Mathematics in LaTeX

Dr. V. Sasi Kumar

FSF India

The Mathematics Environment

Typesetting Mathematics

Typesetting Mathematics

Donald Knuth created TeX primarily to typeset mathematics beautifully.

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.

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.

Typesetting Mathematics

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

Typesetting Mathematics

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

- *inline maths*

Typesetting Mathematics

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 $ax + by + c = 0$

Typesetting Mathematics

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*

Typesetting Mathematics

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*

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

$$ax + by + c = 0$$

Typesetting Mathematics

Inline maths can be typeset like this:

Typesetting Mathematics

Inline maths can be typeset like this:

Typesetting Mathematics

Inline maths can be typeset like this:

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

Typesetting Mathematics

Inline maths can be typeset like this:

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

and **Displayed maths** like this:

The Mathematics Environment

Typesetting Mathematics

Inline maths can be typeset like this:

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

and **Displayed maths** like this:

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

The Mathematics Environment

Typesetting Mathematics

Inline maths can be typeset like this:

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

and **Displayed maths** like this:

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

This is the TEX way of typesetting equations.

Typesetting Mathematics

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

```
The general form of the equation of
a straight line may be written as
\(ax+by+c=0\)
```

Typesetting Mathematics

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

```
The general form of the equation of
a straight line may be written as
\(ax+by+c=0\)
```

Typesetting Mathematics

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

```
The general form of the equation of
a straight line may be written as
\(ax+by+c=0\)
```

and **Displayed maths** like this:

The Mathematics Environment

Typesetting Mathematics

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

```
The general form of the equation of
a straight line may be written as
\(ax+by+c=0\)
```

and **Displayed maths** like this:

```
The general form of the equation of a
straight line may be written as
\[ ax+by+c=0 \]
```

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.
```

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.
```

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.

Typesetting Mathematics

The Mathematics Environment

Typesetting Mathematics

1. The variables x and y and the constants a, b and c are printed in italics. This is the default.

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.

The Mathematics Environment

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

The Mathematics Environment

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 $a, b and c$.

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 $a, b and c$.

The Mathematics Environment

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 $a, b and c$.

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

Superscript and subscript

Superscript

Superscript and subscript

Superscript

Superscript and subscript

Superscript

Superscript (or *exponent*) can be typeset using the ‘cap’ symbol.

Superscript and subscript

Superscript

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

$$\boxed{x^n + y^n = z^n}$$

can be typeset using the statement

Superscript and subscript

Superscript

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

$$\boxed{x^n + y^n = z^n}$$

can be typeset using the statement

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

Superscript and subscript

Subscript

Superscript and subscript

Subscript

Subscript

Subscripts can be typeset using the underscore character.

Superscript and subscript

Subscript

Subscripts can be typeset using the underscore character. Thus:

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

can be typeset using the command

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

Superscript and subscript

Superscript and subscript can be used together:

Superscript and subscript

Superscript and subscript can be used together:

Superscript and subscript

Superscript and subscript can be used together:

$$\boxed{x_1^2 + x_2^2 = x_3^2}$$

Superscript and subscript

Superscript and subscript can be used together:

$$\boxed{x_1^2 + x_2^2 = x_3^2}$$

can be typeset using the statement

Superscript and subscript

Superscript and subscript

Superscript and subscript can be used together:

$$\boxed{x_1^2 + x_2^2 = x_3^2}$$

can be typeset using the statement

```
$ x_1^2 + x_2^2 = x_3^2 $
```

Superscript and subscript

Multiple levels

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

Superscript and subscript

Multiple levels

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

Superscript and subscript

Multiple levels

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

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

Multiple levels

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

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

can be typeset using the command

Multiple levels

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

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

can be typeset using the command

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

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 $\dfrac{1}{2^{n-1}}$)

Operators

Roots

Square roots can be typeset using the command \sqrt:

Roots

Square roots can be typeset using the command \sqrt:

Roots

Square roots can be typeset using the command \sqrt:

```
$ i = \sqrt{-1} $
```

It produces the output:

$$\boxed{i = \sqrt{-1}}$$

Roots

Other roots can also be typeset using the same command. For instance,

Operators

Roots

Other roots can also be typeset using the same command. For instance,

Roots

Other roots can also be typeset using the same command. For instance,

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

is generated using:

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

Roots

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

Roots

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

Operators

Roots

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

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

Roots

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

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

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.

Operators

Sum

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

Operators

Sum

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

Operators

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:

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

Integral

Here is an equation with limits and definite integration:

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

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

Operators

Integral

...and here is its source:

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

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

Integral

...and here is its source:

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

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

Operators

Integral

...and here is its source:

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

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

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

Product

You may want to write something like:

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

Product

You may want to write something like:

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

Operators

Product

You may want to write something like:

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

You can do it like this:

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

More

More

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

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

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

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

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

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

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

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

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.

More

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

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

More

Books:

More

Books:

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

More

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.

More

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.

Leslie Lamport: *LaTeX A Document Preparation System*, Addison-Wesley Professional, 2 edition, 1994.

More

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.

Leslie Lamport: *LaTeX A Document Preparation System*, Addison-Wesley Professional, 2 edition, 1994.

Donald E. Knuth: *The TeX Book*, Addison-Wesley Professional, 1984