A Short Introduction to LaTeX

for IOE Graduate Conference

Jayandra Raj Shrestha

March 2020

Department of Applied Sciences, Pulchowk Campus,
Institute of Engineering, Tribhuvan University, Nepal

jayandra@ioe.edu.np

Contents

Detailed Contents

Basics

What is LaTeX ?

- A family of programs designed to typeset and produce publication-quality documents.
- Literate Programming.
  Computer Code $\Longrightarrow$ Formatted Document
- Very good at working with structured documents and mathematics-intensive content.
- The history of LaTeX begins with TeX, which is a freely available typesetting program developed in 1978 by **Donald Knuth** to typeset documents, particularly those that include formulae to overcome the mistakes that his publishers made in typesetting his work.
- Knuth's product (TeX) is an immensely powerful program, but focuses very much on small details. Later, **Leslie Lamport** wrote a variant of TeX called LaTeX that focuses on document structure rather than such details.

Why LaTeX ?

- High **typographical quality** of the documents
- Great for typesetting **Mathematics**
- Separate **content** from **layout/format**
- **WYSIWYM**[1] rather than **WYSIWYG**[2]
- Create **well structured** documents (articles, books, theses, ...)
- Automated placement of figures and tables
- Automatic generation of references to tables, figures, bibliographies, etc.
- Free, Open Source, and Universal
- Document Source is plain text: portable, reusable, transparent
- "Reproducible" content
  LaTeX + R $\Longrightarrow$ S-weave $\Longrightarrow$ Reproducible Content

[1] What You See Is What You Mean
[2] What You See Is What You Get

Getting the LaTeX software

Major standard distributions of LaTeX software

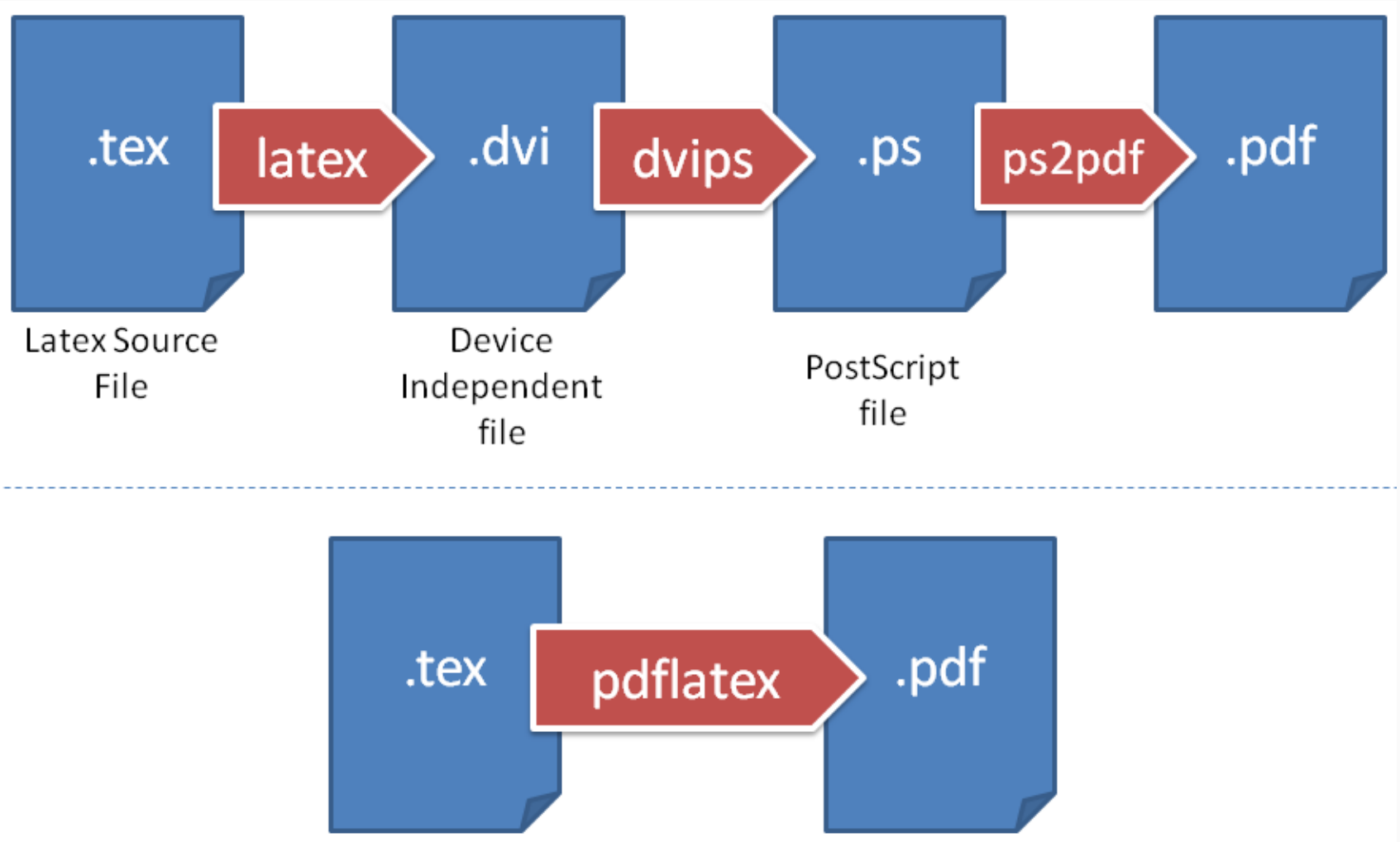
- TeXLive (`https://www.tug.org/texlive`)
- MikTeX (`https://miktex.org`)

- These are freely downloadable from the internet.
- TeXLive works in all the major PC platforms like Windows, Unix, Linux, and Mac. Whereas, MikTeX is for Windows only
- When you install these, you also get the TeXWorks editor as your frontend.
- More than a dozen other front-end Editors / GUIs are available for LaTeX

Some popular LaTeX Editors / GUIs

- TeXMaker (`http://www.xm1math.net/texmaker`)
- TeXnic Center (`http://www.texniccenter.org`)
- TeXstudio (`http://www.texstudio.org`)
- JabRef for Bibliography management (`http://www.jabref.org`)

Producing Output



Bare Minimum in a .tex file

```
\documentclass[option-1, option-2, ...]{class-name}

... ... ...                                          % Preamble

\begin{document}

   ... ... ...
   ... ... ...                                       % Body

\end{document}
```

Example: Article

```
\documentclass[a4paper, 11pt, titlepage]{article}
    \title{Title Goes Here}
    \author{First Author \and Second Author}
    \date{ }                        % empty { } for no date

\begin{document}
    \maketitle
    \begin{abstract}
       ... ... ...
    \end{abstract}

    \section{Introduction}
      ... ... ...

    \subsection{Objectives}
      ... ... ...

    \subsubsection{Specific Objectives}
      ... ... ...
\end{document}
```

Example: Book

```
\documentclass[b4paper, 10pt, twoside, openright]{book}
\usepackage{amsmath}

    \title{A Textbook of Chemistry for Engineering}
    \author{Dr. ABC \and Dr. XYZ}
    \date{October 2017}

\begin{document}
    \maketitle
    \tableofcontents

    \part{Industrial Chemistry}
    \chapter{Common Chemicals used in Industries}
      ... ... ...
    \section{Strong Chemicals}
      ... ... ...

    \part{Organic Chemistry}
      ... ... ...
\end{document}
```

LaTeX Vocabulary: Commands

- **Commands** produce text or space or carries out some special task
- Every command starts with a \
- Many commands take arguments, either mandatory or optional; some commands, like `\today` don't

Examples

- `\vspace{2in}` is a command that creates 2 inches of vertical space
- `\textit{...}` puts the contents of its argument in italic type

Mandatory Arguments

- Supply necessary information for a command to execute
- Enclosed in curly braces: `{ }`
- Examples: `\hspace{2in}` `\textbf{Important Stuff}`

Optional Arguments

- Supply optional information(s) for a command.
- Enclosed in square brackets: `[ ]`.
- Example: `\documentclass[11pt, fleqn]{article}`

LaTeX Vocabulary: Environments

- Blocks of text that receive special processing.
- An environment is defined as:

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

- An environment is also a group, in the same way that a pair of braces delimits a group.

Examples:

- `\begin{document} ... \end{document}`
- `\begin{itemize} ... \end{itemize}`
- `\begin{figure} ... \end{figure}`
- `\begin{Huge} ... \end{Huge}`
- `\begin{center} ... \end{center}`
- `\begin{math} ... \end{math}`

LaTeX Vocabulary: Declarations

- Produce neither text nor space, but either affect the way LaTeX prints the following text or provide information for later use.
- Font size changes are an example of declarations. `\large` will cause any text that follows to appear in a larger type size.
- Declarations are often used within a group / environment to limit their scope.

Example 1 (group):

```
{\large Only the text inside these braces will be
large}
```

Example 2 (environment):

```
\begin{table}
   \small     %applied only within the table environment
     ...
     ...
\end{table}
```

Document Classes

The document class determines the overall layout of the document. There are five standard classes distributed with LATEX:

article for simple or short documents, including journal articles, and short reports. A good all-purpose class.

report for small books and longer reports containing chapters.

book for books.

letter for letters, either business or personal.

slides for making transparencies for projection on a screen.

These classes provide preset formats with default margins, paragraph formatting, and special commands suitable for producing specific sections. For example, the article, report, and book classes include a variety of commands to format section headings, as well as commands to produce a title page, table of contents, etc.

IOEGC.cls
custom class derived from the article class

Document Classes ...

There are minor differences between these three classes.

- The book class is formatted for two-sided printing by default.
- The article class is intended for shorter works and does not have chapters (so articles can be easily included in reports or books).
- Several Chapters of a book can be grouped into parts. This is not the case in report.

The letter class provides special commands to produce the salutation, address, and closing. These four classes are single-spaced by default, and have 10, 11, and 12-point type sizes available as options. 10 points is the default size. The slides class uses sans-serif type fonts much larger than the usual ones and expects the document to be divided up into 1-page sections.

Document Class Options

A document class may be modified by options, which are placed in square brackets after the `\documentclass` command. Multiple options are separated by commas:

```
\documentclass[option1, option2, option3, ...]{class}
```

Standard Class options:

- a4paper, letterpaper, a5paper, b5paper, legalpaper, ...
- 10pt, 11pt, 12pt
- twocolumn
- titlepage, notitlepage (for \maketitle; title on separate page?)
- leqno (Equation numbers on the left; default=right)
- fleqn (Left align equations; default=center)
- oneside, twoside
  (for proper page numbering in case of both side printing)
- openright, openany (New chapter on right page?)

Document Structure

Document Structure: Producing the Title and Author Information

In the preamble section

```
\title{title of the document}
\author{author name(s)}
\date{the date}
```

Just after the `\begin{document}`

```
\maketitle
```

- Produced in a **separate page** for **book and report** classes
- Produced in the **first page** of the document for **article** class
- Can be modified by the document class options: titlepage or notitlepage
- if `\date{...}` is omitted, current date will be used
- To remove the date, use `\date{ }` instead
- use `\\` to break lines, `\and` to separate authors

In IOEGC.cls

- `\PaperTitle{ ... }`
- `\Authors{ ... }`
- `\affiliation{ ... }`

Document Structure: Including Abstract

- Special format for document classes **article** and **report**
- In **report** class: appears on the separate title page
- In **article** class: appears below the title information on the first page
- can be overridden by the `titlepage`/`notitlepage` option
- NOT AVAILABLE in the **book** class

Command

```
\begin{abstract}
   ...
   ...
\end{abstract}
```

In IOEGC.cls

- `\Abstract{ ... }`
- `\Keywords{ ... }`

do not put any extra line at the opening or closing brace!

Document Structure: Sectioning

- The classes article, report, and book have a set of commands for different kinds of sections/headings

```
\part       \section          \paragraph
\chapter    \subsection       \subparagraph
            \subsubsection
```

- LaTeX takes care of formatting the headings and numbering them appropriately
- `\chapter` command is not available for article class
- `\part` command is available only for the book class. Does not affect the numbering.
- `\paragraph` and `\subparagraph` are not numbered by default
- `\tableofcontents` can be used to include table of contents at the beginning of the document (process the document twice to ensure an up-to-date TOC)

Document Structure: Less formal Headings

`\section[Short Version]{Long Version}`

- Normally section headings appear in the table of contents exactly as they do in the text.
- However, if a heading is too long to fit nicely into the table of contents, a shorter version can be provided as an optional argument

`\section*{Introduction}`

- Less formal headings can be made by using the sectioning commands with a star (*) appended to the command names (starred variant)
- In this case, the section headings will not show up in the table of contents and will not be numbered.

`\addcontentsline{toc}{section}{Introduction}`

- To be included just below the starred variant of sectioning command to make it appear in the TOC.
- Also add `\phantomsection` for hyperref to work correctly

Dividing Larger document into multiple files

abstract.tex

```
\begin{abstract}
    ... ... ...
    ... ... ...
\end{abstract}
```

intro.tex

```
\chapter{Introduction}
    ... ... ...
    ... ... ...
```

method.tex

```
\chapter{Methodology}
    ... ... ...
    ... ... ...
```

main.tex

```
\documentclass{report}

\title{Latex Manual}
\author{J R Shrestha}
\date{Sept 2015}

\begin{document}
  \maketitle
  \include{abstract}
  \tableofcontents
  \include{intro}
  \include{method}
  ... ... ...
  ... ... ...
\end{document}
```

Cross Referencing

Setting a marker for referencing

`\label{marker}`

Referencing

`\ref{marker}`	to produce the number of the corresponding section, figure, etc.
`\pageref{marker}`	to produce the corresponding page number

- marker = identifier of your choice; it may contain letters, numbers, or other characters (except special ones)
- It is recommended to start the marker name with a tag that identifies what is being marked: for example,
  sec: for sections, **eqn:** for equations, **fig:** for figures, **tbl:** for tables, etc.
- The `\label` command should be placed immediately after a sectioning command, within an equation environment, or inside a figure or table environment immediately following the `\caption` command
- LaTeX uses the numbers from the .aux file produced by the previous run, so it will take two runs (or more) to get it done correctly

Text Formatting

Formatting: Special Characters

Characters that have special meaning to LaTeX. An example is the % sign, which indicates that the remainder of the line is a comment and should not be processed.

To get	Type	Meaning in LaTeX
#	\#	Parameter in a macro; also used in tables
$	\$	Used to begin and end math mode
%	\%	Used for comments in source file
&	\&	Tabbing, change column in tables, ...
_	_	Used in math mode for subscripts
^	\^	Used in math mode for superscripts
~	\~	Tilde; used to produce a ”hard” space
{	\{	Used to begin a group or an argument
}	\}	Used to end a group or an argument
\	\textbackslash	Used to begin a control sequence
<	\textless	
>	\textgreater	

Formatting: Changing Font Styles

Shape	Command	Declaration
upright	`\textup{...}`	`{\upshape ...}`
italic	`\textit{...}`	`{\itshape ...}`
slanted	`\textsl{...}`	`{\slshape ...}`
SMALL CAP	`\textsc{...}`	`{\scshape ...}`

Series	Command	Declaration
medium	`\textmd{...}`	`{\mdseries ...}`
boldface	`\textbf{...}`	`{\bfseries ...}`

Family	Command	Declaration
roman	`\textrm{...}`	`{\rmfamily ...}`
sans serif	`\textsf{...}`	`{\sffamily ...}`
`typewriter`	`\texttt{...}`	`{\ttfamily ...}`

for *emphasis* use `\emph{...}`
for underlining use `\underline{...}`

Formatting: Changing Font Size

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

- size changing commands are declarations
- Enclose within {...} to limit scope
- have equivalent environment also.
  Example: `\begin{Huge} ... \end{Huge}`
- normalsize = size defined in `\documentclass` option

Formatting: Font Size Metrics

- Other sizes are relative to normalsize
- when normalsize = 12pt; huge = Huge = 25pt

Command	normalsize		
	10pt	11pt	12pt
`\tiny`	5	6	6
`\scriptsize`	7	8	8
`\footnotesize`	8	9	10
`\small`	9	10	10.95
`\normalsize`	10	10.95	12
`\large`	12	12	14.4
`\Large`	14.4	14.4	17.28
`\LARGE`	17.28	17.28	20.74
`\huge`	20.74	20.74	24.88
`\Huge`	24.88	24.88	24.88

Formatting: Horizontal Text Alignment

- Command
  - `\centerline{...}` overflows in larger block of text
- Environments
  - `\begin{center}` ... `\end{center}`
  - `\begin{flushleft}` ... `\end{flushleft}`
  - `\begin{flushright}` ... `\end{flushright}`
- Declarations
  - `{\centering ... }`
  - `{\raggedright ...}`
  - `{\raggedleft ...}`

Lists

Unnumbered List

```
\begin{itemize}
   \item Apple
   \item Ball
\end{itemize}
```

Numbered list

```
\begin{enumerate}
   \item Dog
   \item Cat
\end{enumerate}
```

Description List

```
\begin{description}
   \item[IOE]  Institute of Engineering
   \item[IOM]  Institute of Medicine
\end{description}
```

Nested List

```
\begin{enumerate}
   \item Fruits
   \begin{itemize}
      \item Apple
      \item Orange
      \item Banana
   \end{itemize}

   \item Animals
   \begin{itemize}
       \item Monkey
       \item Dog
       \item Cat
   \end{itemize}
\end{enumerate}
```

Can nest same type of list up to four levels.

Formatting: Special Constructs

Quotation

- `\begin{quote}` ... `\end{quote}`
- `\begin{quotation}` ... `\end{quotation}`
- `\begin{verse}` ... `\end{verse}`

Reproducing text as-is

- `\begin{verbatim}` ... `\end{verbatim}`
- `\verb # ... ... ... #`

  # is the delimiting character, can use any character except *

Formatting: Drawing Horizontal line

Syntax: `\rule[lift]{width}{thickness}`

Example: `\rule[3]{\linewidth}{0.1}`

Typesetting Mathematics

Typesetting Mathematics

- Greek symbols, mathematical symbols, delimiters, operators
- Different font type (math italic) than in normal text (roman upright)
- Blank lines are not allowed in between
- Extra Spaces are ignored
- For advanced features, include in the preamble:
  `\usepackage{amsmath}`

Modes:

- Inline form
  - `$ ... $`
  - `\( ... \)`
  - `\begin{math} ... \end{math}`
- Display form
  - `$$ ... $$`
  - `\[ ... \]`
  - `\begin{displaymath} ... \end{displaymath}`
- Numbered equations
  - `\begin{equation} ... \end{equation}`
  - `\begin{eqnarray} ... \end{eqnarray}`

Inline Math

- To place mathematical formulas in the midst of ordinary text
- Are roughly the same size as the text they're embedded in
- Invoked in one of the three ways: `$...$` or `\(...\)` or `\begin{math}...\end{math}`

Example

```
The quadratic equation $ax^2+bx+c = 0$ has two roots
whose nature depends on the sign of the discriminant
\begin{math}d = \sqrt{b^2 - 4ac}\end{math}. If $d>0$,
then there are two distinct real roots; if \( d=0 \),
then there are two real and equal roots; and if $d<0$,
then the two roots are conjugate complex numbers.
```

Output

The quadratic equation $ax^2 + bx + c = 0$ has two roots whose nature depends on the sign of the discriminant $d = \sqrt{b^2 - 4ac}$. If $d > 0$, then there are two distinct real roots; if $d = 0$, then there are two real and equal roots; and if $d < 0$, then the two roots are conjugate complex numbers.

Display Math

- Puts the content in a separate line with space before and after
- Centered by default. For left-justified equations, include fleqn as an option in the documentclass
- Invoked in one of the three ways: `$$...$$` or `\[...\]` or `\begin{displaymath}...\end{displaymath}`

Example

```
The quadratic equation $ax^2 + bx + c = 0$ has two roots,
given by the following formula:
\[ x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \]
where the nature of the roots is determined by the sign of
the discriminant $b^2 - 4ac$.
```

Output

The quadratic equation $ax^2 + bx + c = 0$ has two roots, given by the following formula:

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

where the nature of the roots is determined by the sign of the discriminant $b^2 - 4ac$.

Numbered Equation

- Similar to displaymath environment
- An equation number in parentheses is placed to the right of the displayed formula. For left-side numbering, include leqno as an option to the documentclass command
- Invoked with `\begin{equation} ... \end{equation}`

Example

```
The derivative of $f(x)$ at the point $x_0$ is
\begin{equation}
    f'(x_0) = \lim_{x \rightarrow x_0}
                \frac{f(x) - f(x_0)}{x - x_0}
\end{equation}
```

Output

The derivative of $f(x)$ at the point x_0 is

$$f'(x_0) = \lim_{x \rightarrow x_0} \frac{f(x) - f(x_0)}{x - x_0} \tag{1}$$

Equation Arrays

- Invoked by `\begin{eqnarray} ... \end{eqnarray}`
- Builds a three-column array of numbered equations, with the first column right-justified, the second centered, and the third left-justified.
- Mainly used for displaying multi-line formulas
- `&` is used to separate columns and `\\` is used to separate lines
- Each line is numbered by default, but the command `\nonumber` can be used to suppress the equation number on any line
- Alternatively, environment `eqnarray*` can be used, which does not number any lines
- `\label` and `\ref` commands can be used to refer to equation numbers
- The amsmath package provides additional environments for formatting multiline equations (e.g., split, align, gather, etc.)

eqnarray Example

Source

```
\begin{eqnarray}
    (a + b)(a + b) & = & a^2 + ab + ba + b^2 \nonumber \\
                   & = & a^2 + 2ab + b^2     \\
    (a + b)(a - b) & = & a^2 - ab + ba - b^2 \nonumber \\
                   & = & a^2 - b^2           \\
    (a + b)^3      & = & a^3 + 3a^2b + 3ab^2 + b^3
\end{eqnarray}
```

Output

$$
\begin{aligned}
(a+b)(a+b) &= a^2 + ab + ba + b^2 \\
&= a^2 + 2ab + b^2 && (2) \\
(a+b)(a-b) &= a^2 - ab + ba - b^2 \\
&= a^2 - b^2 && (3) \\
(a+b)^3 &= a^3 + 3a^2b + 3ab^2 + b^3 && (4)
\end{aligned}
$$

Math mode commands

Command	Output
`x_1`	x_1
`x_{11}`	x_{11}
`x^2`	x^2
`x^{2a}`	x^{2a}
`x_1^2`	x_1^2
`{x_1}^2`	${x_1}^2$
`\frac{x}{y}`	$\frac{x}{y}$
`\tfrac{x}{y}`	fraction in text form
`\dfrac{x}{y}`	fraction in display form
`\sqrt{5}`	$\sqrt{5}$
`\sqrt[3]{5}`	$\sqrt[3]{5}$
`\sum_{i=1}^{n}{x_i}`	$\sum_{i=1}^{n} x_i$
`\prod_{i=1}^{n}{x_i}`	$\prod_{i=1}^{n} x_i$
`\int_a^b{f(x) dx}`	$\int_a^b f(x)\,dx$
`\lim_{\theta\rightarrow\infty}\sin\theta`	$\lim_{\theta\to 0} \sin\theta$

Example 1

```
\[
\left(
\begin{array}{ccc}
  11 & 12 & 13 \\
  21 & 22 & 23 \\
  31 & 32 & 33
\end{array}
\right)
\]
```

Output

$$\left[\begin{array}{ccc} 11 & 12 & 13 \\ 21 & 22 & 23 \\ 31 & 32 & 33 \end{array}\right]$$

`ccc` = 3 columns, all center aligned
use `l` for left
use `r` for right

Example 2

```
\begin{equation}
A = \left[
\begin{array}{llcl}
  a_{1,1} & a_{1,2} & \ldots & a_{1,n} \\
  a_{2,1} & a_{2,2} & \ldots & a_{2,n} \\
  \vdots  & \vdots  & \ddots & \vdots \\
  a_{m,1} & a_{m,2} & \ldots & a_{m,n}
\end{array} \right]
\end{equation}
```

Output

$$A = \left[\begin{array}{llcl} a_{1,1} & a_{1,2} & \ldots & a_{1,n} \\ a_{2,1} & a_{2,2} & \ldots & a_{2,n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m,1} & a_{m,2} & \ldots & a_{m,n} \end{array}\right] \tag{5}$$

use the commands `\left` and `\right` to make the delimiters like `(...)`, `[...]`, `|...|`, etc., lager enough

Matrix (amsmath package)

matrix

```
\begin{displaymath}
  \begin{matrix}
    a_{11} & a_{12} \\
    a_{21} & a_{22}
  \end{matrix}
\end{displaymath}
```

output

$$\begin{matrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{matrix}$$

bmatrix

$$\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}$$

pmatrix

$$\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}$$

smallmatrix

$$\left(\begin{smallmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{smallmatrix}\right)$$

vmatrix

$$\begin{vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{vmatrix}$$

Vmatrix

$$\begin{Vmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{Vmatrix}$$

Alternate 1

```
\begin{equation*}
  |x|= \left\{
  \begin{array}{rcl}
    -x  & \text{if } & x<0\\
     x  & \text{if } & x\ge 0
  \end{array}
  \right.
\end{equation*}
```

output

$$|x| = \begin{cases} -x & \text{if} \quad x < 0 \\ x & \text{if} \quad x \geq 0 \end{cases}$$

Alternate 2

```
\begin{equation*}
|x|=
\begin{cases}
  -x & \text{if } x < 0 \\
   x & \text{if } x \ge 0
\end{cases}
\end{equation*}
```

Output

$$|x| = \begin{cases} -x & \text{if } x < 0 \\ x & \text{if } x \geq 0 \end{cases}$$

Greek Symbols (in Math Mode)

α	\alpha	ι	\iota	ϱ	\varrho
β	\beta	κ	\kappa	σ	\sigma
γ	\gamma	λ	\lambda	ς	\varsigma
δ	\delta	μ	\mu	τ	\tau
ϵ	\epsilon	ν	\nu	υ	\upsilon
ε	\varepsilon	ξ	\xi	ϕ	\phi
ζ	\zeta	o	o	φ	\varphi
η	\eta	π	\pi	χ	\chi
θ	\theta	ϖ	\varpi	ψ	\psi
ϑ	\vartheta	ρ	\rho	ω	\omega
Γ	\Gamma	Ξ	\Xi	Φ	\Phi
Δ	\Delta	Π	\Pi	Ψ	\Psi
Θ	\Theta	Σ	\Sigma	Ω	\Omega
Λ	\Lambda	Υ	\Upsilon		

- Capitals not shown are produced with English capital letters.
- An ordinary “o” looks Greek when used in a math environment.

Relational Operators

$\leq$	`\le or \leq`	$\geq$	`\geq`	$\equiv$	`\equiv`
$\prec$	`\prec`	$\succ$	`\succ`	$\sim$	`\sim`
$\preceq$	`\preceq`	$\succeq$	`\succeq`	$\simeq$	`\simeq`
$\ll$	`\ll`	$\gg$	`\gg`	$\asymp$	`\asymp`
$\subset$	`\subset`	$\supset$	`\supset`	$\approx$	`\approx`
$\subseteq$	`\subseteq`	$\supseteq$	`\supseteq`	$\cong$	`\cong`
$\sqsubset$ *	`\sqsubset` *	$\sqsupset$ *	`\sqsupset` *	$\perp$	`\perp`
$\sqsubseteq$	`\sqsubseteq`	$\sqsupseteq$	`\sqsupseteq`	$\bowtie$	`\bowtie`
$\in$	`\in`	$\ni$	`\ni`	$\propto$	`\propto`
$\vdash$	`\vdash`	$\dashv$	`\dashv`	$\models$	`\models`
$\smile$	`\smile`	$\mid$	`\mid`	$\doteq$	`\doteq`
$\frown$	`\frown`	$\parallel$	`\parallel`		
$\not<$	`\not<`	$\not>$	`\not>`	$\neq$	`\not=`

- `\not` before a relational operator will negate it.
- * `latexsym` package required

Binary Operators

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

* `latexsym` package required

Miscellaneous Symbols

$\aleph$	\aleph	$\prime$	\prime	$\forall$	\forall
$\hbar$	\hbar	$\emptyset$	\emptyset	$\exists$	\exists
$\imath$	\imath	∇	\nabla	$\neg$	\neg
$\jmath$	\jmath	$\surd$	\surd	$\flat$	\flat
ℓ	\ell	$\top$	\top	$\natural$	\natural
$\wp$	\wp	$\bot$	\bot	$\sharp$	\sharp
$\Re$	\Re	$\Vert$	\Vert	$\clubsuit$	\clubsuit
$\Im$	\Im	$\angle$	\angle	$\diamondsuit$	\diamondsuit
∂	\partial	$\triangle$	\triangle	$\heartsuit$	\heartsuit
∞	\infty	$\Diamond$ *	\Diamond *	$\spadesuit$	\spadesuit
$\mho$ *	\mho *	$\Box$ *	\Box *	$\backslash$	\backslash
$\sum$	\sum	$\prod$	\prod	$\coprod$	\coprod
$\int$	\int	$\oint$	\oint	$\Join$ *	\Join *

* `latexsym` package required
** `gensymb` package required

Symbols that can be used in either math mode or text mode:

† \dag ‡ \ddag § \S ¶ \P © \copyright £ \pounds ° \degree

Mathematical Functions

When using function names in math environment, prefix them with a \ so that they print as normal text rather than italics.

```
\arccos  \arcsin  \arctan  \arg  \cos   \cosh
\cot     \coth    \csc     \deg  \det   \dim
\exp     \gcd     \hom     \inf  \ker   \lg
\lim     \liminf  \limsup  \ln   \log   \max
\min     \Pr      \sec     \sin  \sinh  \sup
\tan     \tanh
```

Accents

$\hat{a}$	`\hat{a}`	$\check{a}$	`\check{a}`	$\breve{a}$	`\breve{a}`
$\acute{a}$	`\acute{a}`	$\grave{a}$	`\grave{a}`	$\tilde{a}$	`\tilde{a}`
$\bar{a}$	`\bar{a}`	$\vec{a}$	`\vec{a}`	$\dot{a}$	`\dot{a}`
$\ddot{a}$	`\ddot{a}`	$\widehat{x-y}$	`\widehat{x-y}`	$\widetilde{xyz}$	`\widetilde{a}`

Delimeters

- The following commands can expand in size to “fit” around the expression they delimit
- To make a delimeter the right size, use it with the `\left ... \right` commands
- Example: `\left( ... ... ... \right)`

(	(	)	)	⌊	\lfloor	⌋	\rfloor
[	[	]	]	⌈	\lceil	⌉	\rceil
{	\{	}	\}	⟨	\langle	⟩	\rangle
|	|	‖	||	↑	\uparrow	⇑	\Uparrow
/	/	\	\backslash	↓	\downarrow	⇓	\Downarrow
				↕	\updownarrow	⇕	\Updownarrow

Arrows

$\leftarrow$	\leftarrow	$\longleftarrow$	\longleftarrow
$\Leftarrow$	\Leftarrow	$\Longleftarrow$	\Longleftarrow
$\rightarrow$	\rightarrow	$\longrightarrow$	\longrightarrow
$\Rightarrow$	\Rightarrow	$\Longrightarrow$	\Longrightarrow
$\leftrightarrow$	\leftrightarrow	$\longleftrightarrow$	\longleftrightarrow
$\Leftrightarrow$	\Leftrightarrow	$\Longleftrightarrow$	\Longleftrightarrow
$\mapsto$	\mapsto	$\longmapsto$	\longmapsto
$\hookleftarrow$	\hookleftarrow	$\hookrightarrow$	\hookrightarrow
$\leftharpoonup$	\leftharpoonup	$\rightharpoonup$	\rightharpoonup
$\leftharpoondown$	\leftharpoondown	$\rightharpoondown$	\rightharpoondown
$\rightleftharpoons$	\rightleftharpoons	$\leadsto$	\leadsto *
$\uparrow$	\uparrow	$\Uparrow$	\Uparrow
$\downarrow$	\downarrow	$\Downarrow$	\Downarrow
$\updownarrow$	\updownarrow	$\Updownarrow$	\Updownarrow
$\nearrow$	\nearrow	$\searrow$	\searrow
$\swarrow$	\swarrow	$\nwarrow$	\nwarrow

* `latexsym` package required

Tables and Figures

Tabular Content

Syntax

```
\begin{tabular}{col-spec}
   ...
\end{tabular}
```

- Requires an additional argument that specifies the alignment of each column (centered, left justified, etc.)
- Substitute any combination of the following symbols for the col-spec argument:

`l`	Left-justified column entry
`c`	Centered column entry
`r`	Right-justified column entry
`p{width}`	Paragraph column entry
`m{width}`	Paragraph column entry (middle aligned, requires the array package)
`|`	Vertical rule column
`||`	Double vertical rule column

- The width necessary for each column is determined automatically from the widest entry

`&`	To move to the next column
`\\`	To end each line (except the last one)
`\hline`	To insert a horizontal line
`\cline{m-n}`	To insert a horizontal line from column m to n

Example

```
\begin{tabular}{|c|l|r|}
    \hline
    SN & Faculty    & Seats\\
    \hline
    1  & Civil      & 192  \\
    2  & Electrical & 48   \\
    3  & Mechanical & 48   \\
    \hline
\end{tabular}
```

Output

SN	Faculty	Seats
1	Civil	192
2	Electrical	48
3	Mechanical	48

Using Wizards / Table Generators

- `excel2latex` plugin for Microsoft Excel
- `Wizard` ⇒ `Quick Tabular` in Texmaker software
- Online services like: `https://www.tablesgenerator.com/`

Table with caption, cross-referencing, and placement

Syntax

```
\begin{table}[placement]
  \centering
  \begin{tabular}{col-spec}
    ...
  \end{tabular}
  \caption[...]{...}
  \label{...}
\end{table}
```

Placement (floats)

Combination of the following in desired preference:

H: here (forceful, required the float package)

h: here (not forceful)

t: top of a text page

b: bottom of a text page

p: page with only floats

default = [tbp]

Placing figures/graphics

Syntax

```
\includegraphics[options]{filename}
```

filename with or without extension

options

width	The width of the graphics (units: pt, in, cm, px, ...)
height	The height of the graphics (units: pt, in, cm, px, ...)
scale	Scale factor for the graphics
angle	Angle of rotation, in degrees, anti-clockwise

Figure with caption, cross-referencing, and placement

```
\begin{figure}[placement]
  \centering
  \includegraphics[options]{filename}
  \caption[...]{...}
  \label{...}
\end{figure}
```

placement same as in table

Changing Numbering Scheme

Numbering based on sections

```
\usepackage{amsmath}
\numberwithin{element-type}{section-type}
```

OR

```
\usepackage{chngcntr}
\counterwithin{element-type}{section-type}
```

element-type = equation / figure / table
section-type = chapter / section / subsection / subsubsection

Continuous numbering scheme for the whole document

```
\usepackage{chngcntr}
\counterwithout{element-type}{chapter}   % for book/report
\counterwithout{element-type}{section}   % for article
```

* *the above commands are to be placed in the preamble section*

Bibliography / References

Why BibTeX ?

- Automates most of the work involved in managing references for use in LaTeX documents
- Need to type/prepare each reference only once, and citations and reference list are automatically formatted consistently, in a chosen style
- Referencing style can be easily changed to another without any/much hassle
- BibTeX references are stored in a plain text database (.bib file) with a simple format, which can be prepared / updated easily
- Entries can be sorted in alphabetical order automatically

Easily Generating BibTeX database entries:

- From google scholar website (`http://scholar.google.com`)
- Using the free JabRef software (`http://www.jabref.org/`)
- Via Texmaker software:
  Menu ⇒ Bibliography ⇒ Bibtex

BibTeX Structure

- Bibliography information stored in bibliography database (.bib) file.
- Each entry follows the following syntax:

```
@entry-type{cite-key,
    field-1 = {value-1},
    field-2 = {value-2},
    ...
    field-n = {value-n}
}
```

- Bibliography style to be selected using the command:
  `\bibliographystyle{style}`
- Bibliography placed in the main document using:
  `\bibliography{database1, database2, ...}`
- Bibliography entries cited using the `\cite{...}` command

In IOEGC Template ⇒ `example.tex` or `article-min.tex`

```
\phantomsection
\bibliographystyle{unsrt}
\bibliography{refs}
```

BibTeX Database Entries

- article
- book
- booklet
- conference
- inbook
- incollection
- inproceedings
- manual
- masterthesis
- misc
- phdthesis
- proceedings
- techreport
- unpublished

Bibliography database entries of different types have different fields. For each entry type, the fields are divided into three classes:

required Omitting a required field produces a warning and may produce a badly formatted entry

optional The field's information will be used if present, but can be omitted without causing any formatting problem

ignored BibTeX ignores any field that is not required or optional

BibTeX Database Fields

- address
- annote
- author
- booktitle
- chapter
- crossref
- edition
- editor
- howpublished
- institution
- journal
- key
- month
- note
- number
- organization
- pages
- publisher
- school
- series
- title
- type
- volume
- year

- field values are enclosed either within `{...}` or double quotes ("...")
- use `{...}` to preserve capitalization
- pure numeric values need not be enclosed within `{...}` or double quotes ("...")

BibTeX Database Fields

address Usually the address of the publisher or other type of institution. Can be omitted for major publishing houses. For small publishers, complete address can be given to help the reader.

annote An annotation. It is not used by the standard bibliography styles, but may be used by others that produce an annotated bibliography.

author The name(s) of the author(s) separated by “and”

booktitle Title of a book, part of which is being cited. For book entries, use the title field instead.

chapter A chapter (or section or whatever) number.

crossref The database key of the entry being cross referenced.

edition The edition of a book–for example, “Second”. This should be an ordinal, and should have the first letter capitalized, as shown here; the standard styles convert to lower case when necessary.

editor Name(s) of editor(s). If there is also an author field, then the editor field gives the editor of the book or collection in which the reference appears.

howpublished How something strange has been published. The first word should be capitalized.

Fields ...

institution The sponsoring institution of a technical report.

journal A journal name. Abbreviations are provided for many journals.

key Used for alphabetizing, cross referencing, and creating a label when the “author” information is missing. This field should not be confused with the key that appears in the \cite command and the cite-key at the beginning of the database entry.

month The month in which the work was published or, for an unpublished work, in which it was written. Use the standard three-letter abbreviation.

note Any additional information that can help the reader. The first word should be capitalized.

number The number of a journal, magazine, technical report, or of a work in a series. An issue of a journal or magazine is usually identified by its volume and number; the organization that issues a technical report usually gives it a number; and sometimes books are given numbers in a named series.

organization The organization that sponsors a conference or that publishes a manual.

Fields ...

pages One or more page numbers or range of numbers, such as 42-111 or 7,41,73-97 or 43+ (the '+' in this last example indicates pages following that don't form a simple range). To make it easier to maintain Scribe-compatible databases, the standard styles convert a single dash (as in 7-33) to the double dash used in TeX to denote number ranges (as in 7–33). BibTeX requires double dashes for page ranges (–).

publisher The publisher's name.

school The name of the school where a thesis was written.

series The name of a series or set of books. When citing an entire book, the title field gives its title and an optional series field gives the name of a series or multi-volume set in which the book is published.

title The work's title.

type The type of a technical report–for example, "Research Note".

volume The volume of a journal or multivolume book.

year The year of publication or, for an unpublished work, the year it was written. Generally it should consist of four numerals, such as 1984, although the standard styles can handle any year whose last four nonpunctuation characters are numerals, such as '(about 1984)'.

Entry Types and their Fields

article An article from a journal or magazine.
Required fields: author, title, journal, year.
Optional fields: volume, number, pages, month, note.

book A book with an explicit publisher.
Required fields: author or editor, title, publisher, year.
Optional fields: volume or number, series, address, edition, month, note.

booklet A work that is printed and bound, but without a named publisher or sponsoring institution.
Required field: title.
Optional fields: author, howpublished, address, month, year, note.

conference An article in a conference proceedings.
Required fields: author, title, booktitle, year.
Optional fields: editor, volume or number, series, pages, address, month, organization, publisher, note.

Entry Types and their Fields ...

inbook A part of a book, a chapter (or section or whatever) and/or a range of pages.
Required fields: author or editor, title, chapter and/or pages, publisher, year.
Optional fields: volume or number, series, type, address, edition, month, note.

incollection A part of a book having its own title.
Required fields: author, title, booktitle, publisher, year.
Optional fields: editor, volume or number, series, type, chapter, pages, address, edition, month, note.

inproceedings Same as *conference*.

manual Technical documentation.
Required field: title.
Optional fields: author, organization, address, edition, month, year, note.

mastersthesis A Master's thesis.
Required fields: author, title, school, year.
Optional fields: type, address, month, note.

Entry Types and their Fields ...

misc Use this type when nothing else fits.
Required fields: none.
Optional fields: author, title, howpublished, month, year, note.

phdthesis A PhD thesis.
Required fields: author, title, school, year.
Optional fields: type, address, month, note.

proceedings The proceedings of a conference.
Required fields: title, year.
Optional fields: editor, volume or number, series, address, month, organization, publisher, note.

techreport A report published by a school or other institution, usually numbered within a series.
Required fields: author, title, institution, year.
Optional fields: type, number, address, month, note.

unpublished A document having an author and title, but not formally published.
Required fields: author, title, note.
Optional fields: month, year.

Steps for running BibTeX with LaTeX

1. Run LATEX or PDFLATEX, which generates a list of `\cite` references in its auxiliary file, .aux.
2. Run BIBTEX, which reads the auxiliary file, looks up the references in a database (one or more .bib files, and then writes a file (the .bbl file) containing the formatted references according to the format specified in the style file (the .bst file). Warning and error messages are written to the log file (the .blg file). It should be noted that BIBTEX never reads the original LATEX source file.
3. Run LATEX or PDFLATEX again, which now reads the .bbl reference file.
4. Run LATEX or PDFLATEX a third time, resolving all references.

In Texmaker software

- Menu ⇒ Options ⇒ Configure Texmaker
- Quick Build ⇒ Choose PdfLatex + Bib(la)tex + PdfLatex(x2) + view Pdf
- Use *Quick Build* to process your LaTeX document

Bibliography Style

- To use BibTeX your LaTeX input file must contain a `\bibliographystyle{...}` command.
- This command specifies the bibliography style, which determines the format of the bibliography list being produced.
- For example, the command:

  `\bibliographystyle{plain}`

  specifies that entries should be formatted as specified by the plain bibliography style (plain.bst).
- We can put the `\bibliographystyle{...}` command anywhere in the document after the `\begin{document}` command.

Bibliography Styles

Standard BibTeX Styles:

plain Entries sorted alphabetically with numeric labels.

unsrt Similar to plain, but entries are printed in order of citation, rather than sorted. Numeric labels are used.

alpha Similar to plain, but the labels of the entries are formed from the author's name and the year of publication.

abbrv Similar to plain, but entries are more compact, since first names, month, and journal names are abbreviated.

Alternative BibTeX styles:

acm Used for the journals of the Association for Computing Machinery. It has the author name (surname and first name) in small caps, and numbers as labels.

apalike Used by the journals of the American Psychology Association. It should be used together with the LATEX apalike package. The bibliography entries are formatted alphabetically, last name first, each entry having a hanging indentation and no label.

BibTeX Styles ...

Some other styles:

abbrv	abstract	acm	agsm
alpha	amsalpha	bbs	cbe
cell	dcu	ieeetr	jtb
kluwer	named	natbib	phcpc
phiaea	phjcp	phrmp	plainyr
siam			

- These BibTeX styles can be used via one of:
  - `\bibliographystyle{style-name}`
  - `\usepackage{style-name}`
- include `\usepackage{natbib}` in the preamble section for advanced features in referencing / citation

Including unreferenced entries

- By default, bibliography entries not referenced from the text are not included in the bibliography list.
- To forcefully include such entries use the command `\nocite{key}` anywhere within the document
- With `\nocite{*}`, every entry in all the databases will be included
- The bibliography will be printed where the `\bibliography{...}` command is issued; it infact inputs the .bbl file.

Importing Bibliography database from Word 2007+

- First, export your references from MS Word to xml file:
  - Using a plain text editor like notpad, create an xml file named `refs.xml` with the following content:

`refs.xml`

```
<?xml version="1.0"?>
<b:Sources SelectedStyle=""
xmlns:b="http://schemas.openxmlformats.org/officeDocument/2006/bibliography"
xmlns="http://schemas.openxmlformats.org/officeDocument/2006/bibliography">
</b:Sources>
```

  - Open the Word document containing the references you want to export.
  - On the Citations and Bibliography group of the References tab, click the Manage Sources button.
  - Click the "**Browse**" button to open your refs.xml file.
  - You will see a blank pane on the left and a pane with your references on the right.
  - Select the references you want to export and press the "**<- Copy**" button to put them into the left pane.
  - Now close the Manage References dialog box.
  - Silently, Word 2007 added the references to the refs.xml file.
- Now in JabRef Software, go to the File menu, choose "**Import into New Library**", and browse to **refs.xml**.
- Press the Open button and you will have a JabRef database populated with your Word 2007 references.
- You can now save that database in BibTex or a variety of other formats.

Optionally

You can skip making your own `refs.xml` file by using Word's default references file `Sources.xml` which is stored in your `Application Data` folder whose location depends on the operating system being used.

This Tutorial was made in LaTeX
using the documentclass *Beamer*.