Latex Lecture-4

1) Equations
2) Maths symbols
3) Subscript and superscript
4) Brackets and Parentheses
5) Fractions
6) Managing long equations
7) List of operators
8) Verbatim
9) Tables
10) Figures
11) Algorithms (Pseudocode)
12) Bibliography

1. **Equations:** Two writing modes for mathematical expressions: the ***inline math mode*** and ***display math mode***.
   - ***Example code:*** A basic example for both modes is given in the following code.

```
\documentclass{article}
\begin{document}

The well known Pythagorean theorem \(x^2 + y^2 = z^2\) was
proved to be invalid for other exponents.
Meaning the next equation has no integer solutions:
\[ x^n + y^n = z^n \]

\end{document}
```

Output:

The well known Pythagorean theorem $x^2 + y^2 = z^2$ was proved to be invalid for other exponents. Meaning the next equation has no integer solutions:

$$x^n + y^n = z^n$$

Figure 1. Illustration of basic equation

1.1. Inline math mode:

- Inline math mode is used to write formulas that are ***part of a paragraph.***
- You can use any of these ***"delimiters"*** to typeset your math in inline mode:

  - `\(...\)`

- `$...$`
- `\begin{math}...\end{math}.`

Example:

Command	**Use**
`\(...\)`	In physics, the mass-energy equivalence is stated by the equation `\(E=mc^2\),` discovered in 1905 by Albert Einstein.
`$...$`	In physics, the mass-energy equivalence is stated by the equation `$E=mc^2$`, discovered in 1905 by Albert Einstein.
`\begin{math}...\end{math}`	In physics, the mass-energy equivalence is stated by the equation `\begin{math}E=mc^2\end{math}`, discovered in 1905 by Albert Einstein.
Output: All the three commands results in the similar output	
In physics, the mass-energy equivalence is stated by the equation $E = mc^2$, discovered in 1905 by Albert Einstein. **Figure 2.** Example output of inline equations	

1.2. Display math mode:

- display math mode is used to write expressions that are ***not part of a paragraph***, and are therefore put on separate lines
- The displayed mode has two versions – ***numbered and un-numbered***.
- Many math mode commands require the module `\usepackage{amsmath}` in the preamble.
- Use one of these constructions to typeset math in display mode:
  - `\[...\]`
  - `\begin{displaymath}...\end{displaymath}`
  - `\begin{equation}...\end{equation}`

Example	
Command	**Use**
- `\[...\]`	The mass-energy equivalence is described by the famous equation discovered in 1905 by Albert Einstein.

	`\[E=mc^2\]  % 1st example of unnumbered equation`

`\begin{displaymath}`
 	
`...`
 	
`\end{displaymath}`
	The mass-energy equivalence is described by the famous equation discovered in 1905 by Albert Einstein.
	
	`\begin{displaymath}`
	`E=m    % 2nd Example of unnumbered equation`
	`\end{displaymath}`

`\begin{equation}`
 	
`...`
 	
`\end{equation}`
	The mass-energy equivalence is described by the famous equation (1) discovered in 1905 by Albert Einstein.
	
	`\begin{equation}`
	`E=m        % Example of numbered equation`
	`\end{equation}`

Output:

The mass-energy equivalence is described by the famous equation discovered in 1905 by Albert Einstein.

$$E = mc^2$$

The mass-energy equivalence is described by the famous equation discovered in 1905 by Albert Einstein.

$$E = m$$

The mass-energy equivalence is described by the famous equation (1) discovered in 1905 by Albert Einstein.

$$E = m \tag{1}$$

Figure 3. Example output of display math mode equations

2. **Math symbols:**

- Below is some common maths symbols shown in Figure-4.
- For detailed symbols please check the following links
  - https://www.overleaf.com/learn/latex/List_of_Greek_letters_and_math_symbols
  - https://www.math.uci.edu/~xiangwen/pdf/LaTeX-Math-Symbols.pdf

description	code	examples
Greek letters	`\alpha \beta \gamma \rho \sigma \delta \epsilon`	$\alpha\ \beta\ \gamma\ \rho\ \sigma\ \delta\ \epsilon$
Binary operators	`\times \otimes \oplus \cup \cap`	$\times\ \otimes\ \oplus\ \cup\ \cap$
Relation operators	`< > \subset \supset \subseteq \supseteq`	$<\ >\ \subset\ \supset\ \subseteq\ \supseteq$
Others	`\int \oint \sum \prod`	$\int\ \oint\ \sum\ \prod$

Figure 4. Common math symbols

3. **Subscript and superscript:** The symbols _ and ^ are used for defining the subscripts and superscripts, as given in the following example code.

```
\[ a_1^2 + a_2^2 = a_3^2 \]

\[ \sum_{i=1}^{\infty} \frac{1}{n^s}
= \prod_p \frac{1}{1 - p^{-s}} \]
```

Output:

$$a_1^2 + a_2^2 = a_3^2$$

$$\sum_{i=1}^{\infty} \frac{1}{n^s} = \prod_p \frac{1}{1 - p^{-s}}$$

Figure 5. Output for superscript and subscript

List of some subscript and superscript

LaTeX markup	Renders as
a_{n_i}	a_{n_i}
\int_{i=1}^n	$\int_{i=1}^{n}$
\sum_{i=1}^{\infty}	$\sum_{i=1}^{\infty}$
\prod_{i=1}^n	$\prod_{i=1}^{n}$
\cup_{i=1}^n	$\cup_{i=1}^{n}$
\cap_{i=1}^n	$\cap_{i=1}^{n}$
\oint_{i=1}^n	$\oint_{i=1}^{n}$
\coprod_{i=1}^n	$\coprod_{i=1}^{n}$

Figure 6. List of different subscript and superscript

4. **Brackets and Parentheses:**
The brackets and parentheses can be manually set, where the size will adjust accordingly.

```
\[
F = G \left(\frac{m_1 m_2}{r^2} \right)
\]
```

Output:

$$F = G\left(\frac{m_1 m_2}{r^2}\right)$$

Figure 7. Example output for parenthesis

A list of different parenthesis is given in the following figure

Type	LaTeX markup	Renders as
Parentheses; round brackets	`(x+y)`	$(x+y)$
Brackets; square brackets	`[x+y]`	$[x+y]$
Braces; curly brackets	`\{ x+y \}`	$\{x+y\}$
Angle brackets	`\langle x+y \rangle`	$\langle x+y \rangle$
Pipes; vertical bars	`|x+y|`	$\|x+y\|$
Double pipes	`\\|x+y\\|`	$\\|x+y\\|$

Figure 8. List of different types of parenthesis

Commands for the size of different types of parenthesis

LaTeX markup	Renders as
`\big( \Big( \bigg( \Bigg(`	$\big(\Big(\bigg(\Bigg($
`\big] \Big] \bigg] \Bigg]`	$\big] \Big] \bigg] \Bigg]$
`\big\{ \Big\{ \bigg\{ \Bigg\{`	$\big\{ \Big\{ \bigg\{ \Bigg\{$
`\big \langle \Big \langle \bigg \langle \Bigg \langle`	$\big \langle \Big \langle \bigg \langle \Bigg \langle$
`\big \rangle \Big \rangle \bigg \rangle \Bigg \rangle`	$\big \rangle \Big \rangle \bigg \rangle \Bigg \rangle$
`\big| \Big| \bigg| \Bigg|`	$\big\| \Big\| \bigg\| \Bigg\|$
`\big\\| \Big\\| \bigg\\| \Bigg\\|`	$\big\\| \Big\\| \bigg\\| \Bigg\\|$
`\big \lceil \Big \lceil \bigg \lceil \Bigg \lceil`	$\big \lceil \Big \lceil \bigg \lceil \Bigg \lceil$
`\big \rceil \Big \rceil \bigg \rceil \Bigg \rceil`	$\big \rceil \Big \rceil \bigg \rceil \Bigg \rceil$
`\big \lfloor \Big \lfloor \bigg \lfloor \Bigg \lfloor`	$\big \lfloor \Big \lfloor \bigg \lfloor \Bigg \lfloor$
`\big \rfloor \Big \rfloor \bigg \rfloor \Bigg \rfloor`	$\big \rfloor \Big \rfloor \bigg \rfloor \Bigg \rfloor$

Figure 9. Illustration of parenthesis size

5. **Fractions:** The appearance of the fraction may change depending on the context, example code is and output is illustrated.

Fractions can be used alongside the text, for example `\( \frac{1}{2} \),` and in a mathematical display style like the one below:

```
\[\frac{1}{2}\]
```

Output:

Fractions can be used alongside the text, for example $\frac{1}{2}$, and in a mathematical display style like the one below:

$$\frac{1}{2}$$

Figure 10. Example of fraction

6. **Managing long equations:** There are multiple ways to manage long equations.
   - Displaying long equations
   - Splitting and aligning

- Displaying long equations

```
\begin{multline*}

p(x) = 3x^6 + 14x^5y + 590x^4y^2 +
19x^3y^3\\

- 12x^2y^4 - 12xy^5 + 2y^6 - a^3b^3

\end{multline*}
```

Output:

$$p(x) = 3x^6 + 14x^5y + 590x^4y^2 + 19x^3y^3 - 12x^2y^4 - 12xy^5 + 2y^6 - a^3b^3$$

- Splitting and aligning

```
\begin{align*}
2x - 5y &=  8 \\
3x + 9y &=  -12
\end{align*}
```

Output

$$\begin{aligned} 2x - 5y &= 8 \\ 3x + 9y &= -12 \end{aligned}$$

7. **List of operators**

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

8. **Verbatim:** The `\begin{verbatim}` command prints text in monospaced font and prints spaces, tabs, etc. verbatim. This can be used for displaying code snippets:

```
\begin{verbatim}

#include
Int main()
    {
        std::cout << "Hello, world";
        return 0;
    }

\end{verbatim}
```

Output:

```
#include
Int main()
    {
        std::cout << "Hello, world";
        return 0;
    }
```

Figure 11. Example output for illustrating verbatim

9. **Tables:** The tabular command is used to typeset tables. This is an example of a table and referral in the text to the table.

```
\begin{table}[h!]
\centering                          % centre the table on the page
\begin{tabular}{|c r l|}            % c = cjt column, l = ljt column, etc.
\hline                              % insert a horizontal line
Col1 & Col2 & Col2 \\
\hline
A1 & B1 & C1 \\                     % A1, A2, etc. are data
A2 & B2 & C2 \\
A3 & B3 & C3 \\
\hline
\end{tabular}
\caption{Table Caption}
\label{table:example}
\end{table}

Table \ref{table:example} is an example of referred table.
```

Output:

Col1	Col2	Col2
A1	B1	C1
A2	B2	C2
A3	B3	C3

Table 1: Table Caption

Table 1 is an example of referred table.

Figure 12. Illustration of Table

Alternative option: An easy way is to manage the table using the following online tool. https://www.tablesgenerator.com/

10. **Figures:** Figures can be included and automatically ***numbered sequentially*** and ***centre justified***. Figures are stored ***outside the main.tex file***. Images should be PDF, PNG, JPEG or GIF files. The `\usepackage{graphicx}` needs to be called within the preamble:

```
\usepackage{graphicx}

%%%%%%%%%

Insert the figure here:

\begin{figure}[h]                    % Insert the figure about here
\centering                           % This centres the image
\includegraphics[scale=2]{myimage}
\caption{My Image}
\label{fig:myimage}                  % Figures to be referred to in the text
\end{figure}
```

Figures are cited within the body text as follows:

Refer to figure `\ref{fig:myimage}` above and on the following page `\pageref{fig:myimage}`

If figures are stored in a folder named "figures", then to refer to the figure using the following command.

```
\ref(figures/fig:myimage)
```

`\includegraphics[scale=2]{myimage}` has several options such as:

```
\includegraphics[width=\linetwidth] myimage} % adjust according to linewidth

\includegraphics[width=\textwidth] myimage} % adjust according to textwidth

\includegraphics[width=0.5\textwidth] myimage} % 50% of textwidth
```

11. **Algorithms (Pseudocode):**
    - The algorithm/pseudocode is an abstract level of representation for the computer program.
    - Usually, the algorithm/pseudocode defines the main concept of the computer program.
    - Latex uses the `\usepackage{algorithm}` for writing the algorithm/pseudocode

```
\documentclass{article}
\usepackage{algorithm}
\usepackage{algpseudocode}
\begin{document}
\begin{algorithm}
\caption{An algorithm with caption}\label{alg:cap}
\begin{algorithmic}
\Require $n \geq 0$
\Ensure $y = x^n$
\State $y \gets 1$
\State $X \gets x$
\State $N \gets n$
\While{$N \neq 0$}
\If{$N$ is even}
    \State $X \gets X \times X$
    \State $N \gets \frac{N}{2}$  \Comment{This is a comment}
\ElsIf{$N$ is odd}
    \State $y \gets y \times X$
    \State $N \gets N - 1$
\EndIf
\EndWhile
\end{algorithmic}
\end{algorithm}

\end{document}
```

Output:

Algorithm 1 An algorithm with caption

Require: $n \geq 0$

Ensure: $y = x^n$

$y \leftarrow 1$
$X \leftarrow x$
$N \leftarrow n$
while $N \neq 0$ **do**
  if N is even **then**
    $X \leftarrow X \times X$
    $N \leftarrow \frac{N}{2}$ ▷ This is a comment
  else if N is odd **then**
    $y \leftarrow y \times X$
    $N \leftarrow N - 1$
  end if
end while

A detailed about different styles of algorithms is available at:

https://www.overleaf.com/learn/latex/Algorithms

12. **Bibliography:**

- References are includes using the major bibliography management programs (packages): ***bibtex, biblatex***, and ***natbib***.
- You will also need the **\usepacke{cite}**
- Bibliography is a list of references cited throughout the text with a References list placed at the end of the report.
- Bibliographies can be embedding at the end of your document as follows:

```
\begin{thebibliography}{9}

\bibitem{latexcompanion}
Michel Goossens, Frank Mittelbach, and Alexander Samarin.
\textit{The \LaTeX\ Companion}.
Addison-Wesley, Reading, Massachusetts, 1993.

\bibitem{knuthwebsite}
Knuth: Computers and Typesetting,
\\\texttt{http://www-cs-faculty.stanford.edu.html}

\bibitem{b1} G. O. Young, ``Synthetic structure of industrial
plastics,'' in \emph{Plastics,} 2\textsuperscript{nd} ed., vol. 3, J.
Peters, Ed. New York, NY, USA: McGraw-Hill, 1964, pp. 15--64.

\bibitem{b2} W.-K. Chen, \emph{Linear Networks and Systems.} Belmont,
CA, USA: Wadsworth, 1993, pp. 123--135.

\bibitem{b3} J. U. Duncombe, ``Infrared navigation---Part I: An
assessment of feasibility,'' \emph{IEEE Trans. Electron Devices},
vol. ED-11, no. 1, pp. 34--39, Jan. 1959, 10.1109/TED.2016.2628402.

\end{thebibliography}
```

References are cited in text as follows:

```
This is a reference \cite{knuthwebsite} cited in the text
```

12.1. Biblatex package:

- Use package `\usepackage{biblatex}`
- You will also need the `\usepacke{cite}`
- Add the bib resource file `\addbibresource{file-name.bib}`
- Before end of the `\end{document}` command use the `\printbiblography`

Example:

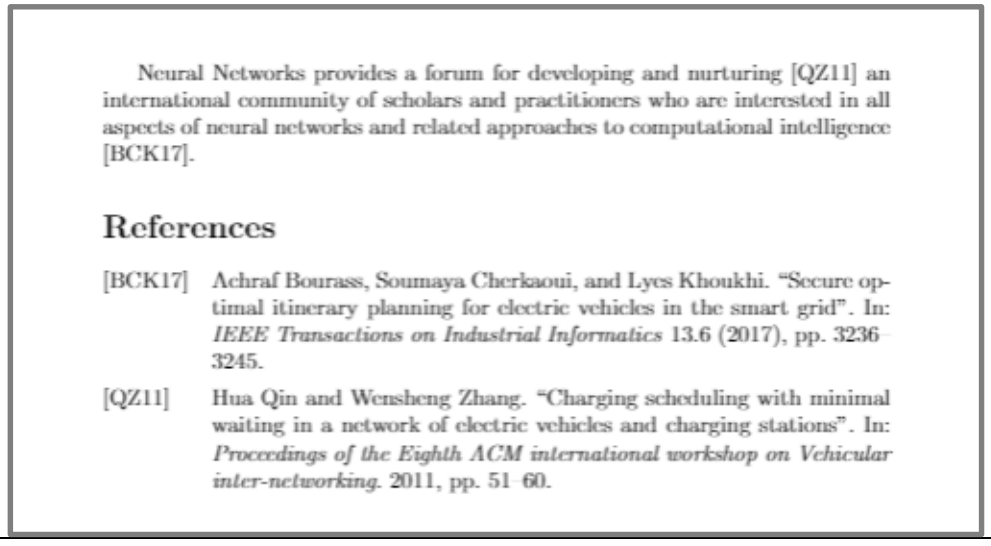
Main.tex

```
\documentclass{article}
\usepackage{cite}
\usepackage[style=alphabetic]
{biblatex}
\addbibresource{CT1112bib.bib}

%----------preamble------------

\begin{document}

Neural Networks provides a forum for developing and nurturing \cite{
qin2011charging} an international community of scholars and practitioners who are interested in all aspects of neural networks and related approaches to computational intelligence \cite{bourass2017secure}.

\printbibliography
\end{document}
```

CT1112bib.bib

```
@inproceedings{qin2011charging,
  title={Charging scheduling with minimal waiting in a network of electric vehicles and charging stations},
  author={Qin, Hua and Zhang, Wensheng},
  booktitle={Proceedings of the Eighth ACM international workshop on Vehicular inter-networking},
  pages={51--60},
  year={2011}
}

@article{bourass2017secure,
  title={Secure optimal itinerary planning for electric vehicles in the smart grid},
  author={Bourass, Achraf and Cherkaoui, Soumaya and Khoukhi, Lyes},
  journal={IEEE Transactions on Industrial Informatics},
  volume={13},
  number={6},
  pages={3236--3245},
  year={2017},
  publisher={IEEE}
}
```

Output:



Neural Networks provides a forum for developing and nurturing [QZ11] an international community of scholars and practitioners who are interested in all aspects of neural networks and related approaches to computational intelligence [BCK17].

References

[BCK17] Achraf Bourass, Soumaya Cherkaoui, and Lyes Khoukhi. "Secure optimal itinerary planning for electric vehicles in the smart grid". In: *IEEE Transactions on Industrial Informatics* 13.6 (2017), pp. 3236–3245.

[QZ11] Hua Qin and Wensheng Zhang. "Charging scheduling with minimal waiting in a network of electric vehicles and charging stations". In: *Proceedings of the Eighth ACM international workshop on Vehicular inter-networking*. 2011, pp. 51–60.

12.2. natbib package:

- Use package `\usepackage{natbib}`

- You will also need the `\usepacke{cite}`
- Use the style `\bibliographystyle{style name}`
- Before end of the `\end{document}` command use the `\bibliography{file-name.bib}`

Example:

main.tex

```
\documentclass{article}
\usepackage{cite}
\usepackage{natbib}
\bibliographystyle{alpha} % style
\begin{document}
Neural Networks provides a forum for developing and nurturing \cite{bourass2017secure} an international community of scholars and practitioners who are interested in all aspects of neural networks and related approaches to computational intelligence \cite{qin2011charging}.
\bibliography{CT1112bib.bib}
\end{document}
```

CT1112.bib

```
@inproceedings{qin2011charging,
  title={Charging scheduling with minimal waiting in a network of electric vehicles and charging stations},
  author={Qin, Hua and Zhang, Wensheng},
  booktitle={Proceedings of the Eighth ACM international workshop on Vehicular inter-networking},
  pages={51--60},
  year={2011}
}

@article{bourass2017secure,
  title={Secure optimal itinerary planning for electric vehicles in the smart grid},
  author={Bourass, Achraf and Cherkaoui, Soumaya and Khoukhi, Lyes},
  journal={IEEE Transactions on Industrial Informatics},
  volume={13},
  number={6},
  pages={3236--3245},
  year={2017},
  publisher={IEEE}
}
```

Output:

Neural Networks provides a forum for developing and nurturing [BCK17] an international community of scholars and practitioners who are interested in all aspects of neural networks and related approaches to computational intelligence [QZ11].

References

[BCK17] Achraf Bourass, Soumaya Cherkaoui, and Lyes Khoukhi. Secure optimal itinerary planning for electric vehicles in the smart grid. *IEEE Transactions on Industrial Informatics*, 13(6):3236–3245, 2017.

[QZ11] Hua Qin and Wensheng Zhang. Charging scheduling with minimal waiting in a network of electric vehicles and charging stations. In *Proceedings of the Eighth ACM international workshop on Vehicular inter-networking*, pages 51–60, 2011.

Available styles: `dinat, plainnat, abbrvnat, unsrtnat, rusnat, ksfh_nat`