Mathematics in LaTeX

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September 16, 2009

The Mathematics Environment

Typesetting Mathematics

Donald Knuth created TEX primarily to typeset mathematics beautifully.

LATEX supports the full range of capabilities of TEX in mathematics.

Additional packages like **amsmath** refine and enhance the interfaces in LATEX.

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There are two ways in which mathematics can be included in a document:

- *inline maths*

  The general form of the equation of a straight line may be written as $ax + by + c = 0$

- *displayed maths*

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Alternatively, **inline maths** can be written like this:

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Typesetting Mathematics

By using the amsmath package, we can also use the equation environment:

```
The general form of the equation of a
straight line may be written as
\begin{equation}
ax+by+c=0
\end{equation}
```

Typesetting Mathematics

Now let us take a closer look at this:

```
The general form of the equation of a straight
line may be written as \begin{equation} ax+by+c=0
\end{equation} where $a, b, c$ are constants.
```

It appears as:

The general form of the equation of a straight line may be written as

$$ax + by + c = 0 \tag{1}$$

where a, b, c are constants.

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Typesetting Mathematics

1. The variables x and y and the constants a, b and c are printed in italics. This is the default.
2. The different parts of the equation are spaced out properly although we did not include space anywhere. The spacing is adjusted so that the equation looks nice.
3. The equation is numbered on the right hand margin
4. The space between a, b and c on the last line is less than seen here. This happens when a, b and c are all put between a pair of \$ signs – that is, they are typeset in math mode. Thus `$a, b and c$` would appear as $a, bandc$.

To get unnumbered equations, use the environment `equation*`

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Superscript and subscript

Superscript

Superscript (or *exponent*) can be typeset using the 'cap' symbol. Thus:

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

can be typeset using the statement

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Subscripts can be typeset using the underscore character. Thus:

$$x_n = x_{(n-1)} + x_{(n-2)}$$

can be typeset using the command

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Superscript and subscript

Multiple levels

Superscript (and subscript) can be used in two levels. For instance:

$$x^{m^2} \times x^{n^2} = x^{m^2+n^2}$$

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Operators

Basic operators

Notice the operator we already used for multiplication, namely, \times. This gives a better looking $\times$ ('into') compared to what we normally use, namely, the alphabet x.

We have other operators like \frac (for fractions such as $\frac{1}{2}$) and \dfrac (for large size fractions like $\dfrac{1}{2^{n-1}}$)

Roots

Square roots can be typeset using the command \sqrt:

```
$ i = \sqrt{-1} $
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Other roots can also be typeset using the same command. For instance,

$$y = \sqrt[n]{x^m}$$

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Note that the *vinculum*, as mathematicians used to call the horizontal line in the square root symbol, extends to include the entire text inside:

$$Sum = \sqrt{\frac{n(n+1)}{2}}$$

The square root symbol can be nested:

The sequence

$$2\sqrt{2}, \quad 2^2\sqrt{2-\sqrt{2}}, \quad 2^3\sqrt{2-\sqrt{2+\sqrt{2}}}, \ \ldots$$

converges to π.

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Sum

Sum is often used in mathematics. It is written, simply, as:

```
$ \sum_{n=1}^\infty\frac{1}{n^ 2} = \frac{\pi^2}{6} $
```

This appears as:

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$$

This is the inline form. In the display form, it appears as:

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Integral

Here is an equation with limits and definite integration:

Thus, $\lim_{x\to\infty} \int_0^x \frac{\sin x}{x} dx = \frac{\pi}{2}$ and so, by definition,

$$\int_0^\infty \frac{\sin x}{x} dx = \frac{\pi}{2}$$

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...and here is its source:

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You can, of course, write the equation yourself now.

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Operators

Product

You may want to write something like:

$$p_k(x) = \prod_{\substack{i=1 \\ i \neq k}}^{n} \left(\frac{x - t_i}{t_k - t_i} \right)$$

You can do it like this:

```
\begin{equation*}
p_k(x) = \prod_{\substack{i=1\\i\ne k}}^n \left(\frac{ x-t_ i}
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More

We have now learnt the basics of writing a LaTeX document. But we have not touched upon a number of aspects such as:

- using fonts
- creating text boxes
- setting paragraph properties
- creating complex tables
- writing matrices and determinants
- creating cross references
- inserting hyperlinks
- building table of contents, table of figures, etc.
- managing references and bibliography
- ... and so on

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Books:

TUG India: *LaTeX Tutorials: A Primer*, Indian TeX User Group, Trivandrum, India, 2003.

Peter Flynn: *Formatting Information: A beginners introduction to typesetting with LaTeX* , Silmaril Consultants, 2005.

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