LaTeX
A Document Preparation System

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Outline

- Introduction
- Absolute beginners
- Basics
- Document structure
- Tables
- Importing graphics
- Mathematics
- Useful commands for slides

Introduction

- What is TEX (pronounced "Tech")?
  - A *markup language* created by Donald Knuth to typeset documents attractively and consistently
    - Started in *1977*, released in *1982*, with some slight enhancements added in *1989*
  - Powerful, but difficult and time-consuming to use
  - Renowned for
    - being extremely stable
    - running on many different kinds of computers
    - and being virtually bug free

Introduction

- What is LaTeX (pronounced "Lah-tech")?
  - A *macro package* based on TeX created by Leslie Lamport
    - Purpose: simplify TeX typesetting, especially for documents containing *mathematical formulae*
    - Many extensions to LaTeX contributed by later authors, called *packages* or *styles*

Since LaTeX comprises a group of TeX commands, LaTeX document processing is essentially programming. You create a text file in LaTeX markup, and the LaTeX macro reads this to produce the final document.

Introduction

- LaTeX vs. Writer or Microsoft Word:
  - *Disadvantages*
    - You can't see the final result straight away.
    - You need to know the necessary commands.
    - It can be difficult to obtain a certain "look".
  - *Advantages*
    - The layout, fonts, tables are consistent throughout.
    - Mathematical formulae can be easily typeset.
    - Indices, footnotes and references are generated easily.
    - Your documents will be correctly structured.

Introduction

- LaTeX is a very easy system to learn, and requires no specialist knowledge.
  - Skills needed:
    - How to use a good plain-text editor (e.g. notepad)
    - How to create, open, save, close, rename, move, and delete files and folders (directories)
    - How to use a Web browser and/or File Transfer Protocol (FTP) program to download and save files from the Internet
    - How to uncompress and unwrap (unzip or detar) downloaded files

Introduction

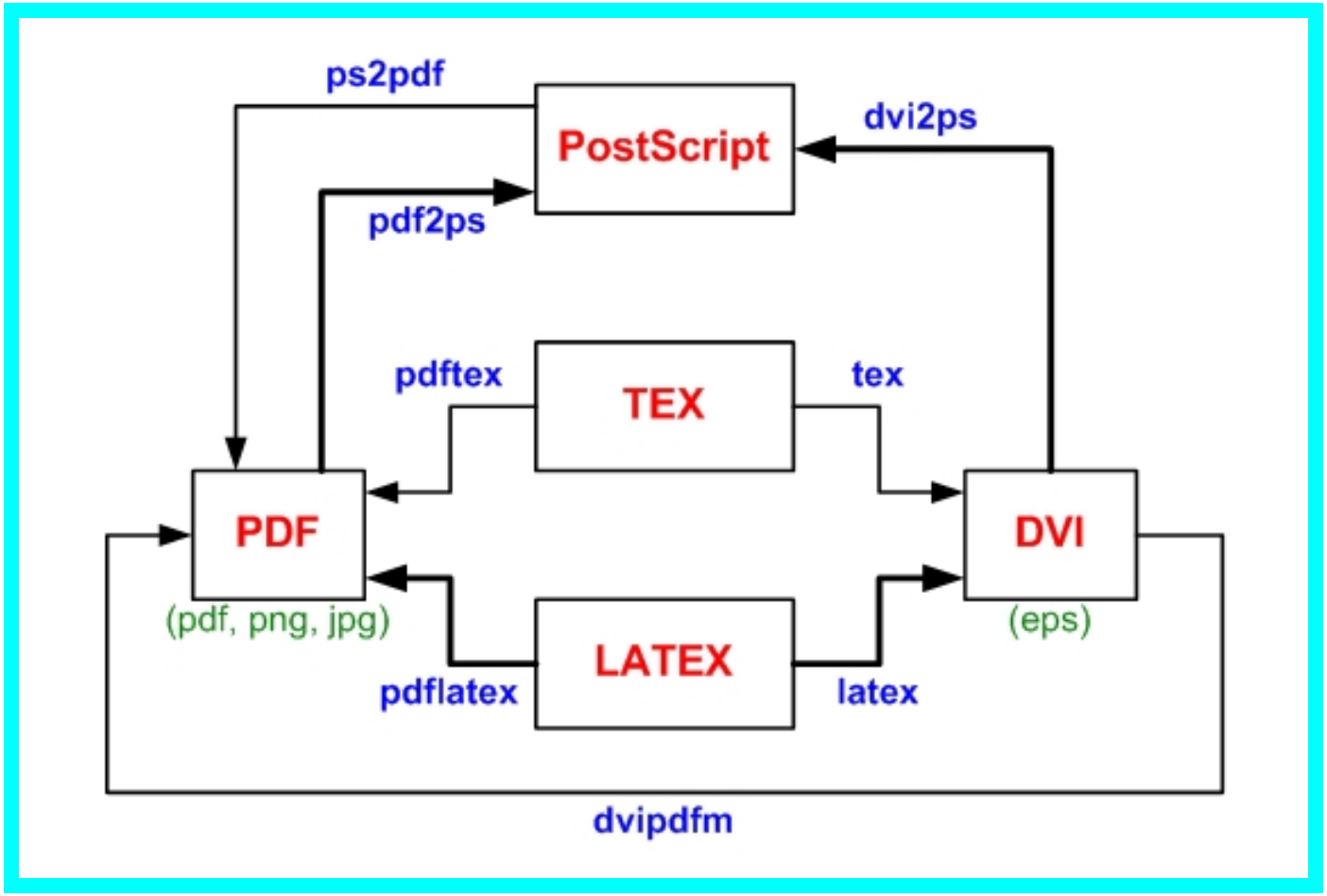
- Prerequisites – you'll need the following programs to edit LaTeX:
  - An editor
    - On Windows: TeXnicCenter
    - On Unix-like (including Mac OS X) systems: Emacsen, gvim, Texmaker, and Kile
  - The LaTeX binaries and style sheets
    - MiKTeX for Windows
    - teTeX for Unix/Linux and for Mac OS X
  - A DVI viewer to view and print the final result
- A distribution of LaTeX can be obtained from the TeX users group at http://www.tug.org/texlive/.

Introduction

- Applications within a TeX/LaTeX distribution
  - Main programs found in any distribution:
    - **tex:** generates DVI from TeX source (simplest)
    - **pdftex:** generates PDF from TeX source
    - **latex:** generates DVI from LaTeX source (most used)
    - **pdflatex:** generates PDF from LaTeX source
    - **dvi2ps:** converts DVI to PostScript
    - **dvipdf:** converts DVI to PDF
    - **dvipdfm:** an improved version of **dvipdf**
- See http://en.wikibooks.org/wiki/LaTeX/Installation for more details of installation

Introduction

➢ Relationships between the TEX/LATEX source code and all the formats created from it:



Absolute Beginners

The LaTeX Source

- LaTeX uses a markup language in order to describe document structure and presentation.
  - Convert your source text, combined with the markup, into a high quality document
- The input for LaTeX is a plain ASCII text file.
  - Can be created with any text editor
  - Contains the text of the document, as well as the commands to typeset the text

Absolute Beginners

The LaTeX Source

- A minimal example:

```
\documentclass{article}

\begin{document}
Hello world!
\end{document}
```

Absolute Beginners

The LaTeX Source

- Spaces
  - "Whitespace" characters, such as blank or tab
  - Several consecutive whitespace characters are treated as one "space".
  - Whitespace at the start of a line is ignored, and a single line break is treated as "whitespace".
  - An empty line between two lines of text defines the end of a paragraph.
  - Several empty lines are treated as one empty line.

Absolute Beginners

The LaTeX Source

- Spaces (an example)

```
It does not matter whether you
enter one or          several spaces
after a word.

  An empty line starts a new
paragraph.
```

It does not matter whether you enter one or several spaces after a word.

An empty line starts a new paragraph.

Absolute Beginners

The LaTeX Source

- Special characters
  - The following symbols are reserved characters that either have a special meaning under LaTeX or are unavailable in all the fonts.
    # $ % ^ & _ { } \
  - These characters can be used in your documents all the same by adding a prefix backslash "\":
    ```
    \# \$ \% \^{} \& \_ \{ \} \textbackslash
    ```

Absolute Beginners

The LaTeX Source

- LaTeX commands (case sensitive)
  - Take one of the following two formats:
    - Start with a backslash \ and then have a name consisting of letters only
      - Command names are terminated by a space, a number, or any other "non-letter".
    - Consist of a backslash \ and exactly one non-letter
  - Some commands need a parameter (given between { } after the command name), and some support optional parameters (added after the command name in [ ]).
    - General syntax:

      `\commandname[option,...]{argument}...`

Absolute Beginners

The LaTeX Source

- LaTeX environments
  - Have a similar role to commands, but usually have effect on a wider part of the document
  - Syntax:

```
\begin{environmentname}
text to be influenced
\end{environmentname}
```

- Between the \begin and the \end you can put other commands and nested environments.
- Anything in LaTeX can be expressed in terms of *commands* and *environments*.

Absolute Beginners

The LaTeX Source

- Comments
  - A % character ignores the rest of the present line, the line break, and all whitespace at the beginning of the next line.
    - Used to write notes into the input file, which will not show up in the printed version
    - Used to split long input lines where no whitespace or line breaks are allowed
  - Example:

```
This is an % stupid
% Better: instructive
example: Supercal%
                ifragilist%
icexpialidocious
```

This is an example: Supercalifragilisticexpialidocious

Absolute Beginners

The LaTeX Source

➢ Input file structure

1. Every input file must start with `\documentclass{...}`, which specifies what sort of document you intend to write.
2. Include commands to influence the style of the whole document, or load packages to add new features to the LaTeX system
   ☞ To load such a package, use `\usepackage{...}`
3. When all the setup work is done, start the body of the text with `\begin{document}`
4. Enter the text mixed with some useful LaTeX commands
5. At the end of the document, add `\end{document}`
   ☞ Anything that follows this command will be ignored by LaTeX.
   ☞ The area between `\documentclass` and `\begin{document}` is called the *preamble*.

Basics

Document Classes

- The type of document is specified with
  `\documentclass[options]{class}`
  - "class" – the type of document to be created
  - "options" – the behavior of the document class
- Example:
  `\documentclass[11pt,twoside,a4paper]{article}`
  - This instructs LaTeX to typeset the document as an article with a base font size of 11 points, and to produce a layout suitable for double sided printing on A4 paper.

Basics

Document Classes

`article`	for articles in scientific journals, presentations, short reports, program documentation, invitations, etc.
`proc`	a class for proceedings based on the article class.
`minimal`	is as small as it can get. It only sets a page size and a base font. It is mainly used for debugging purposes.
`report`	for longer reports containing several chapters, small books, thesis, etc.
`book`	for real books
`slides`	for slides. The class uses big sans serif letters.
`memoir`	for changing sensibly the output of the document. It is based on the book class, but you can create any kind of document with it.
`letter`	for writing letters.

Basics

Document Class Options

`10pt, 11pt, 12pt`	Sets the size of the main font in the document. If no option is specified, 10pt is assumed.
`a4paper, letterpaper, etc.`	Defines the paper size. The default size is `letterpaper`; However, many European distributions of TeX now come preset for A4, not Letter, and this is also true of all distributions of pdfLaTeX. Besides that, `a5paper`, `b5paper`, `executivepaper`, and `legalpaper` can be specified.
`fleqn`	Typesets displayed formulas left-aligned instead of centered.
`leqno`	Places the numbering of formulae on the left hand side instead of the right.

Basics

Document Class Options

`titlepage, notitlepage`	Specifies whether a new page should be started after the document title or not. The article class does not start a new page by default, while report and book do.
`onecolumn, twocolumn`	Instructs LaTeX to typeset the document in one column or two columns.
`twoside, oneside`	Specifies whether double or single sided output should be generated. The classes `article` and `report` are single sided and the `book` class is double sided by default. Note that this option concerns the style of the document only. The option `twoside` does not tell the printer you use that it should actually make a two-sided printout.

Basics

Document Class Options

`landscape`	Changes the layout of the document to print in landscape mode.
`openright, openany`	Makes chapters begin either only on right hand pages or on the next page available. This does not work with the `article` class, as it does not know about chapters. The `report` class by default starts chapters on the next page available and the `book` class starts them on right hand pages.
`draft`	makes LaTeX indicate hyphenation and justification problems with a small square in the right-hand margin of the problem line so they can be located quickly by a human.

- For a report to be in 12pt type on A4, but printed one-sided in draft mode, you would use:
  `\documentclass[12pt,a4paper,oneside,draft]{report}`

Basics

Packages

While writing your document, you will probably find that there are some areas where basic LaTeX cannot solve your problem. If you want to include graphics, colored text or source code from a file into your document, you need to enhance the capabilities of LaTeX. Such enhancements are called packages.

- Packages are activated with `\usepackage[options]{package}`
  - "package" – the name of the package
  - "options" – a list of keywords that trigger special features in the package
- See http://en.wikibooks.org/wiki/LaTeX/Packages for more details

Document Structure

- LaTeX is different from other typesetting systems:
  - You just have to tell it the logical and semantical structure of a text.
  - It then derives the typographical form of the text according to the "rules" given in the document class file and in various style files.
- LaTeX allows users to structure their documents with a variety of hierarchal constructs, including chapters, sections, subsections, and paragraphs.
- Preamble, Top matter, Abstract, Sections, Appendices, Table of contents, Bibliography

Document Structure

The `document` Environment

- After the document class declaration, the text of your document is enclosed between two commands which identify the beginning and end of the document:

```
\documentclass[11pt,a4paper,oneside]{report}

\begin{document}
...
\end{document}
```

Document Structure

The `document` Environment

- Preamble
  - Everything from the start of the Latex source file until the `\begin{document}`
  - Contains commands that affect the entire document

```
% A simple example for document structure

\documentclass{article}
\usepackage{mathptmx}

\begin{document}
```

Document Structure

The `document` Environment

- Top matter
  - Information about the document itself (title and date) and about the authors (name, address, email, etc.)
  - A simple example:

```
\documentclass[11pt,a4paper,oneside]{report}

\begin{document}
\title{How to Structure a LaTeX Document}
\author{Andrew Roberts}
\date{December 2004}
\maketitle
\end{document}
```

Document Structure

The `document` Environment

- Top matter
  - A more complicated example:

```
\title{How to Structure a \LaTeX{} Document}
\author{Andrew Roberts\\
        School of Computing,\\
        University of Leeds,\\
        Leeds,\\
        United Kingdom,\\
        LS2 1HE\\
        \texttt{andyr@comp.leeds.ac.uk}}
\date{\today}
\maketitle
```

Document Structure

The `document` Environment

- Abstract
  - Predefined command available for the document class *article* and *report*, but not *book*

```
\begin{document}

\begin{abstract}
Your abstract goes here...
...
\end{abstract}
...
\end{document}
```

Document Structure

The `document` Environment

- Sectioning commands

```
\section{Structure}
This section's content...

\subsection{Top Matter}
This subsection's content...

\subsubsection{Article Information}
This subsubsection's content...
```

Document Structure

The `document` Environment

- Levels of depth for defining sections:

Command	Level	comment
`\part{}`	-1	not in letters
`\chapter{}`	0	only books and reports
`\section{}`	1	not in letters
`\subsection{}`	2	not in letters
`\subsubsection{}`	3	not in letters
`\paragraph{}`	4	not in letters
`\subparagraph{}`	5	not in letters

Document Structure

The `document` Environment

- Appendices
  - The `\appendix` macro can be used to indicate that following sections or chapters are to be numbered as appendices.
  - In the report or book classes this gives:

```
\appendix
\chapter{First Appendix}
```

  - For the article class use:

```
\appendix
\section{First Appendix}
```

Document Structure

The `document` Environment

- Table of contents
  - All auto-numbered headings get entered in the Table of Contents automatically.
  - Add `\tableofcontents` at the point where you want it printed (usually after the Abstract or Summary)
  - `\listoffigures` and `\listoftables` work in exactly the same way as `\tableofcontents` to automatically list all your tables and figures.

Document Structure

The `document` Environment

- Bibliography
  - To insert your references into LaTeX, you can:
    1. Embed them within the document itself. It's simpler, but it can be time-consuming if you are writing several papers about similar subjects (often have to cite the same books).
    2. Store them in an external BibTeX file and then link them via a command to your current document and use a Bibtex style to define how they appear (create a small database and simply link them).
  - See http://en.wikibooks.org/wiki/LaTeX/Bibliography_Management for more details

Tables

The `tabular` Environment

- Used to typeset beautiful tables with optional horizontal and vertical lines
  - LaTeX determines the width of the columns automatically.
- Start with `\begin{tabular}[pos]{table spec}`
  - "table spec" tells LaTeX the alignment to be used in each column and the vertical lines to insert.
  - "pos" is used to specify the vertical position of the table relative to the baseline of the surrounding text, e.g. `b` for bottom, `c` for center, and `t` for top.

Tables

The `tabular` Environment

- Symbols to describe the table columns:

`l`	left-justified column
`c`	centered column
`r`	right-justified column
`p{width}`	paragraph column with text vertically aligned at the top
`m{width}`	paragraph column with text vertically aligned in the middle (requires *array* package)
`b{width}`	paragraph column with text vertically aligned at the bottom (requires *array* package)
`|`	vertical line
`||`	double vertical line

Tables

The `tabular` Environment

- Commands used for separating between cells and introducing new lines:

`&`	column separator
`\\`	start new row (additional space may be specified after `\\` using square brackets, such as `\\[6pt]`)
`\hline`	horizontal line
`\cline{i-j}`	partial horizontal line beginning in column i and ending in column j

Tables

The `tabular` Environment

- Basic examples:

```
\begin{tabular}{ l c r }
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9 \\
\end{tabular}
```

1	2	3
4	5	6
7	8	9

Tables

The `tabular` Environment

- Basic examples:

```
\begin{tabular}{ l | c || r | }
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9 \\
\end{tabular}
```

1	2	3
4	5	6
7	8	9

Tables

The `tabular` Environment

- Basic examples:

```
\begin{tabular}{ l | c || r | } \hline
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9 \\ \hline
\end{tabular}
```

1	2	3
4	5	6
7	8	9

Tables

The `tabular` Environment

- Basic examples:

```
\begin{tabular}{ l | c || r | } \hline
1 & 2 & 3 \\ \hline
4 & 5 & 6 \\ \hline
7 & 8 & 9 \\ \hline
\end{tabular}
```

1	2	3
4	5	6
7	8	9

Tables

The tabular Environment

➢ A more complicated example:

```
\begin{tabular}{ ||| c | c | c ||| } \hline\hline\hline
\multicolumn{3}{ ||| c ||| }{\textbf{Table}}\\ \hline
column $1$ & column $2$ & column $3$ \\ \hline
$1$        & $a$        & $x$ \\ \cline{2-3}
$2$        & $b$        & $y$ \\ \cline{2-3}
$3$        & \multicolumn{2}{ c ||| }{cz} \\ \hline\hline\hline
\end{tabular}
```

Table		
column 1	column 2	column 3
1	a	x
2	b	y
3	cz	

Importing Graphics

- LaTeX cannot manage pictures directly.
- We have to load the `graphicx` package in the preamble of our document: `\usepackage{graphicx}`
- Have your images in the right format!
  - Compiling with *latex*: EPS
  - Compiling with *pdflatex*: JPG, PNG, or PDF
- Including graphics with `\includegraphics[attr=val]{imagename}`

Importing Graphics

- Most useful attributes:

`width=xx`	Specify the preferred width of the imported image to xx.
`height=xx`	Specify the preferred height of the imported image to xx.
`keepaspectratio`	This can be set to either $true$ or $false$. When true, it will scale the image according to both height and width, but will not distort the image, so that neither width or height are exceeded.
`scale=xx`	Scales the image by the desired scale factor. e.g., 0.5 to reduce by half, or 2 to double.
`angle=xx`	This option can rotate the image by xx degrees (anti-clockwise)
`trim=l b r t`	This option will crop the imported image by l from the left, b from the bottom, r from the right, and t from the top. Where l, b, r and t are lengths.
`clip`	For the trim option to work, you must set `clip=true`.

Importing Graphics

- Examples:

```
\includegraphics{fig/bubble.jpg}
```

Importing Graphics

- Examples:

```
\includegraphics[scale=0.5]{fig/bubble.jpg}
```

Importing Graphics

- Examples:

```
\includegraphics[width=8cm]{fig/bubble.jpg}
```

Mathematics

- Typesetting mathematics is one of LaTeX's greatest strengths.
  - Use plain LaTeX if you are writing a document that needs only a few simple mathematical formulas
  - Use the `amsmath` package for a scientific document that contains numerous complicated formulas
- Mathematics environments
  - LaTeX needs to know beforehand that the subsequent text does in fact contain mathematical elements.

1. *Text* – displayed in-line (within the body of text)
2. *Display* – separate from the main text

Mathematics

Text Type

- `$ mathematical formula $`
- `\( mathematical formula \)`
  - Example:

```
A norm-bounded uncertainty form,
$\bigtriangleup A_{ij}(t) = E_{ij}\Gamma_{ij}(t)F_{ij1}$,
can be derived.
```

A norm-bounded uncertainty form, $\triangle A_{ij}(t) = E_{ij}\Gamma_{ij}(t)F_{ij1}$, can be derived.

Mathematics

Display Type

➢ `\[ mathematical formula \]`

☞ Example:

```
A norm-bounded uncertainty form,
\[\bigtriangleup A_{ij}(t) = E_{ij}\Gamma_{ij}(t)F_{ij1}\]
can be derived.
```

A norm-bounded uncertainty form,

$$\triangle A_{ij}(t) = E_{ij}\Gamma_{ij}(t)F_{ij1}$$

can be derived.

Mathematics

Display Type

- The `equation` environment:

```
\begin{equation}
mathematical formula
\end{equation}
```

  - Example:

```
\begin{equation}
\frac{dx_1}{dt} = x_1^2 + 3x_1 - 2
\end{equation}
```

$$\frac{dx_1}{dt} = x_1^2 + 3x_1 - 2 \tag{1}$$

Mathematics

Display Type

- The `equation` environment:

```
\begin{equation*}
mathematical formula
\end{equation*}
```

  - Example:

```
\begin{equation*}
\frac{dx_1}{dt} = x_1^2 + 3x_1 - 2
\end{equation*}
```

$$\frac{dx_1}{dt} = x_1^2 + 3x_1 - 2$$

Mathematics

Greek Letters

α	β	δ	ϵ	ε	ϕ	γ
\alpha	\beta	\delta	\epsilon	\varepsilon	\phi	\gamma
η	κ	λ	μ	ν	π	θ
\eta	\kappa	\lambda	\mu	\nu	\pi	\theta
ρ	σ	τ	ω	ξ	ψ	Δ
\rho	\sigma	\tau	\omega	\xi	\psi	\Delta
Γ	Ω	Φ	Π	Ψ	Σ	Θ
\Gamma	\Omega	\Phi	\Pi	\Psi	\Sigma	\Theta

Mathematics

Relation Symbols

$\leq$	$\geq$	$\equiv$	$\prec$	$\succ$	$\sim$
\leq	\geq	\equiv	\prec	\succ	\sim
$\preceq$	$\succeq$	$\simeq$	$\ll$	$\gg$	$\asymp$
\preceq	\succeq	\simeq	\ll	\gg	\asymp
$\subset$	$\supset$	$\approx$	$\subseteq$	$\supseteq$	$\cong$
\subset	\supset	\approx	\subseteq	\supseteq	\cong
$\sqsubset$	$\sqsupset$	$\neq$	$\sqsubseteq$	$\sqsupseteq$	$\doteq$
\sqsubset	\sqsupset	\neq	\sqsubseteq	\sqsupseteq	\doteq
$\in$	$\ni$	$\propto$	$\vdash$	$\dashv$	$\smile$
\in	\ni	\propto	\vdash	\dashv	\smile
$\models$	$\parallel$	$\frown$	$\perp$	$\bowtie$	$\Join$
\models	\parallel	\frown	\perp	\bowtie	\Join

Mathematics

Arrows

$\leftarrow$	$\longleftarrow$	$\Leftarrow$	$\Longleftarrow$
\leftarrow	\longleftarrow	\Leftarrow	\Longleftarrow
$\rightarrow$	$\longrightarrow$	$\Rightarrow$	$\Longrightarrow$
\rightarrow	\longrightarrow	\Rightarrow	\Longrightarrow
$\rightleftharpoons$	$\leadsto$	$\uparrow$	$\downarrow$
\rightleftharpoons	\leadsto	\uparrow	\downarrow
$\Uparrow$	$\Downarrow$	$\updownarrow$	$\Updownarrow$
\Uparrow	\Downarrow	\updownarrow	\Updownarrow

Mathematics

Binary Operators

$\pm$	$\mp$	$\times$	$\div$	$*$	$\star$
\pm	\mp	\times	\div	\ast	\star
$\circ$	$\bullet$	$\cdot$	$\oplus$	$\ominus$	$\otimes$
\circ	\bullet	\cdot	\oplus	\ominus	\otimes
$\cap$	$\cup$	$\uplus$	$\sqcap$	$\sqcup$	$\vee$
\cap	\cup	\uplus	\sqcap	\sqcup	\vee
$\wedge$	$\setminus$	$\wr$	$\oslash$	$\odot$	$\bigcirc$
\wedge	\setminus	\wr	\oslash	\odot	\bigcirc
$\triangleright$	$\triangleleft$	$\trianglerighteq$	$\dagger$	$\ddagger$	$\amalg$
\rhd	\unlhd	\unrhd	\dagger	\ddagger	\amalg

Mathematics

Miscellaneous Symbols

$\aleph$	$\hbar$	$\imath$	ℓ	$\wp$
\aleph	\hbar	\imath	\ell	\wp
$\Re$	$\Im$	$\mho$	$\Diamond$	$\triangle$
\Re	\Im	\mho	\Diamond	\triangle
$\prime$	$\emptyset$	∇	$\surd$	$\top$
\prime	\emptyset	\nabla	\surd	\top
$\bot$	$\|$	$\angle$	∞	$\clubsuit$
\bot	\\|	\angle	\infty	\clubsuit
$\diamondsuit$	$\forall$	$\exists$	$\neg$	$\flat$
\diamondsuit	\forall	\exists	\neg	\flat
$\natural$	∂	$\Box$	$\heartsuit$	$\spadesuit$
\natural	\partial	\Box	\heartsuit	\spadesuit

Mathematics

Fractions, Powers, & Indices

Fractions		
a/b	$\frac{x+1}{2x^2-x+3}$	$\dfrac{x+1}{2x^2-x+3}$
a/b	\frac{x+1}{2x^2-x+3}	\dfrac{x+1}{2x^2-x+3}
Powers (superscripts)		
x^2	a^{b^c}	h^{ij}
x^2	{a^b}^c	h^{ij}
Indices (subscripts)		
x_2	a_{bc}	h_{ij}
x_2	{a_b}_c	h_{ij}

Mathematics

Roots & Accents

Roots	
$\sqrt{x+1}$	$\sqrt[3]{x+1}$
`\sqrt{x+1}`	`\sqrt[3]{x+1}`

Math mode accents			
$\hat{a}$	$\bar{a}$	$\dot{a}$	$\vec{a}$
`\hat{a}`	`\bar{a}`	`\dot{a}`	`\vec{a}`
$\tilde{a}$	$\ddot{a}$	$\check{a}$	$\grave{a}$
`\tilde{a}`	`\ddot{a}`	`\check{a}`	`\grave{a}`

Mathematics

Arrays: the array Environment

```
\begin{equation*}
\begin{array}{ c c c }
x + y  & 8       & 5 \\
12     & a^2 + c & 2b \\
2x - y & 9       & x^3
\end{array}
\end{equation*}
```

$$\begin{array}{ c c c }
x + y & 8   & 5 \\
12   & a^2 + c & 2b \\
2x - y & 9   & x^3
\end{array}$$

Mathematics

Arrays: the array Environment

```
\begin{equation*}
\begin{array}{ c ||| c c }
x + y  & 8       & 5 \\
12     & a^2 + c & 2b \\
2x - y & 9       & x^3
\end{array}
\end{equation*}
```

$$\left.\begin{array}{c|cc} x+y & 8 & 5 \\ 12 & a^2+c & 2b \\ 2x-y & 9 & x^3 \end{array}\right.$$

Mathematics

Arrays: the `array` Environment

```
\begin{equation*}
\begin{array}{ c ||| c c }
x + y  & 8       & 5 \\
12     & a^2 + c & 2b \\ \hline\hline\hline
2x - y & 9       & x^3
\end{array}
\end{equation*}
```

$$\begin{array}{ c ||| c c }
x + y & 8   & 5 \\
12   & a^2 + c & 2b \\ \hline\hline\hline
2x - y & 9   & x^3
\end{array}$$

Mathematics

Arrays: the array Environment

```
\begin{equation*}
\left[
\begin{array}{cccc}
a_{11} & a_{12} & a_{13} & a_{14} \\
a_{21} & a_{22} & a_{23} & a_{24} \\
a_{31} & a_{32} & a_{33} & a_{34} \\
a_{41} & a_{42} & a_{43} & a_{44}
\end{array}
\right]
\end{equation*}
```

$$\left[\begin{array}{cccc} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{array} \right]$$

Mathematics

Arrays: the array Environment

```
\begin{equation*}
\left[\begin{array}{cc}
\left[\begin{array}{cc}
a_{11} & a_{12} \\
a_{21} & a_{22}
\end{array}\right] & B \\
B^T & \left[\begin{array}{cc}
c_{11} & c_{12} \\
c_{21} & c_{22}
\end{array}\right]
\end{array}\right]
\end{equation*}
```

$$\left[\begin{array}{cc}
\left[\begin{array}{cc}
a_{11} & a_{12} \\
a_{21} & a_{22}
\end{array}\right] & B \\
B^T & \left[\begin{array}{cc}
c_{11} & c_{12} \\
c_{21} & c_{22}
\end{array}\right]
\end{array}\right]$$

Mathematics

Arrays: the array Environment

```
\begin{equation*}
\det\left|
\begin{array}{cccc}
a_{11} & a_{12} & \cdots & a_{1m} \\
a_{21} & a_{22} & \cdots & a_{2m} \\
\vdots & \vdots & \ddots & \vdots \\
a_{n1} & a_{n2} & \cdots & a_{nm}
\end{array}
\right| = 0
\end{equation*}
```

$$\det \left| \begin{array}{cccc} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nm} \end{array} \right| = 0$$

Mathematics

Arrays: the array Environment

```
\begin{equation*}
f(t) = \left\{
\begin{array}{ccl}
(t-1)^2 & & \text{for} \quad t>1 \\
0       & & \text{for} \quad-1\leq t\leq 1 \\
(t+1)^2 & & \text{for} \quad t<-1
\end{array}
\right.
\end{equation*}
```

$$f(t) = \begin{cases} (t-1)^2 & \text{for} \quad t > 1 \\ 0 & \text{for} \quad -1 \leq t \leq 1 \\ (t+1)^2 & \text{for} \quad t < -1 \end{cases}$$

➢ Note: \lift and \right must exist simultaneously.

Mathematics

Arrays: the array Environment

```
\begin{equation}
\begin{array}{rcl}
|f(z)| & = & |e^{z^2-4}-1|^3\\
& \leq & (|e^{z^2-4}|+1)^3 = (e^{Re(z^2-4)}+1)^3\\
& = & (e^{x^2-y^2-4}+1)^3
\end{array}
\end{equation}
```

$$\begin{array}{rcl} |f(z)| & = & |e^{z^2-4}-1|^3 \\ & \leq & (|e^{z^2-4}|+1)^3 = (e^{Re(z^2-4)}+1)^3 \\ & = & (e^{x^2-y^2-4}+1)^3 \end{array} \tag{2}$$

Mathematics

Arrays: the eqnarray Environment

```
\begin{eqnarray}
|f(z)| & = & |e^{z^2-4}-1|^3 \nonumber \\
& \leq & (|e^{z^2-4}|+1)^3 = (e^{Re(z^2-4)}+1)^3\\
& = & (e^{x^2-y^2-4}+1)^3 \nonumber
\end{eqnarray}
```

$$
\begin{aligned}
|f(z)| &= |e^{z^2-4}-1|^3 \\
&\leq (|e^{z^2-4}|+1)^3 = (e^{Re(z^2-4)}+1)^3 \\
&= (e^{x^2-y^2-4}+1)^3
\end{aligned} \tag{3}
$$

Mathematics

Arrays: the eqnarray Environment

```
\begin{eqnarray}
|f(z)| & = & |e^{z^2-4}-1|^3\\
& \leq & (|e^{z^2-4}|+1)^3 = (e^{Re(z^2-4)}+1)^3\\
& = & (e^{x^2-y^2-4}+1)^3
\end{eqnarray}
```

$$
\begin{aligned}
|f(z)| &= |e^{z^2-4}-1|^3 && (4)\\
&\leq (|e^{z^2-4}|+1)^3 = (e^{Re(z^2-4)}+1)^3 && (5)\\
&= (e^{x^2-y^2-4}+1)^3 && (6)
\end{aligned}
$$

Useful Commands for Slides

Font Sizes

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

Useful Commands for Slides

Fonts

`\emph{emphasize NTU}`	*emphasize NTU*
`\bf{boldface NTU}`	**boldface NTU**
`\tt{typewriter NTU}`	`typewriter NTU`
`\sc{small caps ntu}`	SMALL CAPS NTU
`\it{italic NTU}`	*italic NTU*
`\sl{slanted NTU}`	*slanted NTU*
`\rm{roman NTU}`	roman NTU
`\sf{sans serif NTU}`	sans serif NTU
`{$\cal NTU$}`	$\mathcal{NTU}$

Useful Commands for Slides

Alignment – Center

```
\begin{center}
Practical controller design for most nonlinear processes is based
on local linear models and linear theories\\
although the adequacy of the model might be questionable
for a process operated far from its original design conditions.
\end{center}
```

Practical controller design for most nonlinear processes is based on local linear models and linear theories
although the adequacy of the model might be questionable for a process operated far from its original design conditions.

Useful Commands for Slides

Alignment – Right

```
\begin{flushright}
Practical controller design for most nonlinear processes is based
on local linear models and linear theories\\
although the adequacy of the model might be questionable
for a process operated far from its original design conditions.
\end{flushright}
```

Practical controller design for most nonlinear processes is based on local linear models and linear theories
although the adequacy of the model might be questionable for a process operated far from its original design conditions.

Useful Commands for Slides

Alignment – Left

```
\begin{flushleft}
Practical controller design for most nonlinear processes is based
on local linear models and linear theories\\
although the adequacy of the model might be questionable
for a process operated far from its original design conditions.
\end{flushleft}
```

Practical controller design for most nonlinear processes is based on local linear models and linear theories
although the adequacy of the model might be questionable for a process operated far from its original design conditions.

Useful Commands for Slides

Vertical Space

```
Practical controller design for most nonlinear processes is based
on local linear models and linear theories\\
\vspace{3cm}
although the adequacy of the model might be questionable
for a process operated far from its original design conditions.
```

Practical controller design for most nonlinear processes is based on local linear models and linear theories

although the adequacy of the model might be questionable for a process operated far from its original design conditions.

Useful Commands for Slides

Horizontal Space

```
Practical controller design for most nonlinear processes is based
on local linear models and linear \hspace{3cm} theories\\
although the adequacy of the model might be questionable
for a process operated far from its original design conditions.
```

Practical controller design for most nonlinear processes is based on local linear models and linear theories
although the adequacy of the model might be questionable for a process operated far from its original design conditions.

Useful Commands for Slides

Quotation

```
\begin{quotation}
Practical controller design for most nonlinear processes is based
on local linear models and linear theories
although the adequacy of the model might be questionable
for a process operated far from its original design conditions.
\end{quotation}
```

> Practical controller design for most nonlinear processes is based on local linear models and linear theories although the adequacy of the model might be questionable for a process operated far from its original design conditions.

Useful Commands for Slides

Minipage

```
\begin{minipage}{0.65\linewidth}
Practical controller design for most nonlinear processes is based
on local linear models and linear theories
although the adequacy of the model might be questionable
for a process operated far from its original design conditions.
\end{minipage}
```

Practical controller design for most nonlinear processes is based on local linear models and linear theories although the adequacy of the model might be questionable for a process operated far from its original design conditions.

Useful Commands for Slides

List Structures – Itemize

```
\begin{itemize}
\item Chemical Engineering
  \begin{itemize}
  \item Process control
  \item Material and energy balance
  \end{itemize}
\item Mechanical Engineering
  \begin{itemize}
  \item Heat exchanger design
  \item Optimization
  \end{itemize}
\end{itemize}
```

- Chemical Engineering
  - Process control
  - Material and energy balance
- Mechanical Engineering
  - Heat exchanger design
  - Optimization

Useful Commands for Slides

List Structures – Enumerate

```
\begin{enumerate}
\item Chemical Engineering
  \begin{enumerate}
  \item Process control
  \item Material and energy balance
  \end{enumerate}
\item Mechanical Engineering
  \begin{enumerate}
  \item Heat exchanger design
  \item Optimization
  \end{enumerate}
\end{enumerate}
```

1. Chemical Engineering
   (a) Process control
   (b) Material and energy balance
2. Mechanical Engineering
   (a) Heat exchanger design
   (b) Optimization

Useful Commands for Slides

List Structures – Description

```
\begin{description}
\item[Department] Chemical Engineering
  \begin{description}
  \item[Subject] Process control
  \item[Subject] Material and energy balance
  \end{description}
\item[Department] Mechanical Engineering
  \begin{description}
  \item[Subject] Heat exchanger design
  \item[Subject] Optimization
  \end{description}
\end{description}
```

Department Chemical Engineering

- **Subject** Process control
- **Subject** Material and energy balance

Department Mechanical Engineering

- **Subject** Heat exchanger design
- **Subject** Optimization

Thank You for Your Attention

Questions Are Welcome