LEHIGH
U N I V E R S I T Y

Creating Documents with LaTeX and Overleaf

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  - ◆ Journal Articles and Research Reports
  - ◆ Dissertation
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Introduction

Overleaf

Getting Started

LaTeX Basics

Document Structure

Typesetting
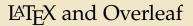
Wrap Up

Introduction
- What is TEX?
- What is LATEX?
- Advantages of LATEX?
- Disadvantages of LATEX?

- TEX is a low-level markup and programming language created by Donald Knuth to typeset documents attractively and consistently.

- TEX is a programming language in the sense that it supports the if-else construct: you can make calculations with it (that are performed while compiling the document), etc., but you would find it very hard to do anything else but typesetting with it.

- The fine control TEX offers over document structure and formatting makes it a powerful and formidable tool.

- TEX is renowned for being extremely stable, for running on many different kinds of computers, and for being virtually bug free.

- TEX is a popular means by which to typeset complex mathematical formulae; it has been noted as one of the most sophisticated digital typographical systems in the world.

- Programming in TEX generally progresses along a very gradual learning curve, requiring a significant investment of time to build custom macros for text formatting.

- Document preparation systems based on TEX, consisting of collections of pre-built macros, exist making it easier for the user to create documents without the need to learn the TEX language.

- LATEX is a macro package based on TEX created by Leslie Lamport.

- Its purpose is to simplify TEX typesetting, especially for documents containing mathematical formulae.

- Popular in academia, especially in mathematics, computer science, economics, engineering, physics, statistics, and quantitative psychology.

- Many of the academic publishing houses such as American Institute of Physics, Elsevier, etc provide templates to prepare manuscripts in LATEX.

- Since LATEX comprises a group of TEX commands, LATEX document processing is essentially programming.

- Using LATEX to create documents is a WYSIWYM (What You See Is What You Mean) approach rather than

  WYSIWYG (What You See Is What You Get) approach of Microsoft Word and Libre Office.

- In LATEX, you create a text file in LATEX markup, which then needs to be compiled to produce the final document, most commonly is postscript (ps) or portable document format (pdf).

- The final document can be viewed uniformly on any Operating System using any version of the document viewer.

- Document sources can be read with any text editor.

- You can concentrate purely on the structure and contents of the document, not get caught up with superficial layout issues.

- You don't need to manually adjust fonts, text sizes, line heights, or text flow for readability, as LaTeX takes care of them automatically.

- In LaTeX the document structure is visible to the user, and can be easily copied to another document.

- The layout, fonts, tables and so on are consistent throughout the document.

- Mathematical formulae can be easily typeset.

- Indexes, footnotes, citations and references are generated easily.

- Since the document source is plain text, tables, figures, equations, etc. can be generated programmatically with any language.

- You are forced to structure your documents correctly.

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- LATEX is WYSIWYM and not WYSIWYG approach

  i.e. you can't see what the final version will look like while typing.

- You need to know the necessary commands for the markup language.

  i.e. there is no drop-down menu to create the document content such as equations, tables, inserting figures etc, you need to know how to enter those in a text editor.

- It can sometimes be difficult to obtain a certain look for the document.

- an online collaborative writing and publishing tool that makes the whole process of writing, editing and publishing scientific documents much quicker and easier.

- provides the convenience of an easy-to-use LaTeX editor with real-time collaboration and the fully compiled output produced automatically in the background as you type.

- makes the journal submission process smoother for LaTeX users across many academic publishers.

- Why use Overleaf?

  - cloud based product that only needs a web browser.

  - effortless sharing with collaborators.

  - compiles your project in the background, so you can see the output PDF right away.

  - real-time commenting and integrated chat, you can discuss your work without having to switch to email, printed versions or any other tool.

  - Rich Text and LaTeX modes if you prefer to see less of the code when youâĂŹre writing

  - Overleaf shows you errors and warnings as you go, so you can catch them early, and it shows them inline, so you don't have to find them in the LaTeX log.

  - Write your thesis, create a calendar, make amazing presentations with the beamer package and create posters to showcase your work, all from a wide selection of popular templates.

  - The real-time preview also helps when you're working with complicated tables, tikz figures and pgfplots graphs.

- Overleaf Professional accounts âĂŞ for students, faculty and staff.

  - ◆ Unlimited collaborators

  - ◆ Full document history

  - ◆ Reference Manager Sync

  - ◆ Dropbox and Git/Github integration

  - ◆ 20GB of storage

- Hassle-free license management - users simply register with their institutional email address on Overleaf (or add it to their existing Overleaf account) to join your Overleaf Commons license and receive their upgrade automatically.

- Visit `https://www.overleaf.com/register`
- Sign up with your email address, Google or ORCID.
  - ◆ Your Lehigh email address and Google account is valid as long as you are a student, staff or faculty.
  - ◆ Your Overleaf account is tied to the registered email address. If your email address is deactivated, you lose access to your overleaf account.
  - ◆ Consider using your personal email or Google account for registration.
  - ◆ Go to Account Settings and add your Lehigh email as your secondary email to convert to a Pro account.

- Click on New Project in the left sidebar.
- Choose from

  Blank Project : Start with a empty .tex file.

  Example Project : Start with an example article that overleaf provides.

  Upload Project : Upload a zip file containing an existing LaTeX project i.e. at least one .tex file.

  Import from Github : Import an existing LaTeX project from your Github account.

- Start with a Blank Document and add the following lines to it

```
\documentclass[10pt]{article}

\ title {My First Document}
\author{Enter your name}
\date{\today}

\begin{document}

\maketitle
\tableofcontents

\section{My First Section}\label{section1}
Hello World!

\section{My Second Section}
In Sec. \ref{section1}, we said Hello to the World.

\end{document}
```

- Watch the document compile on the right window. Click "Recompile" for compiling the document on demand.

LaTeX Basics
Syntax
Reserved Characters
Comments
Commands
Environments
Groups
Type Fonts
Type Size

- LaTeX uses a markup language in order to describe document structure and presentation.
- LaTeX converts your source text, combined with the markup, into a high quality document.
- For the purpose of analogy, web pages work in a similar way: the HTML is used to describe the document, but it is your browser that presents it in its full glory - with different colors, fonts, sizes, etc.
- "Whitespace" characters such as space or tab are treated uniformly as "space" by LaTeX.
- Several consecutive whitespace characters are treated as one "space".

```
Several␣consecutive␣whitespace␣characters␣such␣as␣␣␣␣␣␣␣␣␣␣are␣treated␣as␣one␣space
```

Several consecutive whitespace characters such as are treated as one space

- LaTeX has special characters or symbols that either have a special meaning or are bit available in all fonts.

- If you enter them directly in your text, they will normally not print.

- To print these symbols, you need to be escape with a \ except \ itself since \\ is reserved for line break.

Symbol	Command	Usage
#	\#	reference arguments
%	\%	Comment
$	\$	Math Mode
^	\^	Superscript
_	_	Subscript
&	\&	Alignment
{ }	\{ \}	wrap arguments
~	\~	produce non-breakable space
\	\textbackslash	escape character
\\	\\	line break

- When LaTeX encounters a % character while processing an input file, it ignores the rest of the current line, the line break, and all whitespace at the beginning of the next line.

- This can be used to write notes into the input file, which will not show up in the printed version.

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

This is an example: Supercalifragilisticexpialidocious

- Note that the % character can be used to split long input lines that do not allow whitespace or line breaks, as with Supercalifragilisticexpialidocious above.

- The core LaTeX language does not have a predefined syntax for commenting out regions spanning multiple lines.

- LaTeX commands are case sensitive, and take one of the following two formats:

  - ◆ They 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".

  - ◆ They consist of a backslash \and exactly one non-letter.

- Some commands need an argument, which has to be given between curly braces { } after the command name.

- Some commands support optional parameters, which are added after the command name in square brackets [ ].

- The general syntax is: `\commandname[option1,option2,...]{argument1}{argument2}...`

- Most standard LaTeX commands have a switch equivalent.

- Switches have no arguments but apply on the rest of the scope, i.e. the current group or environment.

- A switch should (almost) never be called outside of any scope, otherwise it will apply on the rest of the document.

```
{\bf This is in bold}\\
\em This is in italics
This is normal text
```

This is in bold
This is in italics This is normal text

- Environments in LaTeX have a role that is quite similar to commands, but they usually have effect on a wider part of the document.

- Their syntax is:

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

- Between the \begin and the \end you can put other commands and nested environments.

- The internal mechanism of environments defines a group, which makes its usage safe (no influence on the other parts of the document).

- In general, environments can accept arguments as well, but this feature is not commonly used and so it will be discussed in more advanced parts of the document.

- Anything in LaTeX can be expressed in terms of commands and environments.

- A group is basically defined by a pair of braces.

- The range of commands put between braces is limited to them.

- Example

```
{\bf This is in bold}\\
{\em This is in italics}
This is normal text
```

This is in bold
This is in italics This is normal text

- The actual letters and symbols (collectively called type) that LaTeX produces are characterized by their style and size.

- A type style is specified by family, series and shape.

- Default font type is roman family, medium series and upright shape.

	STYLE	COMMAND	ALTERNATE DECLARATION	
FAMILY	roman sans serif typewriter	\textrm{roman} \textsf{sans serif} \texttt{typewriter}	{\rmfamily roman} {\sffamily sans serif} {\ttfamily typewriter}	{\rm roman} {\sf sans serif} {\tt typewriter}
SERIES	medium **boldface**	\textmd{medium} \textbf{boldface}	{\mdseries medium} {\bfseries boldface}	{\bf boldface}
SHAPE	upright *italics* *slanted* SMALL CAP	\textup{upright} \textit{italics} \textsl{slanted} \textsc{small cap}	{\upshape upright} {\itshape italics} {\slshape slanted} {\scshape small caps}	{\it italics} {\sl slanted} {\sc small caps}

- Type size is traditional measured in (printer) points.
- The default type produced by LaTeX documents is 10pt size.
- To change the type size, LaTeX has ten declarations available

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

Document Structure
    Preamble
    Document Types
    documentclass options
    Creating a Title Page
    Structuring a LaTeX Document
    Section Numbering
    Appendix
    Cross Referencing
    Table of Contents
    Structuring a LaTeX Document
    Adding Packages

- When LaTeX processes an input file, it expects it to follow a certain structure.
- Every LaTeX input file must contain the commands,

```
\documentclass{...}

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

- The area between \documentclass{...} and \begin{document} is called the **Preamble**.
- The document content goes between the \begin{document} and \end{document} commands,

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

- The Preamble is anything that comes before the main document.
- It is used for
    - Defining the type of document.
    - Defining the top matter i.e. title, author, etc.
    - Applying global formatting including changing page layout from the default.
    - Including packages to add functionality.

- The first uncommented line of the LaTeX document needs to describe the type of document that you are creating using

  `\documentclass[options]{documenttype}`

- LaTeX can be used to create documents of various types

  ❶ article

  ❷ report

  ❸ book

  ❹ letter

  ❺ beamer[1], powerdot[2], prosper or seminar[3] for Presentations

- The difference between article, report and book is in the document structure and presentation:

- In article type, there is no chapter and the title page and document content can appear on the first page.

- In report and book, the title page is the first page and document content begins on the second page onwards.

- In article and report, there is an abstract environment to write the abstract of the article or report that you are writing.

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[1] For Tutorial, visit `http://www.hpc.lsu.edu/training/archive/tutorial.php`

[2] THIS PRESENTATION, style file included in downloads

[3] Not popular anymore, use beamer or powerdot

- The options to documentclass are used to define a predetermined structure for the document.
- The most commonly used options are defining
  - ◆ font size: 10pt (default), 11pt or 12pt
  - ◆ paper size: letterpaper (default), legalpaper, executivepaper, a4paper, a5paper or b5paper
  - ◆ orientation: portrait (default) or landscape
  - ◆ page format: onecolumn (default) or twocolumn
- Options that depend on document type
  - ◆ Where to print page numbers for book, report and article

oneside	page numbers are printed the same on even and odd pages, default for article & report
twoside	page number appears on the right side for odd pages and on the left for even pages, default for book

  - ◆ Where new chapters begin in the book and report class

openright	chapters start on the right hand insert blank page if necessary i.e. odd numbered page
openany	chapters always start on the next page

  - ◆ Where the title appears
    - ★ In book and report classes, the title appears on the first page separate from the document content
    - ★ In article class, the title appears on the first page followed by the document content
    - ★ Use **titlepage** and **notitlepage** to override this standard behavior.

- Other options commonly used

  leqno : display equation numbers on the left rather than the default right

  fleqn : displayed formulas are flushed left instead of default centered

  draft : mark lines that are too wide with a thick black bar

  final : default, do not mark lines that are too wide.

- Add some options to documentclass to create your second document.

```
\documentclass[12pt,twocolumn,fleqn]{article}
```

- To create a title page LaTeX has three commands.
  - ◆ \ title {Title} where Title is the title of your article, book or report.
  - ◆ \author{FirstName LastName}, if there are multiple authors, list them all delimited by a comma (,) or and.
  - ◆ \date{\today} to set the date when the article was created i.e. today
    If the date required is different from today, add the date that you need as in \date{Feb. 29, 2016}
- If you are publishing a journal article, please see their LaTeX templates and style files. Most of their style and class files define additional commands such as \affiliation{...}, \institution{...}, etc.
- To create the actual page, you need to add \maketitle in your document i.e. after the \begin{document} command.
- The \maketitle is almost always the first line of your document content.

```
\documentclass[12pt,twocolumn,fleqn]{article}
\ title {Simple \LaTeX{} Document}
\author{Alex Pacheco, Bhupender Thakur, Feng Chen and Le Yan}
\date{\today}
\begin{document}
\maketitle
\end{document}
```

- Document Content i.e. everything between the \begin{document} and \end{document} is partitioned into

Section	Command	Level	Comment
part	\part{title}	-1	not in letters
chapter	\chapter{title}	0	only in book and report
section	\section{title}	1	not in letters
subsection	\subsection{title}	2	not in letters
subsubsection	\subsubsection{title}	3	not in letters
paragraph	\paragraph{title (optional)}	4	not in letters
subparagraph	\subparagraph{title (optional)}	5	not in letters

- LaTeX provides 7 levels of depth for defining sections. The depth levels for the various commands are listed in column three in the above table.

- The depth level of a section affects whether that section appears in the table of content or not. This can however be changed as we will see in the next few slides.

- Since LaTeX is used very often for writing scientific articles and reports, there are environments defined to create Abstract, Appendices and Bibliographies.

- Numbering of the sections is performed automatically by LaTeX.

- Parts get roman numerals (Part I, Part II, etc.);

- chapters and sections get decimal numbering, and

- appendices (which are just a special case of chapters, and share the same structure) are lettered (A, B, C, etc.).

- You can change the depth to which section numbering occurs, so you can turn it off selectively. By default it is set to 2.

- To change the depth level, use the \setcounter command.

- For example, to change depth to only include chapters: \setcounter{secnumdepth}{1}

- You can change the numbering mechanism of the sectioning commands as well as lists, captions, equations, tables, figures etc. We'll discuss more about this when we get to user defined commands.

- As most research papers have an abstract, there are predefined commands for telling LaTeX which part of the content makes up the abstract.

  - ◆ This should appear in its logical order, therefore, after the top matter, but before the main sections of the body.

  - ◆ *This command is available for the document classes article and report, but not book.*

  - ◆ In document class report, the abstract appears on a separate page without a page number.

  - ◆ In document class article, the abstract comes after the title heading on the first page.

```
\begin{abstract}
In this article we discuss how to create simple LaTeX documents. Topics include
    structuring a document, list environment, inserting equations and figures,
    creating tables and more.
\end{abstract}
```

Abstract

In this article we discuss how to create simple LaTeX documents. Topics include structuring a document, list environment, inserting equations and figures, creating tables and more.

- The following commands are available for producing automatic, sequential sectioning

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

- Except for \part, these commands form a sectioning hierarchy.

- In document class report and book, the highest sectioning level is \chapter while in article class, it is \section.

- The chapters are divided into sections using the \section command, which is further divided into subsections using the \subsection command and so on.

- The syntax for these commands is \command[short title]{title} or \command*{title}

- In the first form, the section is given the next number in the sequence which is then printed together with a heading using the text "title".

- The text "short title" becomes the entry in the table of contents and page head. If "short title" is omitted, then the "title" is used.

- In the second form (with *), no section number is printed and no entry is created in the table of contents.

- The highest sectioning command is given a single number (1,2,···), the second highest command then creates a double number (1.1, 2.3, ···) and so on.

- The paragraph and subparagraph commands are not numbered.

- For each sectioning command, there is an internal counter that is incremented by one every time that command is called and reset to zero on every call to a higher sectioning command.

- The sectioning command, \part is a special case and does not affect the numbering of other sectioning commands.

- The \part are usually numbered with Uppercase Roman Numerals as in Part I, Part IV, etc.

- The \part is used to divide your document into multiple parts which can be independent of each other.

```latex
\documentclass{article}

\title {Report of Projects I'm working on}
\author{Alex Pacheco}
\date{Oct 30, 2013}
\begin{document}
\maketitle
\part{First Project}
\section{Introduction}
Some stuff I'm doing
\section{Results}
Some useless results that I got
\section{Conclusion}
Unsuccessful Project ... keep working
\part{Second Project}
\section{Introduction}
Some stuff I'm doing
\section{Results}
More useless results
\section{Conclusion}
Unsuccessful Project ... keep working
\part{Third Project}
\section{Introduction}
Some stuff I'm doing
\section{Results}
Finally got some useful results
\section{Conclusion}
Successful Project ... boss says no, can't graduate ... keep
      working
\end{document}
```

```latex
\documentclass{report}

\title {Report of Projects I'm working on}
\author{Alex Pacheco}
\date{Oct 30, 2013}
\begin{document}
\maketitle
\part{First Project}
\chapter{Project Title}
\section{Introduction}
Some stuff I'm doing
\section{Results}
Some useless results that I got
\section{Conclusion}
Unsuccessful Project ... keep working
\part{Second Project}
\chapter{Project Title}
\section{Introduction}
Some stuff I'm doing
\section{Results}
More useless results
\section{Conclusion}
Unsuccessful Project ... keep working
\part{Third Project}
\chapter{Project Title}
\section{Introduction}
Some stuff I'm doing
\section{Results}
Finally got some useful results
\section{Conclusion}
Successful Project ... boss says no, can't graduate ... keep
      working
\end{document}
```

Report of Projects I'm working on

Alex Pacheco

Oct 30, 2013

Part I
First Project

1 Introduction

Some stuff I'm doing

2 Results

Some useless results that I got

3 Conclusion

Unsuccessful Project ... keep working

Part II
Second Project

4 Introduction

Some stuff I'm doing

5 Results

More useless results

6 Conclusion

Unsuccessful Project ... keep working

Part III
Third Project

7 Introduction

Some stuff I'm doing

8 Results

Finally got some useful results

9 Conclusion

Successful Project ... boss says no, can't graduate ... keep working

Report of Projects I'm working on

Alex Pacheco

Oct 30, 2013

Part I

First Project

Chapter 1

Project Title

1.1 Introduction
Some stuff I'm doing

1.2 Results
Some useless results that I got

1.3 Conclusion
Unsuccessful Project ... keep working

Part II

Second Project

Chapter 2

Project Title

2.1 Introduction
Some stuff I'm doing

2.2 Results
More useless results

2.3 Conclusion
Unsuccessful Project ... keep working

Part III

Third Project

Chapter 3

Project Title

3.1 Introduction
Some stuff I'm doing

3.2 Results
Finally got some useful results

3.3 Conclusion
Successful Project ... boss says no, can't graduate ... keep working

- An appendix is introduced with the declaration `\appendix`

- The `\appendix` resets the section counter in article and chapter counter in book and report.

- The numbering for the sectioning commands is also changed from numerals to capital letters, A, B, $\cdots$

- The word "Chapter" is replaced by "Appendix" so that subsequent chapter headings are preceded by "Appendix A", "Appendix B", etc.

- The numbering of lower sectioning commands contain the letter in place of chapter number, for e.g. A.2.1

```
\appendix
\section{My First Appendix}
...
\subsection{Subsection in My First Appendix}
...
```

- Since the various sectioning commands are numbered automatically, the chapter, section, etc numbers may not be known at the time of writing the document and may change as more content is added.

- LaTeX has a cross-reference system, which allows you to label the various sectioning commands to refer to them at point in the document.

- To label a command, use \label{name} as in \chapter{Introduction}\label{chap:intro} or \section{My First document}\label{first}

- To reference the labeled section, use \ref{name} as in

```
\chapter{Introduction}\label{chap:intro}
\section{My First document}\label{sec:first}
In section \ref{sec:first} of Chapter \ref{chap:intro}, we wrote our first LaTeX document
```

- The cross-reference commands \label{name} and \ref{name} can also be used for other content such as tables, figures and equations.

- To get the cross-referencing to show up correctly, you need to compile your document i.e. run latex filename or pdflatex filename two times.

- The first time, the compiler stores the labels with the right number to be used for referencing.

- The second time, it replaces \ref{name} with the right number.

- The name that you use in the label command must be unique else the compiler will complain that there are multiply defined references.

- All auto-numbered headings get entered in the Table of Contents (ToC) automatically.

- Just add the command `\tableofcontents` at the point where you want it printed (usually after the title page).

- Entries for the ToC are recorded each time you process your document, and reproduced the next time you process it, so you need to re-run LaTeX one extra time to ensure that all ToC pagenumber references are correctly calculated.

- The commands `\listoffigures` and `\listoftables` work in exactly the same way as `\tableofcontents` to automatically list all your tables and figures, usually created after the TOC.

- The `\tableofcontents` commands normally shows only numbered section headings.

- To add extra entries, use the `\addcontentsline` command

```
\subsection*{Preface}
\addcontentsline{toc}{subsection}{Preface}
```

- This will format an unnumbered ToC entry for "Preface" in the "subsection" style.

- To change the title of the TOC, you have to use this command `\renewcommand{\contentsname}{New table of contents title}` in your document preamble.

- The default ToC will list headings of level 3 and above. Use the `\setcounter` command to change this depth. For e.g. `\setcounter{tocdepth}{4}`.

```latex
\documentclass[12pt,fleqn]{article}

\title{Simple \LaTeX{} Document}
\author{Alex Pacheco}
\date{\today}

\begin{document}
\maketitle
\tableofcontents

\begin{abstract}
  In this article we discuss how to create simple \LaTeX{} documents. Topics include structuring a document, list environment,
        inserting equations and figures, creating tables and more.
\end{abstract}

\section{Section 1}
\subsection{Section 1.1}
\subsection{Section 1.2}
\subsection*{Section nonumber}
\addcontentsline{toc}{subsection}{Section nonumber}
  blah blah blah

\section{Section 2}
\subsection{Section 2.1}
\subsubsection{Section 2.1.1}
\subsubsection{Section 2.1.2}
\paragraph{Paragraph} no numbering for this paragraph
\subparagraph{Subparagraph} no numbering for this subparagraph
\subsection{Section 2.2}
  blah blah blah

\appendix
\section{Appendix A}
\subsection{Appendix A.1}
  blah blah blah

\section{Appendix B}
\subsection{Appendix B.1}
\subsubsection{Appendix B.1.1}
  blah blah blah

\end{document}
```

Simple LaTeX Document

Alex Pacheco

October 25, 2013

Contents

Abstract

In this article we discuss how to create simple LaTeX documents. Topics include structuring a document, list environment, inserting equations and figures, creating tables and more.

1 Section 1

1.1 Section 1.1

1.2 Section 1.2

Section nonumber

blah blah blah

2 Section 2

2.1 Section 2.1

2.1.1 Section 2.1.1

2.1.2 Section 2.1.2

Paragraph   no numbering for this paragraph

     Subparagraph   no numbering for this subparagraph

2.2 Section 2.2

blah blah blah

A   Appendix A

A.1   Appendix A.1

blah blah blah

B   Appendix B

B.1   Appendix B.1

B.1.1   Appendix B.1.1

blah blah blah

- In LaTeX, the document type determines its overall general properties, such as layout and sectioning.
- However, it is possible to change the way certain commands work by invoking specific packages which may define new commands to add features that are not part of standard LaTeX.
- A LaTeX packages is nothing more than a set of LaTeX or TeX commands stored in a file with an extension .sty.
- To use a package, add \usepackage[options]{packagename} in the preamble of the document. The [options] is optional and some packages do not provide options at all.
- There are hundreds of useful packages and listing them all is beyond the scope of this tutorial.
- Some of the most commonly used packages are:

  amsmath   contains the advanced math extensions for LaTeX

  graphicx   manage external pictures.

  color   adds support for colored text.

  geometry   easy management of document margins and the document page size.

  inputenc   choose the encoding of the input text.

  babel   provides the internationalization of LaTeX. It has to be loaded in any document, and you have to give as an option the main language you are going to use in the document. e.x. \usepackage[english]{babel}

  hyperref   It gives LaTeX the possibility to manage links within the document or to any URL when you compile in PDF.

  cite   assists in citation management.

  natbib   gives additional citation options and styles.

Typesetting

- Special letters that exist in European languages can be generated with TeX.

{\oe}	œ	{\o}	ø	{\ae}	æ	{\l}	ł	{\aa}	å	{\ss}	ß
{\OE}	Œ	{\O}	Ø	{\AE}	Æ	{\L}	Ł	{\AA}	Å	{\SS}	SS

- In non-English languages, there is a multiplicity of diacritic marks or accents, most of which can be printed with TeX.

- The examples below are shown for the letter "o" but can be used with any letter.

\'{o}	ò	\'{o}	ó	\^{o}	ô	\"{o}	ö	\~{o}	õ
\={o}	ō	\.{o}	ȯ	\u{o}	ŏ	\v{o}	ǒ	\H{o}	ő
\t{oo}	o͡o	\c{o}	ǫ	\d{o}	ọ	\b{o}	o̲	\r{o}	o̊

- When using these accents with the letters i and j, the dot must be removed using the commands \i and \j respectively to yield ı and ȷ.

- \u{\i} and \H{\j} now yield ĭ and ̋ȷ instead of ĭ and ̋j.

- One of the greatest motivating forces for Donald Knuth when he began developing the original TeX system was to create something that allowed simple construction of mathematical formulas, while looking professional when printed.

- Typesetting mathematics is one of LaTeX's greatest strengths.

- If your document requires only a few simple mathematical formulas, plain LaTeX has most of the tools that you will need.

- If you are writing a scientific document that contains numerous complicated formulas, the amsmath package introduces several new commands that are more powerful and flexible than the ones provided by LaTeX.

- The mathtools package fixes some amsmath quirks and adds some useful settings, symbols, and environments to amsmath.

- To use either package, include `\usepackage{amsmath}` or `\usepackage{mathtools}` in the preamble of the document.

- The mathtools package loads the amsmath package and hence there is no need to add `\usepackage{amsmath}` in the preamble if mathtools is used.

- LaTeX needs to know beforehand that the subsequent text does indeed contain mathematical elements.

- This is because LaTeX typesets maths notation differently from normal text. Therefore, special environments have been declared for this purpose.

- They can be distinguished into two categories depending on how they are presented:

  text   text formulas are displayed inline, that is, within the body of text where it is declared, for example, I can say that $a + a = 2a$ within this sentence.

  displayed   displayed formulas are separate from the main text.

- As maths require special environments, there are naturally the appropriate environment names you can use in the standard way.

- Unlike most other environments, however, there are some handy shorthands to declaring your formulas.

Type	Inline	Displayed	Displayed & automatically numbered
Environment	math	displaymath	equation
Requires			amsmath
LaTeX shorthand	\(... \)	\[... \]	
TeX shorthand	$ ... $	$$ ... $$	
Comment			starred version suppresses numbering

- Using the `$$...$$` should be avoided, as it may cause problems, particularly with the AMS-LaTeX macros.

- Mathematics has many symbols!

- One of the most difficult aspects of learning LaTeX is remembering how to produce symbols.

- The following set of symbols can be accessed directly from the keyboard

  ```
  + - = ! / ( ) [ ] < > | ' :
  ```

- Beyond those listed above, distinct commands must be issued in order to display the desired symbols.

- There are a great deal of examples such as Greek letters, set and relations symbols, arrows, binary operators, etc.

  ```
  $\ forall  x \in X, \quad \exists y \leq \epsilon$
  ```

  $$\forall x \in X, \quad \exists y \leq \epsilon$$

- Fortunately, there's a tool that can greatly simplify the search for the command for a specific symbol.

  - Detexify: applet for looking up LaTeX symbols by drawing them
    `http://detexify.kirelabs.org/classify.html`

  - The Comprehensive LaTeX Symbol List
    `http://www.ctan.org/tex-archive/info/symbols/comprehensive`

- Mathematical formulas often contains exponents (power) and indices, characters that are either raised or lowered relative to the main line of the formula.

- Superscripts and subscripts are typographically the same things as exponents and indices respectively.

- The character command caret (^) set the next character as an exponent (superscript).

- The character command underscore (_) set the next character as an index (subscript).

- If the exponent or index contains more than one character, the group of characters must be enclosed in braces { }.

```
\begin{math}x^2, a_n, x^{10}, b_{i,j}, x^n_i\end{math}
```

$$x^2, a_n, x^{10}, b_{i,j}, x_i^n$$

- When exponents and indices occur together, their order is unimportant i.e. `x^n_i` and `x_i^n` will produce the same result as above.

- Multiple raisings and lowerings are generated by applying ^ and _ to the exponents and indices.

```
\begin{displaymath}
x^{y^2}, x^{y_1}, A^{x_i^2}_{j^{2n}_{n,m}}
\end{displaymath}
```

$$x^{y^2}, x^{y_1}, A^{x_i^2}_{j^{2n}_{n,m}}$$

- The raising and lowering commands ^ and _ are only permitted in math mode.

- By convention, all text in math mode is in italics or slanted text.

- If you need to write normal text with superscripts or subscripts, you need to use special commands to typeset the fonts correctly

```
The HPC Training on LaTeX will be held on Oct. $30^{th}$, 2013.\\
A better way to write this is to set the superscript th in roman font using Oct. $30^{\mathrm{th}}$
```

The HPC Training on LaTeX will be held on Oct. 30th, 2013.

A better way to write this is to set the superscript th in roman font using Oct. 30th

- Other available font typesets in math modes are

```
\mathrm{Roman} & \mathsf{sanserif} \\
\mathnormal{normal} & \mathtt{typewriter} \\
\mathit{italic} & \mathbf{boldface} \\
\mathcal{CAL} & \\
```

Roman	sanserif
$normal$	typewriter
$italic$	**boldface**
$\mathcal{CAL}$	

- A fraction is created using the \frac{numerator}{denominator} command.
- The binomial function can be written using the \binom command.

```
\[ \frac{n!}{k!(n-k)!} = \binom{n}{k} \]
```

$$\frac{n!}{k!(n-k)!} = \binom{n}{k}$$

- Another way to write fractions is using the \over command while binomials can also be written with the \choose command,

```
\[ {n! \over k!(n-k)!} = {n \choose k} \]
```

$$\frac{n!}{k!(n-k)!} = \binom{n}{k}$$

- For relatively simple fractions, it may be more aesthetically pleasing to use powers and indices,

```
\[ {}^3/_7 \]
```

$${}^3/_7$$

- You can embed fractions within fractions,

```
\[ \frac{\frac{1}{x}+\frac{1}{y}}{y-z} \]
```

$$\frac{\frac{1}{x} + \frac{1}{y}}{y - z}$$

- Inline fractions can be typeset using the \ displaystyle {math command} or \dfrac{numerator}{denominator} command.

- Similarly, inline binomials can be typeset using the \dbinom{numerator}{denominator} command.

```
For example: $\frac{n!}{k!(n-k)!} = \binom{n}{k}$ looks crummy but $\dfrac{n!}{k!(n-k)!} = \dbinom{n}{k}$ or
        $\displaystyle{\frac{n!}{k!(n-k)!} = \binom{n}{k}}$ looks pleasing.
```

For example: $\frac{n!}{k!(n-k)!} = \binom{n}{k}$ looks crummy but $\dfrac{n!}{k!(n-k)!} = \binom{n}{k}$ or $\dfrac{n!}{k!(n-k)!} = \binom{n}{k}$ looks pleasing.

- Alternatively you can also use \tfrac, \tbinom or \ textstyle {math command} commands.

- Continued fractions should be written using \cfrac command,

```
x = a_0 + \cfrac{1}{a_1
        + \cfrac{1}{a_2
        + \cfrac{1}{a_3 + \cfrac{1}{a_4} } } }
```

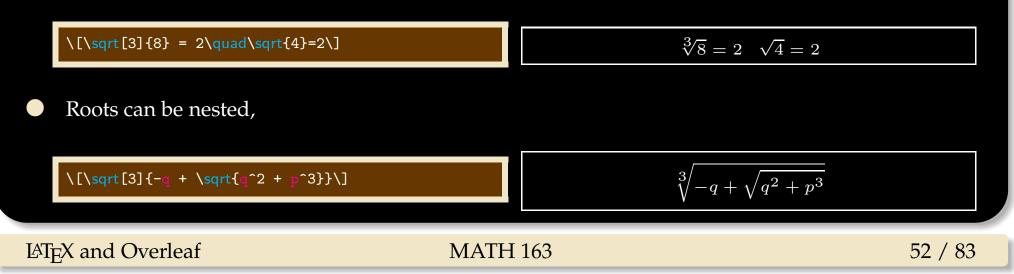$$x = a_0 + \cfrac{1}{a_1 + \cfrac{1}{a_2 + \cfrac{1}{a_3 + \cfrac{1}{a_4}}}}$$

- Summation, Product and Integral signs are made with the commands \sum, \prod and \int respectively.

- Sums, products and integrals very often occur with upper and lower limits.

- These are printed using the power and index commands ^ and _ respectively.

```
2\sum^{i=1}_{n}\int^{b}_{a}f_i(x)g_i(x)dx \\
P^m_n = \prod^{m-1}_{i=0}(n-i)
```

$$2\sum_{n}^{i=1}\int_{a}^{b}f_i(x)g_i(x)dx$$

$$P_n^m = \prod_{i=0}^{m-1}(n-i)$$

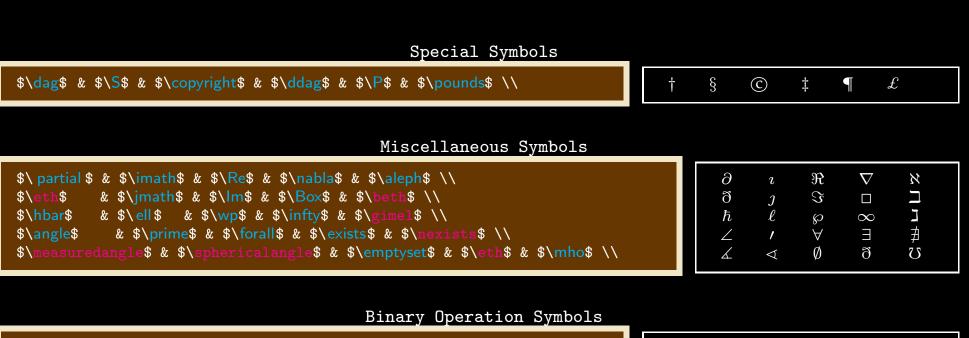- Roots are printed using the command \sqrt[n]{arg} where n is the order. Default is $n = 2$ which can be omitted.

```
\[\sqrt[3]{8} = 2\quad\sqrt{4}=2\]
```

$$\sqrt[3]{8} = 2 \quad \sqrt{4} = 2$$

- Roots can be nested,

```
\[\sqrt[3]{-q + \sqrt{q^2 + p^3}}\]
```

$$\sqrt[3]{-q + \sqrt{q^2 + p^3}}$$

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Greek letters are commonly used in mathematics, and they are very easy to type in math mode.

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

Special Symbols

```
$\dag$ & $\S$ & $\copyright$ & $\ddag$ & $\P$ & $\pounds$ \\
```

†	§	©	‡	¶	£

Miscellaneous Symbols

```
$\ partial $ & $\imath$ & $\Re$ & $\nabla$ & $\aleph$ \\
$\eth$      & $\jmath$ & $\Im$ & $\Box$ & $\beth$ \\
$\hbar$     & $\ell$   & $\wp$ & $\infty$ & $\gimel$ \\
$\angle$      & $\prime$ & $\forall$ & $\exists$ & $\nexists$ \\
$\measuredangle$ & $\sphericalangle$ & $\emptyset$ & $\eth$ & $\mho$ \\
```

∂	ι	ℜ	∇	ℵ
ð	ȷ	ℑ	□	ℶ
ℏ	ℓ	℘	∞	ℷ
∠	′	∀	∃	∄
∡	◁	∅	ð	℧

Binary Operation Symbols

```
$\pm$ & $\mp$ & $\times$ & $\cdot$ & $\oplus$ & $\ominus$ \\
$\otimes$ & $\odot$ & $\ast$ & $\star$ & $\dagger$ & $\ddagger$ \\
```

±	∓	×	·	⊕	⊖
⊗	⊙	∗	⋆	†	‡

Function Names

```
$\sin$ & $\arcsin$ & $\sinh$ & $\sec$ \\
$\cos$ & $\arccos$ & $\cosh$ & $\csc$ \\
$\tan$ & $\arctan$ & $\tanh$ & \\
$\cot$ &         & $\coth$ & \\
$\arg$ & $\deg$    & $\det$ & $\inf$ \\
$\exp$ & $\ln$     & $\log$ & $\lim$ \\
$\max$ & $\min$  & &\\
```

sin	arcsin	sinh	sec
cos	arccos	cosh	csc
tan	arctan	tanh	
cot		coth	
arg	deg	det	inf
exp	ln	log	lim
max	min		

Delimiters

```
$|$        & $\|$      & $\lfloor$    & $\rfloor$ & $\lceil$   & $\rceil$ \\
$\{$       & $\}$      & $($          & $)$       & $\langle$  & $\rangle$ \\
```

Arrows

```
$\leftarrow$      & $\Leftarrow$      & $\rightarrow$    & $\Rightarrow$ \\
$\uparrow$        & $\Uparrow$        & $\downarrow$     & $\Downarrow$ \\
$\leftrightarrow$ & $\Leftrightarrow$ & $\updownarrow$   & $\Updownarrow$ \\
```

Mathematical Symbols

```
$\sum$   & $\prod$  & $\coprod$ & $\int$  & $\oint$ \\
$\ldots$ & $\cdots$ & $\vdots$  & $\ddots$ & \\
```

Relational Symbols

```
$<$        & $>$        & $\not<$        & $\not>$ \\
$\le$      & $\ge$      & $\not\le$      & $\not\ge$ \\
$\ll$      & $\gg$      & $\lll$         & $\ggg$ \\
$\subset$  & $\supset$  & $\not\subset$  & $\not\supset$ \\
$\subseteq$& $\supseteq$& $\not\subseteq$& $\not\supseteq$ \\
$\in$      & $\ni$      & $\not\in$      & $\not\ni$ \\
$\neq$     & $\sim$     & $\not\sim$     & $\doteq$ \\
$\approx$  & $\cong$    & $\not\approx$  & $\not\cong$ \\
$\equiv$   & $\asymp$   & $\not\equiv$   & $\not\asymp$ \\
$\propto$  & $\simeq$   & $\not\simeq$   & $\perp$ \\
$\parallel$& $\mid$     & $\nparallel$   & $\nmid$ \\
```

Math Accents

```
$\hat{a}$ & $\check{a}$ & $\dot{a}$ & $\breve{a}$ & $\acute{a}$ & $\ddot{a}$ \\
$\grave{a}$ & $\tilde{a}$ & $\mathring{a}$ & $\bar{a}$ & $\vec{a}$ \\
```

$\hat{a}$	$\breve{a}$	$\dot{a}$	$\breve{a}$	$\acute{a}$	$\ddot{a}$
$\grave{a}$	$\tilde{a}$	$\mathring{a}$	$\bar{a}$	$\vec{a}$	

Math Alphabet Commands

```
$\mathrm{Roman}$ & $\mathsf{sanserif}$ & $\mathnormal{normal}$ \\
$\mathtt{typewriter}$ & $\mathit{italic}$ & $\mathbf{boldface}$ \\
$\mathcal{CAL}$ \\
```

Roman	sanserif	$normal$
typewriter	$italic$	**boldface**
$\mathcal{CAL}$		

```
Note that in math mode as in the normal text i.e. anything other than numbers or
    commands is $slanted or italics\,and\quad there\qquad are no spaces in the text
    $. Thats the reason for the mathxx commands allows you to write text which is
    in non-math mode i.e. upright in the same font as your document.
```

Note that in math mode as in the normal text i.e. anything other than numbers or commands is *slantedoritalics and there arenospacesinthetext*. Thats the reason for the mathxx commands allows you to write text which is in non-math mode i.e. upright in the same font as your document.

If you need your text in math mode to be slanted and you do not use the mathit command, you can use the commands \, \quad \qquad to add space wherever you need to in your text.

- There are several environments available to write equations.

  1. equation

  2. eqnarray

  3. align

  4. gather

- The equation environment can be used to enter one equation at a time.

- The equations are automatically numbered in sequence. If you do not want equations to be numbered, use the starred version of the environment for e.g. equation*

- You can also add `\nonumber` at the end of the equation to skip the numbering.

```
\begin{equation}
\imath\hbar\frac{\partial}{\partial t}\Psi = \mathcal{H}\Psi
\end{equation}
\begin{equation*}
\mathcal{H}\Psi = E\Psi
\end{equation*}
\begin{equation}
\Psi = \sum_i^n c_i\psi_i\nonumber
\end{equation}
```

$$\imath\hbar\frac{\partial}{\partial t}\Psi = \mathcal{H}\Psi \tag{1}$$

$$\mathcal{H}\Psi = E\Psi$$

$$\Psi = \sum_i^n c_i\psi_i$$

- To enter multi-line equations, use the eqnarray, align or gather environment.

- The individual lines of the equation are separated by \\.

- In eqnarray each line has the form

  `left formula` & `mid formula` & `right formula`

  where mid formula is centered and is single math character such as an assignment operators, =, >, etc.,

  the left formula is left justified and

  the right formula is right justified

- align is similar to eqnarray with the form `left formula` & `right formula` with the whole equation centered by default.

- eqnarray and align require the alignment marker & to align the equations while gather center aligns all equations.

- By default, all equations are centered. To left justify all equations add fleqn option to documentclass.

```
\begin{eqnarray}
\imath\hbar\frac{\ partial }{\ partial  t}|\Psi\rangle &=& \hat{\mathcal{H
      }}\mid\Psi\rangle\\
\mid\Psi_i\rangle &=& \sum_p|\psi_p\rangle c_{pi}
\end{eqnarray}
```

$$\imath\hbar\frac{\partial}{\partial t}|\Psi\rangle \quad = \quad \hat{\mathcal{H}} \mid \Psi\rangle \tag{2}$$

$$\mid \Psi_i\rangle \quad = \quad \sum_p |\psi_p\rangle c_{pi} \tag{3}$$

- The starred version of these environments i.e. eqnarray*, align* and gather* suppress printing of equation numbers.

- You can use the `\setcounter{counter}{value}` to set the equation number to value where counter=equation.

- You can also use the `\addtocounter{counter}{value}` to increment the equation by the value.

```
\addtocounter{equation}{4}
\begin{align}
\hat{\rho} &= \sum\mid\Psi\rangle\langle\Psi\mid\\
\imath\hbar\frac{\ partial }{\ partial  t}\hat{\rho} &= [\hat{\mathcal{H}},\hat{\rho}]
\end{align}
```

$$\hat{\rho} = \sum \mid \Psi \rangle \langle \Psi \mid \qquad (8)$$

$$\imath\hbar\frac{\partial}{\partial t}\hat{\rho} = [\hat{\mathcal{H}}, \hat{\rho}] \qquad (9)$$

```
\setcounter{equation}{2}
\begin{gather}
\hat{\rho} = \sum_{pq}|\psi_p\rangle c_{pi}c^{\ast}_{iq}\langle\psi_q| \\
  = \sum_{pq}|\psi_p\rangle{\boldsymbol\Gamma}^{i}_{pq}\langle\psi_q|
\end{gather}
```

$$\hat{\rho} = \sum_{pq} |\psi_p\rangle c_{pi} c^*_{iq} \langle \psi_q| \qquad (3)$$

$$= \sum_{pq} |\psi_p\rangle \boldsymbol{\Gamma}^i_{pq} \langle \psi_q| \qquad (4)$$

- LaTeX has a multline environment for writing long equations that need to split across multiple lines.

- The multline environment switches to math mode at the start and back to text mode at the end.

- The line break occurs when \\ is encountered.

- By default, the first line is left justified, the last line is right justified while all others are centered.

- You can use the commands `\shoveleft{formula}` and `\shoveright{formula}` to shift the lines to the left and right respectively.

```
\begin{multline}
|\Psi_{II}(t+\delta t)\rangle = \exp\left[-\frac{i}{\hbar} H_{II}\delta t\right] \\
\times\ left [|\Psi_{II}(t)\rangle + \frac{\delta t}{2\hbar}V_{I-II}|\Psi_I(t)\rangle\right]\\
 + \frac{\delta t}{2\hbar}V_{I-II}|\Psi_I(t+\delta t)\rangle
\end{multline}
```

$$|\Psi_{II}(t + \delta t)\rangle = \exp\left[-\frac{i}{\hbar} H_{II}\delta t\right]$$

$$\times \left[|\Psi_{II}(t)\rangle + \frac{\delta t}{2\hbar} V_{I-II}|\Psi_I(t)\rangle\right]$$

$$+ \frac{\delta t}{2\hbar} V_{I-II}|\Psi_I(t + \delta t)\rangle \qquad (5)$$

- Like multline, the split environment is meant for single equations that does not fit on a single line.

- Line breaks are forced with the \\ command.

- In the split environment, the alignment marker & is required to align the multi line equation.

- The split environment doesn't switch to math mode and needs to be used within an equation environment.

```
\begin{equation}\begin{split}
H_c &= \frac{1}{2n}\sum_{l=0}^n (-1)^l (k-1)^{p-2} \sum_{l_1+\dots+l_p=l} \prod_{i=1}^p \binom{n_i}{l_i} \\
  & \times [(k-l)-(k_i-l_i)]^{k_i-l_i} \times\left[(k-l)^2 - \sum_{j=1}^p (k_i-l_i)^2\right]
\end{split}\end{equation}
```

$$
\begin{split}
H_c = \frac{1}{2n} \sum_{l=0}^{n} (-1)^l (k-1)^{p-2} \sum_{l_1+\cdots+l_p=l} \prod_{i=1}^{p} \binom{n_i}{l_i} \\
\times [(k-l)-(k_i-l_i)]^{k_i-l_i} \times \left[(k-l)^2 - \sum_{j=1}^{p} (k_i-l_i)^2 \right]
\end{split}
\tag{6}
$$

- To number subordinate equations in a numbered equation environment, place the part of document containing them in a subequations environment:

```
\begin{subequations}
Maxwell's equations:
\begin{align}
B'&=-\nabla \times E,\\
E'&=\nabla \times B - 4\pi j,
\end{align}
\end{subequations}
```

Maxwell's equations:

$$B' = -\nabla \times E, \tag{7a}$$

$$E' = \nabla \times B - 4\pi j, \tag{7b}$$

- A basic matrix (or determinant) can be created using the matrix or array environment.

- Entries specified by row, with columns separated using an ampersand (&) and a new rows separated with a double backslash (\\).

- By default, all columns are center aligned in matrix environment but need to be specified in the array environment.

```
\begin{equation*}
\begin{matrix}
a & b & c \\
d & e & f \\
ghi & jkl & mno
\end{matrix}
=
\left (
\begin{array}{lcr}
a & b & c \\
d & e & f \\
ghi & jkl & mno
\end{array}
\right )
\end{equation*}
```

$$\begin{matrix} a & b & c \\ d & e & f \\ ghi & jkl & mno \end{matrix} = \left(\begin{array}{lcr} a & b & c \\ d & e & f \\ ghi & jkl & mno \end{array} \right)$$

- The matrix and array environments do not contain any delimiters.

- In general, matrices are enclosed in different delimiters such as ( ), { }, [ ], | |, || ||.

- You can add these delimiters explicitly as above or

- use the predefined LaTeX environments.

Environment name	Surrounding delimiter
matrix	
pmatrix	( )
bmatrix	[ ]
Bmatrix	{ }
vmatrix	| |
Vmatrix	‖ ‖

- If you need to align the columns differently i.e. either left or right aligned, use the starred version of these environment with column alignment as option to the environment command.

```
\begin{equation*}
\begin{Bmatrix*}[r]
a & b & c \\
ghi & jkl & mno
\end{Bmatrix*}
=
\begin{Vmatrix*}[l]
a & b & c \\
ghi & jkl & mno
\end{Vmatrix*}
\end{equation*}
```

$$\begin{Bmatrix} a & b & c \\ ghi & jkl & mno \end{Bmatrix} = \begin{Vmatrix} a & b & c \\ ghi & jkl & mno \end{Vmatrix}$$

- **amsmath** has a case environment to write piecewise functions,

```
\[ u(x) =
  \begin{cases}
  \exp{x} & \text{if } x \geq 0 \\
  1       & \text{if } x < 0
  \end{cases} \]
```

$$u(x) = \begin{cases} \exp x & \text{if } x \geq 0 \\ 1 & \text{if } x < 0 \end{cases}$$

- If the purpose is to make comments on particular parts of an equation, use the \overbrace and \underbrace commands,

```
\[ z = \overbrace{
  \underbrace{x}_\text{real} +
  \underbrace{iy}_\text{imaginary}
 }^\text{complex number} \]
```

$$z = \overbrace{\underbrace{x}_{\text{real}} + \underbrace{iy}_{\text{imaginary}}}^{\text{complex number}}$$

- The \xleftarrow and \xrightarrow commands produce arrows which extend to the length of the text. The optional argument [ ] contains the subscript while { } contains the superscript which can be empty.

```
\[ A \xleftarrow{\text{this way}} B \xrightarrow[\
    text{or that way}]{} C \]
```

$$A \xleftarrow{\text{this way}} B \xrightarrow[\text{or that way}]{} C$$

- Very often mathematical features will differ in size, in which case the delimiters surrounding the expression should vary accordingly. This can be done automatically using the \ left , \ right , and \middle commands.

```
\[ \left(\frac{x^2}{y^3}\right) \]
\[ P\left(A=2\middle|\frac{A^2}{B}>4\right) \]
```

$$\left(\frac{x^2}{y^3}\right)$$

$$P\left(A = 2 \,\middle|\, \frac{A^2}{B} > 4\right)$$

- If a delimiter on only one side of an expression is required, then an invisible delimiter on the other side may be denoted using a period (.).

```
\[\left.\frac{x^3}{3}\right|_0^1\]
```

$$\left.\frac{x^3}{3}\right|_0^1$$

- Mathematical documents include elements that require special formatting and numbering such as theorems, definitions, propositions, remarks, corollaries, lemmas and so on.

- Make sure you have the amsthm package enabled: \usepackage{amsthm}

- In the preamble, add \newtheorem{name}{Printed output}

- The first argument is the name of the environment that is defined, the second argument is the word that will be printed, in boldface font, at the beginning of the environment.

- For example: add \newtheorem{theorem}{theorem} to preamble and the following within the document.

```
\begin{theorem}
Let $f$ be a function whose derivative exists in every point, then $f$
is a continuous function.
\end{theorem}
```

Theorem 1. *Let f be a function whose derivative exists in every point, then f is a continuous function.*

- You can add a name within brackets in the environment opening command

```
\begin{theorem}[Pythagorean theorem]
\label{pythagorean}
This is a theorem about right triangles summarised by
equation
\[ x^2 + y^2 = z^2 \]
\end{theorem}
```

Theorem 2 (Pythagorean theorem). *This is a theorem about right triangles summarised by equation*

$$x^2 + y^2 = z^2$$

- The `\newtheorem` command accepts different options to change the numbering style

- `\newtheorem{theorem}{Theorem}[section]`: restart the theorem counter for each section.

- `\newtheorem{lemma}[theorem]{Lemma}`: Create a new environment lemma that uses the same counter as theorem.

- `\newtheorem{corollary}{Corollary}[theorem]`: Create a new environment corollary such that the counter is reset every time a new theorem environment is used.

- `\newtheorem*{remark}{remark}`: Create an unnumbered environment for remarks and comments.

```latex
\begin{corollary}
There's no right rectangle whose sides measure 3cm, 4cm, and 6cm.
\end{corollary}
\begin{lemma}
Given two line segments whose lengths are $a$ and $b$ respectively there is a
real number $r$ such that $b=ra$.
\end{lemma}
\begin{corollary}
There's no right rectangle whose sides measure 3cm, 4cm, and 6cm.
\end{corollary}
\begin{remark}
This statement is true, I guess.
\end{remark}
```

Corollary 2.1. *There's no right rectangle whose sides measure 3cm, 4cm, and 6cm.*

Lemma 3. *Given two line segments whose lengths are a and b respectively there is a real number r such that $b = ra$.*

Corollary 3.1. *There's no right rectangle whose sides measure 3cm, 4cm, and 6cm.*

Remark. *This statement is true, I guess.*

- Proofs are the core of mathematical papers and books and is customary to keep them visually apart from the normal text in the document.

  Lemma 4. *Given two line segments whose lengths are a and b respectively there is a real number r such that $b = ra$.*

  Proof. To prove it by contradiction try and assume that the statement is false, proceed from there and at some point you will arrive to a contradiction. □

- The word Proof is italicized and there is some extra spacing.
- A special symbol is used to mark the end of the proof.
- To change the symbol to say a blacksquare, add the following to the preamble

  `\renewcommand\qedsymbol{$\blacksquare$}`

- LaTeX has several environments to create bulleted or numbered lists.

- itemize environment, creates a bulleted list.

- enumerate environment, creates a numbered list.

- description environment, creates a list with text instead of bullets and numbers.

```
\begin{itemize}
\item first level is a filled circle
  \begin{itemize}
  \item second level is a hyphen
    \begin{itemize}
    \item third level is an asterix
      \begin{itemize}
      \item fourth level is a period
      \end{itemize}
    \end{itemize}
  \end{itemize}
\end{itemize}
\begin{enumerate}
\item first level arabic numeral
  \begin{enumerate}
  \item second level is a letter in parenthesis
    \begin{enumerate}
    \item third level is a lowercase roman numeral
      \begin{enumerate}
      \item fourth level is an uppercase letter
      \end{enumerate}
    \end{enumerate}
  \end{enumerate}
\end{enumerate}
\begin{description}
\item[Header 1] Item 1
\item[Header 2] Item 2
\end{description}
```

Lists in LaTeX

1 itemize environment

begin{itemize}
  item item 1
  item item 2
    begin{itemize}
      item subitem 1 of item 2
        begin{itemize}
          item subsubitem 1 of subitem 1
            begin{itemize}
            item subsubsubitem 1 of subsubitem 1
            end{itemize}
        end{itemize}
    end{itemize}
end{itemize}

- item 1

- item 2

  - subitem 1 of item 2

    * subsubitem 1 of subitem 1

      · subsubsubitem 1 of subsubitem 1

2 enumerate environment

begin{enumerate}
  item item 1
  item item 2
    begin{enumerate}
      item subitem 1 of item 2
        begin{enumerate}
          item subsubitem 1 of subitem 1
            begin{enumerate}
            item subsubsubitem 1 of subsubitem 1
            end{enumerate}
        end{enumerate}
    end{enumerate}
end{enumerate}

1. item 1

2. item 2

   (a) subitem 1 of item 2

       i. subsubitem 1 of subitem 1

          A. subsubsubitem 1 of subsubitem 1

3 description environment

begin{description}
  item[Description]: The description environment is slightly   different .
  item[item label]: You can specify the item label by passing it as an optional argument
  item[] (although optional, it would look odd if you didn't include it !).
  item[Use]: Ideal for a series of definitions , such as a glossary .
end{description}

Description : The description environment is slightly different.

item label : You can specify the item label by passing it as an optional
   argument

(although optional, it would look odd if you didn't include it!).

Use : Ideal for a series of definitions, such as a glossary.

- Tables are created within the tabular environment.

- The arguments to the tabular environment is the positional alignment of all columns in the table.

- Every column entry needs to be separated by the alignment character &, a blank entry will be bounded by & except if it the last column entry.

- Each row needs to have \\ at the end signifying the end of row.

- To create a horizontal line between rows, use \hline. Note that \hline is not followed by \\.

- To create a horizontal line between columns m and n, use \cline{m-n}.

- To add border to each column add | to the position arguments of the tabular environment.

- The tabular environment is in text mode. To add column entries in math mode, your column entries should be within $...$.

  Recall all the math symbols in previous slides, they were created within a tabular environment.

```
\begin{tabular}{|l|c|r}
R1C1 & R1C2 & R1C3 \\
\hline
R2C1 & R2C2 & \\
\cline{2-3}
R3C1 & & R3C3 \\
\end{tabular}
```

R1C1	R1C2	R1C3
R2C1	R2C2	
R3C1		R3C3

- Creating fancy tables with one column spanning multiple columns is possible with LaTeX.
- use the command \multicolumn{num}{col}{text} where
  - ◆ num columns are merged into one,
  - ◆ col is the alignment of the column, either l, c, or r for left, center and right, and
  - ◆ text is the column entry.
- If you need one row to span multiple rows, you need to include \usepackage{multirow} in the preamble and
- use the command \multirow{num}{row}{text} where
  - ◆ num and text have the same meaning as in multicolumn, and
  - ◆ row is location of the text, by default centered using ∗.
  - ◆ You can use the \raisebox{lift}{text} command to reposition the text in both the multicolumn and multirow environments.
- To write long tables in landscape mode use the lscape package,

```
\usepackage{lscape} % this goes in the preamble
\begin{landscape} % to print a table in landscape mode
\begin{table} ... \end{table}
\end{landscape}
```

```
\begin{center}
\begin{tabular}{ |l|l|l| }
\hline
\multicolumn{3}{ |c| }{Team sheet} \\
\hline
Goalkeeper & GK & Paul Robinson \\ \hline
\multirow{4}{*}{Defenders} & LB & Lucus Radebe \\
 & DC & Michael Duberry \\
 & DC & Dominic Matteo \\
 & RB & Didier Domi \\ \hline
\multirow{3}{*}{Midfielders} & MC & David Batty \\
 & MC & Eirik Bakke \\
 & MC & Jody Morris \\ \hline
Forward & FW & Jamie McMaster \\ \hline
\multirow{2}{*}{\raisebox{-10pt}{Strikers}} & ST &
      Alan Smith \\
 & ST & Mark Viduka \\
\end{tabular}
\end{center}
```

Team sheet		
Goalkeeper	GK	Paul Robinson
Defenders	LB	Lucus Radebe
	DC	Michael Duberry
	DC	Dominic Matteo
	RB	Didier Domi
Midfielders	MC	David Batty
	MC	Eirik Bakke
	MC	Jody Morris
Forward	FW	Jamie McMaster
	ST	Alan Smith
Strikers	ST	Mark Viduka

- The tabular environment does not create a caption.

- If you need captions, the tabular environment needs to be within a table environment.

- The table environment is basically a floating table and LaTeX will place it at the earliest location without causing excessive space.

  i.e. if the table cannot fit at the location of content where entered, then LaTeX will put the table on the next page and add content that follows the table at the current location.

- Usage: \begin{table}[loc] ... \end{table}

- The caption can be either at the top i.e. before the table contents or at the bottom i.e. after the table contents.

- The caption is specified using \caption[short title]{title}

- The short title is the text that will appear in the list of contents (TOC for tables) if present else title will be used.

- To display a list of tables in the table of contents, add the command \listoftables at the location you want it to appear usually after the table of contents.

- The List of Tables (LoT) name can be changed by using the command \renewcommand{\listtablenamename}{New List of Tables Title}

- **You need to have a caption to cross reference tables in your document** for e.g. in Table **??** we show an example of a floating table.

```
\begin{center}
\begin{table}[ht]
\caption{First example of table with caption}\label{
      table1}
\begin{tabular}{ |l|l|l| }
\hline
\multicolumn{3}{ |c| }{Team sheet} \\
\hline
Goalkeeper & GK & Paul Robinson \\ \hline
\multirow{4}{*}{Defenders} & LB & Lucus Radebe \\
 & DC & Michael Duberry \\
 & DC & Dominic Matteo \\
 & RB & Didier Domi \\ \hline
\multirow{3}{*}{Midfielders} & MC & David Batty \\
 & MC & Eirik Bakke \\
 & MC & Jody Morris \\ \hline
Forward & FW & Jamie McMaster \\ \hline
\multirow{2}{*}{Strikers} & ST & Alan Smith \\
 & ST & Mark Viduka \\
\hline
\end{tabular}
\end{table}
\end{center}
```

Table 1: First example of table with caption

Team sheet		
Goalkeeper	GK	Paul Robinson
Defenders	LB	Lucus Radebe
	DC	Michael Duberry
	DC	Dominic Matteo
	RB	Didier Domi
Midfielders	MC	David Batty
	MC	Eirik Bakke
	MC	Jody Morris
Forward	FW	Jamie McMaster
Strikers	ST	Alan Smith
	ST	Mark Viduka

- LaTeX cannot manage pictures directly.
- We need to load the graphicx package in the preamble of the document.

  `\usepackage[options]{graphicx}`
- This package accepts as an optional argument the external driver to be used to manage pictures,

  dvips : (default) if you are compiling with latex to get a DVI and you want to see your document with a DVI or PS viewer.

  dvipdfm : if you are compiling with latex to get a DVI that you want to convert to PDF using dvipdfm.

  pdftex : (default if compiling with pdflatex), if you are compiling with pdftex to get a PDF that you will see with any PDF viewer.
- Supported Image Formats if compiling with

  latex : EPS (Encapsulated PostScript)

  pdflatex : JPG, PNG, PDF. You can use EPS if using the epstopdf package with compiler command `pdflatex -shell-escape file.tex`

- You can include images using the command

  `\includegraphics[attr1=val1, attr2=val2, ..., attrn=valn]{imagename}`

  where the attributes can be

  width=xx   Specify the preferred width of the imported image to xx cm (or in, pt).

  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 nor 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 (counter-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.

- On Page 41, the simple latex document was inserted using the command
  `\includegraphics[height=\slidewidth,angle=90]{./asimple.ps}`

- If you need to include a caption, then you need use the figure environment,

```
\begin{figure}[loc]
\includegraphics[attr1=val1, attr2=val2, ..., attrn=valn]{imagename}
\caption{Figure Caption}
\end{figure}
```

- In WYSIWYG document processors, it is common to put tables and figures in the middle of the text.

- Professional documents, however, often make it a point to print tables and figures on a dedicated page so that they do not disrupt the flow.

- From the point of view of the source code, one has no idea on which page the current text is going to lie, so it is hardly possible to guess which page may be appropriate for our table.

- LaTeX can automate this task by abstracting objects such as tables and pictures, and decide for us where they might fit best. This abstraction is called a float.

- The table and figure environment create a table and figure as float respectively.

- For Example: \begin{table}[loc] ... \end{table} OR
  \begin{figure}[loc] ... \end{figure}

- where loc is the position of the table (or figure) and can be one of the following

  h : Print the table (or figure) on the current page with content.

  t : Print the table (or figure) at the top of the page.

  b : Print the table (or figure) at the bottom of the page.

  p : Print the table (or figure) as a float on pages along with other floating tables and figures in sequence.

- Default location is tbp i.e. LaTeX will try to put the floating table or figure first at the top of the page, bottom of the page or on a separate page depending on the accompanying content.

Wrap Up
    References
    Creating LaTeX Presentations

[1] Helmut Kopka and Patrick W. Daly. *A Guide to LATEX*. Addison-Wesley, 1999.

[2] Andrew Roberts. *Getting to Grips with LaTeX*. `http://www.andy-roberts.net/writing/latex`.

[3] *LaTeX*. Wikibooks.org. `http://en.wikibooks.org/wiki/LaTeX`.

[4] E. Krishnan, editor. *LATEX Tutorial: A Primer*. Indian TEX Users Group, 2003. http://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf.

```
This slide content was generated using
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  \ bibliographystyle {unsrt}
  \ bibliography{asv}
The BibTeX file, asv.bib is included in the download tar file
```

❶ Beamer: The most popular package for creating presentations.

● Template: `https://github.com/alexpacheco/LehighBeamer`

❷ Powerdot: This presentation was created using the powerdot package.

● Source Files: `https://github.com/alexpacheco/latex`

❸ Prosper: `https://www.ctan.org/pkg/prosper?lang=en`

❹ HA-prosper: `https://www.ctan.org/pkg/ha-prosper?lang=en`

❺ Seminar: `https://www.ctan.org/pkg/seminar?lang=en`