

# $\text{\LaTeX}$ -course

## 2<sup>e</sup> session: mathematics in $\text{\LaTeX}$

$\text{\TeX}$ niCie

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# Last week

Last week you learned how to:

- handle \*.tex and \*.pdf documents.
- show a title.
- divide a document in sections and paragraphs.
- make a table of contents.
- produce symbols.

You have also learned to handle **environments**

You already know two environments

In the **document** environment typed text is displayed in the document.

In the **itemize** or **enumerate** environment you can make nice listings.



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# This week

**1** Mathematical notation

**2** Advanced constructions

**3** Tables and Matrices



# Mathmode

- Mathmode is the environment in which you can make mathematical formulas and signs. In ‘normal’ text,  $\text{\LaTeX}$  will not recognise the commands.



# Formulas within the lines or individual

Inline math mode:

## Example

In the lines (“inline”) it looks like  $\oint_C B \cdot d\ell = \mu_0 \sum_{i=\text{encl}} I_i$ , just like words in text.

Display math mode:

## Example

Important formulas can be displayed with more space:

$$\oint_C B \cdot d\ell = \mu_0 \sum_{i=\text{encl}} I_i$$

# Formulas in the lines or individually

*Math mode* start and close:

## Inline math mode

■  $\langle \dots \rangle$

■  $\$ \dots \$$

## Individual equations

■  $\left[ \dots \right]$

■  $\$ \$ \dots \$ \$$



# Greek

## Example

$$\frac{\hbar^2 \nabla^2}{2m} \psi(r) + \frac{1}{4\pi\epsilon_0 r} \psi(r) = E \psi(r)$$

```
$$\frac{\hbar^2 \nabla^2}{2m} \psi(r) +
\frac{1}{4 \pi \epsilon_0 r} \psi(r) = E \psi(r) $$
```

Greek characters:

`\theta` ( $\theta$ ).

Greek capitals:

`\Phi` ( $\Phi$ ).

Nicer Greek characters:

`\varepsilon` ( $\varepsilon$ ).

*N.B. Not all characters can be made nicer.*

Different version of a character: letter: `\hbar` ( $\hbar$ ), `\ell` ( $\ell$ ).

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# Vertical combinations

## Example

$$\backslash\mathrm{frac}\{\langle\mathit{num}\rangle\}\{\langle\mathit{denom}\rangle\} \quad \frac{1}{137} \quad \$\backslash\mathrm{frac}\{1\}\{137\}$$$

$$\backslash\mathrm{binom}\{\langle\mathit{high}\rangle\}\{\langle\mathit{low}\rangle\} \quad \binom{n}{p} \quad \$\backslash\mathrm{binom}\{n\}\{p\}$$

$$\backslash\mathrm{sqrt}[\mathit{power}]\{\langle\mathit{number}\rangle\} \quad \sqrt[3]{512} \quad \$\backslash\mathrm{sqrt}[3]\{8\}$$$

# Subscript and superscript

Relative placing (sub- and superscript):

The hat (^) and the dash (-).

- One argument, surrounded by accolades.
- No accolades → only the next character is taken into account.

## Example

$x_n$	<code>\$x_n\$</code>
$e^{tA}$	<code>\$e^{\{tA\}}\$</code>
$3^rd$	<code>\$3^{rd}\$</code>

# Sommutations, integrals and products

Use of sub- and superscripts in summations etc:

Example

$$\sum_{n=0}^{\infty} \int_0^1 \frac{1}{n!} A^n t^n dt$$

`$$\sum_{n=0}^{\infty} \int_0^1 \frac{1}{n!} A^n t^n dt $$`



# Symbols

L<sup>A</sup>T<sub>E</sub>X has many, many mathematical symbols. You can find them here:

- Complete list at CTAN:

<http://www.ctan.org/tex-archive/info/symbols/comprehensive/>.

- Drawing a symbol yourself:

<http://detexify.kirelabs.org/>

- Other problems:

- <http://www.duckduckgo.com/>
- <http://www.google.com/>
- <http://www.bing.com/>
- <http://www.yahoo.com/>
- <http://www.altavista.com/>



# Brackets (left and right)

**Pairs** of vertical symbols can be enlarged automatically using `\left` en `\right` right in front of the symbol.

## Example

Ugly:

$$\left(\frac{1}{2}\right) \quad (\backslash\text{frac}\{1\}\{2\})$$

Beautiful:

$$\left(\frac{1}{2}\right) \quad \backslash\text{left}( \backslash\text{frac}\{1\}\{2\} \backslash\text{right})$$

Only a left bracket? Place after `\right` a dot.

$$\backslash\text{left}\{ \dots \backslash\text{right}. \rightarrow \left\{ \frac{1}{\omega} \right.$$



# White space

White spacings are neglected in math mode. You can force white spacings using:

<code>\!</code>	<code>  </code>	<code>\pi\!\varphi</code>	$\pi\varphi$
	<code>  </code>	<code>\pi\varphi</code>	$\pi\varphi$
<code>\,</code>	<code>  </code>	<code>\pi\,\varphi</code>	$\pi\varphi$
<code>\quad</code>	<code>   </code>	<code>\pi\quad\varphi</code>	$\pi\varphi$
<code>\qquad</code>	<code>   </code>	<code>\pi\qquad\varphi</code>	$\pi\varphi$



# Advanced *math mode* -environments

**align** Displays multiple vertically aligned numbered equations.

**equation** Displays a single numbered equation on a new line.

No numbering: place a star (\*) after the environment.

Example: `\begin{equation*}`

You can add a row of text within the **align** environment using `\intertext`.



# Advanced *math mode*-environments (example)

## Example

$$a = b + c$$

(1)

```
\begin{align}
a      &=   b+c\\
```

$$a + 2b = c$$

(2)

```
a+2b &=   c
```

```
\end{align}
```

$$2x + 3 = 0$$

Hence:

$$x = -\frac{3}{2}$$

```
\begin{align*}
```

```
2x + 3 &= 0   \\
```

```
\intertext{Hence:}
```

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

```
\end{align*}
```

# Time for exercises



# Environments in equations

Groups, alignments and numbering of equations can be influenced within the environment `math mode`:

- split** Displays a formula with multiple (in)equalities and assigns only one number to the equation.
- cases** Places a big accolade left from the split-environment.



# cases (example)

## Example

$$fib(n) = \begin{cases} 0 & \text{if } n \leq 0 \\ 1 & \text{if } n = 1 \\ fib(n-1) + fib(n-2) & \text{if } n \not\leq 1 \end{cases} \quad (3)$$

```
\begin{equation}
```

```
fib(n) =
```

```
\begin{cases}
```

```
0 & \text{if } n \leq 0 \\
```

```
1 & \text{if } n = 1 \\
```

```
fib(n-1) + fib(n-2) & \text{if } n \not\leq 1
```

```
\end{cases}
```

```
\end{equation}
```

The American Mathematical Society provides a number of packages for working with mathematical formulae. This project includes the following packages:

- amsmath** The basis of most mathematical editing, used many times in these slides.
- amssymb** Additional symbols like  $\therefore$ ,  $\sqsupset$  and  $\mathfrak{U}$ .
- amsfonts** Provides some additional font types. (Try also the packages **eufrak** and **eucal**).
- amsthm** Support for defining environments for definitions, theorems, exercises and so on.



# Mathmode and text

Normal text in *math mode*: `\text{}`.

Standard *math mode*-text: `\mathnormal{}`.

Other text forms:

## Mathematical characters:

Roman `\mathrm{}`

*Italic* `\mathit{}`

**Bold** `\mathbf{}`

Teletype `\mathtt{}`

SansSerif `\mathsf{}`

## Normal text

Roman `\textrm{}`

*Italic* `\textit{}`

**Bold** `\textbf{}`

Teletype `\texttt{}`

Sans Serif `\textsf{}`

## Only in math environments

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

`\mathbb{R}, \mathbb{C}, \mathbb{N}, \mathbb{Q}`

# $\mathcal{AMS}$ -theorem: an example

Theorem (Non-compactness of unit sphere in  $\ell^2$ )

*Show that the unit sphere is not compact in  $\ell^2$ .*

Proof.

Take the sequence  $(1, 0, \dots)$ ,  $(0, 1, 0, \dots)$ , etc. This is a bounded sequence in  $\ell^2$ , but clearly has no convergent subsequence. □

This type of construction is done by

Example

```
\begin{theorem}[<Name of the theorem>]
```

Theorem.

```
\end{theorem} \begin{proof}
```

The difficult proof.

```
\end{proof}
```



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The difficult proof.

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\end{proof}
```

# Tips

- In the manual you can often find a way to make the exercise.
- The command `\verb` is used to display commands in text.



# Tables

$\text{\LaTeX}$  has three standard tables:

- `array` A table to display formulas.
- `tabular` A standard table, as big as needed.
- `tabular*` A table with given width.



# A simple table

## Example

Theme	Foreground	Background
Albatross	white	navy
Crane	blue	orange
Fly	black	grey
Seagull	black	white

```

\begin{tabular}{lcc}
Theme & Foreground & Background \\ \hline
Albatross & white & navy \\
Crane & blue & orange \\
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Seagull & black & white \\
\end{tabular}

```



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```



# Packages

For listings and tables, the following packages can be really useful:

`supertabular` for a table using multiple pages.

`longtable` for a table covering multiple pages.

`multirow` for input in multiple rows.

`enumitem` for changing options in tables and listings.

<http://www.ctan.org>



## Example

◀ ◻ ▶ ◀ ◻ ▶ ◀ ≡ ▶ ◀ ≡ ▶ ≡ ≡ ≡ ↺ 🔍 ↻

# Matrices

- Matrices are special arrays.
- The `matrix`-environment is used like the `array`-environment.
- Matrices in textline: the `smallmatrix`-environment.

## Example

$$\begin{bmatrix} \alpha & -\beta \\ \bar{\beta} & \bar{\alpha} \end{bmatrix}$$

```
\[
\left[\begin{matrix}
\alpha & -\beta \\
\bar{\beta} & \bar{\alpha}
\end{matrix}\right]
\]
```

# Next week

- Figures, in all forms and formats
- References and labels



# Do you like this activity?

- If you have remarks, please tell us or e-mail to `texnicie@a-eskwadraat.nl`
- Maybe you like other A-Eskwadraat activities as well. More information can be found at <https://www.a-eskwadraat.nl/Activiteiten/?setlanguage=en>

