Mathematical Typesetting in LaTeX

Practical 1

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Overview

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- **Microsoft Word/Equation Editor?**

  OK for one or two formulae or expressions, but not much use for an entire mathematical project.

- **LaTeX**

  Simply the best thing going in mathematical typesetting and the choice of the vast majority of professional mathematicians.
  Originally conceived by Knuth (1978) — TeX. Updated by Lamport (1984) — LaTeX (Lamport TeX).

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- Access to all special symbols;
- With a few simple instructions, LaTeX will typeset almost anything mathematical (and anything else for that matter) — e.g. these slides are produced in LaTeX;
- The basic program is free. All you need in addition is a text (or TeX!) editor (there are many free possibilities for that).

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- We use a specialised LaTeX editor called TeXmaker.
- The basic approach is:
  - type the LaTeX instructions and the text into the editor in the predefined format (.tex file);
  - compile it through LaTeX (produces a .dvi file) or pdfLaTeX (produces a .pdf file);
  - convert the .dvi file into .ps or .pdf format.
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  - convert the .dvi file into .ps or .pdf format.
  - With TeXmaker these various tasks are simplified into pressing a single button or choosing a menu option for each task.
- TeXmaker is a free, cross-platform LaTeX editor. There are many other alternative and free setups. Just look on the web for the free packaged LaTeX installation known as MiKTeX (for Windows users) or MacTeX (for Mac users) and follow the advice given there for downloads.

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The main way to learn is to experiment and write documents for yourself.

We will provide exercises at the end of this talk to assist you.

Example 1

Let us go through a simple LaTeX file. The general form is:

```
\documentclass[a4paper]{article}

\begin{document}

\section{Section 1}
\subsection{Subsection 1.1}
\subsubsection{A Header}

This is where the text goes.

\end{document}
```


Example 1 Output

1 Section 1

1.1 Subsection 1.1

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- It looks as though the file consists of rather too many instructions for one line of text but the individual lines of LaTeX code are the building blocks. For example, the `\section{}` command allows us to define a section.

- Notice that the section, subsection, etc. are all numbered consecutively — LaTeX does this for us! We can produce all kinds of documents (articles, books, letters, ...) by changing the `\documentclass` command.

Example 2

Let's produce a few simple expressions:

```
\documentclass[a4paper]{article}
\begin{document}
\section{Some Formulae and Expressions}

\begin{equation}
\int^1_0 f_i(x)g_i(x)\,\mathrm{d}x
\end{equation}

\begin{equation}
\sqrt[n]{\frac{x^n-y^n}{1+u^{2n}}}
\end{equation}

\begin{equation}
\cos^2\theta+\sin^2\theta=1
\end{equation}

\end{document}
```

Example 2 Output

1 Some Formulae and Expressions

$$\int_0^1 f_i(x)g_i(x)\,\mathrm{d}x \tag{1}$$

$$\sqrt[n]{\frac{x^n - y^n}{1 + u^{2n}}} \tag{2}$$

$$\cos^2\theta + \sin^2\theta = 1 \tag{3}$$

Example 3

Now let's do something akin to a front cover that looks professional:

```
\documentclass[a4paper]{article}

\title{A New \LaTeX\ Document}
\author{A. Student}
\date{5th October 2005}

\begin{document}
\maketitle

\section{Section 1}
This is the rest of the \LaTeX\ document.

\end{document}
```


Example 3 Output

A New LaTeX Document

A. Student

5th October 2005

1 Section 1

This is the rest of the LaTeX document.

Summary

Hopefully you can see just what can be done with LaTeX. You will be expected to use it in various ways over the duration of your degree programme.

You are particularly expected to develop some LaTeX skills in the module ECM1704 Mathematical Investigations. Don't waste that opportunity.

Remember: The main way to learn is to experiment and write documents yourself.

Information Sources

Websites (correct at 22/09/15):

- TeXmaker documentation: `http://www.xm1math.net/texmaker/doc.html`
- Getting started with LaTeX: `http://www.maths.tcd.ie/~dwilkins/LaTeXPrimer/`
- Archive of TeX material: `http://www.ctan.org/`

Books:

- H. Kopka and P. W. Daly, *A Guide to LaTeX*, Addison Wesley (2003)
- L. Lamport, *LaTeX: A Document Preparation System*, Addison Wesley (1994)
- F. Mittelbach et al., *The LaTeX Companion*, Prentice Hall (2004)

LaTeX Exercises

The aim of these few simple exercises is to encourage you to experiment with LaTeX. The main way to learn how to use it is trial and error — write documents yourself. You may be expected to submit certain LaTeX-prepared assignments over the duration of your degree programme, so getting used to this material very early on is important. As with many other activities, LaTeX becomes easier the more it is practiced.

- Start by experimenting with the functions of TeXmaker. In particular, type in one of the examples used earlier in this introduction, compile it to a DVI file and then work out how to convert it to a PS and a PDF file. Then try compiling it straight to a PDF file.

LaTeX Exercises

- Find the `LaTeX` and `math` menus in TeXmaker. These allow us to select preset comments/symbols for inclusion into the current tex file. Try to make a few formulae or equations with the symbols. Note: all mathematical symbols are usually either placed with dollar (`$`) signs or between `\begin` and `\end` tags. So for example, $\beta + 2\alpha$ is written `$\beta+2\alpha$` in LaTeX.

- Look at the following file: `http://www.math.toronto.edu/mathit/symbols-letter.pdf`
  It contains many useful tables of LaTeX symbols and their printed equivalents side by side.

LaTeX Exercises

- The 2×2 matrix

$$\begin{pmatrix} 3 & -2 \\ 1 & \sqrt{3} \end{pmatrix}$$

is produced by the following code:

```
$$ \left(
\begin{array}{ c c }
3 & -2 \\
1 & \sqrt{3}
\end{array} \right) $$
```

  - Create a 5×5 matrix using similar code.
  - Find out about the `\begin{bmatrix} ... \end{bmatrix}` and `\begin{pmatrix} ... \end{pmatrix}` commands and how to use them.

LaTeX Exercises

- TeXmaker also spots if mistakes are made in the tex file. For example, not completing the `\author` command of Example 3 (i.e. typing `\author{A. Student`) produces an error message. Clicking on the blue triangle (▶) usually prompts the cursor to move to near where the error occurred and displays the error message
  `! Paragraph ended before \author was complete.`
  Deliberately make some errors to familiarise yourself with the range of error messages that occur and to practise correcting these errors.

- Produce the following formulae in LaTeX:
  1. $\cos^2(x) + \sin^2(x) = 1$;
  2. $e^{i\pi} = -1$;
  3. $\sin(x) = \sum_{k=0}^{\infty} (-1)^k \frac{x^{2k+1}}{(2k+1)!}$;
  4. $$\int_0^{\infty} \frac{x \sin(ax)}{(b^2 + x^2)^2} \, \mathrm{d}x = \frac{\pi}{4b} a e^{-ab} \, .$$

LaTeX Exercises

There are seven LaTeX errors in the following tex file. Type in the file, try to compile it and then correct the errors.

```
\documentclass[a4paper]{article}
\title{An Example of an Error-Prone \LaTeX\ Document
\author{A. Student}

\begin{document}
\maketile

\setion{A Brief Look at Some Laws of Set Theory} The following laws of set theory are
fundamental and can be used to manipulate expressions involving sets:

\begin{enumerate}

\item De Morgan's Laws: For any two sets $A$ and $B$,
\begin{eqnarray*}
(A\cup B)' = A'\cap B' \\
(A\cap B)' = A'\cup B'
\end{eqnarray}

\item Distributive Law: For any three sets $A,B$ and $C$,
\begin{eqnarray}
A\cap(B\cup C) = (A\cap B) \cup (A\cap C) \\
A\cup(B\cap C) = (A\cup B) \cap (A\cup C)
\end{eqnarray}

$\ldots$

\[
\sum\limits_{r=0}^\infty \frac{1}{r^2}=\frac{pi^2}{6}
]

\end{enumerate}
```