use the cases environment:

```
\Theta(x) =
\begin{cases}
0, & \text{falls} x<0, \\
1, & \text{falls} x\geq0.
\end{cases}
```

$$\Theta(x) = \begin{cases} 0, & \text{if } x < 0, \\ 1, & \text{else } x \geq 0. \end{cases}$$

1 Nutrition Facts

	per 100 g	**per serving (40 g)**
Caloric Value	1.705 kJ 406 kcal	682 kJ 162 kcal
Fat	too much	

2 Schedule

Friday	**Saturday**	**Sunday**
On Friday I want to calculate the *Jacobian matrix* for polar coordinates. $$J = \begin{pmatrix} \frac{\partial r}{\partial x} & \frac{\partial r}{\partial y} \\ \frac{\partial \phi}{\partial x} & \frac{\partial \phi}{\partial y} \end{pmatrix}$$	Sleeping	Sleeping

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The graphicx Package

To include pictures you can use the graphicx packages. Supported formats are .jpg, .png, .pdf, and .eps (using epstopdf).

The graphicx Package

To include pictures you can use the graphicx packages. Supported formats are .jpg, .png, .pdf, and .eps (using epstopdf).

The syntax is:

```
\includegraphics[arguments]{filename.jpg}
```

Optional Arguments for `\includegraphics`

Size related arguments:

`width`	Width, e. g. `width=10cm`
`height`	Height, e. g. `height=5cm`
`scale`	Scaling, e. g. `scale=0.5`

Optional Arguments for `\includegraphics`

Size related arguments:

`width`	Width, e. g. `width=10cm`
`height`	Height, e. g. `height=5cm`
`scale`	Scaling, e. g. `scale=0.5`

If only `width` **or** `height` is set, the size ratio is kept. Alternatively you can use the `scale` argument.

Optional Arguments for `\includegraphics`

Size related arguments:

`width`	Width, e. g. `width=10cm`
`height`	Height, e. g. `height=5cm`
`scale`	Scaling, e. g. `scale=0.5`

If only `width` **or** `height` is set, the size ratio is kept. Alternatively you can use the `scale` argument.

Example:

```
\includegraphics[width=8cm]{figure.jpg}
```

Optional Arguments for \includegraphics

Cropping arguments:

`clip`	Trim figure by lengths defined by `trim`
`trim=l u r o`	Lengths by which the figure is trimmed in the left (`l`), down (`u`), right (`r`) and up (`o`) directions.

Optional Arguments for \includegraphics

Cropping arguments:

`clip`	Trim figure by lengths defined by `trim`
`trim=l u r o`	Lengths by which the figure is trimmed in the left (`l`), down (`u`), right (`r`) and up (`o`) directions.

Example:

```
\includegraphics[clip, trim=1cm 2.5cm 1cm 0cm]{figure.pdf}
```

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Float Environments

It is useful to place tables and figures in a float environment for the following advantages:

- 'optimized' placing
- referencing
- simple labeling
- automatic listing of figures and tables

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For figures you can use the `figure` environment and for tables you can use the `table` environment.

```
\begin{figure}[placing] ... \end{figure}

\begin{table}[placing] ... \end{table}
```

Content of Float Environments

In general you can place any object within a float environment. A typical application is given below:

```
\begin{figure}
\centering
\includegraphics[width=10cm]{sombrero.jpg}
\caption{The Sombrero Galaxy (M104).}
\end{figure}
```

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In general you can place any object within a float environment. A typical application is given below:

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\begin{figure}
\centering
\includegraphics[width=10cm]{sombrero.jpg}
\caption{The Sombrero Galaxy (M104).}
\end{figure}
```

`\centering` Centers the content of the environment.

`\caption{}` Includes a caption with successive numbering. It can be placed either above or below the object.

Figure 1: The Sombrero Galaxy (M104).

Image credits: NASA and The Hubble Heritage Team (STScI/AURA)

Positioning Arguments:

```
\begin{figure}[!ht]
\centering
\includegraphics[width=10cm]{sombrero.jpg}
\caption{The Sombrero Galaxy (M104).}
\end{figure}
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Positioning Arguments:

```
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\centering
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\caption{The Sombrero Galaxy (M104).}
\end{figure}
```

- `h` „‘here’ – The floating object is placed at the same location as in the source code.
- `t` „‘top’ – The floating object is placed at the top of the page.
- `b` The floating object is placed at the bottom of the page.
- `p` „‘page’ – The floating object is placed on its own page.
- `!` The floating object is prioritized.

Lists of Figures and Tables

The lists of figures and tables can be created using `\listoffigures` and `\listoftables` respectively. The entries are the captions.

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If you want to use a customized caption (e. g. if the original caption is to long) you can do this with an optional argument of the `\caption` command.

```
\caption[short caption]{long caption}
```

Table of Contents

Labels and References

Labels are used to refer to the following objects in the body of the document.

- numbered sections (`\section`, `\subsection`, `\subsubsection`)
- pages
- floating objects (`figure`, `table`)
- numbered equations

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Example:

For all $x \in \mathbb{C}$

$$\cos^2 x + \sin^2 x = 1\,. \tag{4}$$

Equation (5) is also known as trigonometric Pythagoras identity.

Labels and References

`\label{xyz}` creates the label `xyz` for an object.

Labels and References

`\label{xyz}` creates the label `xyz` for an object.

`\ref{xyz}` creates a reference for the object with the label `xyz`.

`\eqref{xyz}` creates a reference for the object with the label `xyz` and puts brackets around it.

`\pageref{xyz}` returns the page number where the object is placed.

Labels and References

For all $x \in \mathbb{C}$

$$\cos^2 x + \sin^2 x = 1\,. \tag{5}$$

Equation (5) is also known as trigonometric Pythagoras identity.

```
For all $x\in\mathbb{C}$
%
\begin{equation}
\cos^2x+\sin^2x=1\,. \label{trigpyth}
\end{equation}
%
Equation \eqref{trigpyth} is also known as
   trigonometric Pythagoras identity.
```

The hyperref Package

The hyperref package turns all references into hyperlinks. This facilitates the navigation both within the document and for external links. Example:

```
\url{https://www.ctan.org/pkg/excel2latex}
```

creates:

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The hyperref package should be included last since it can cause conflicts in combination with other packages.