

# Introduction to LaTeX for Mathematical Expressions

The goal of the lesson is to become familiar with the TeX language, specifically for the purpose of writing mathematical expressions.

## 1. Introduction to LaTeX

### What is LaTeX?

1. LaTeX is a high-quality typesetting system, primarily used for technical and scientific documents. It is particularly powerful for formatting complex mathematical equations and formulas, making it a preferred choice in academia and research.

### What are the advantages of LaTeX?

1. **Precision and Control:** LaTeX allows precise formatting of documents and mathematical expressions.
2. **Consistency:** LaTeX automatically manages references, labels, and numbering, ensuring consistency throughout your document.
3. **Professional Quality:** Documents created in LaTeX look professional and are publication-ready.

### Getting Started:

1. **Overleaf:** We will use Overleaf, a free online LaTeX editor, which allows you to write and compile LaTeX documents directly in your browser.
  1. Sign up at [Overleaf](#).
  2. Overleaf offers collaborative features, version control, and a vast library of LaTeX templates.

### Basic Document Structure:

```
\documentclass{article} % Specifies the document class (article, report,
book, etc.)
\begin{document}        % Begins the content of the document
% Your content goes here
\end{document}         % Ends the content of the document
```

1. **\documentclass{article}**: Defines the overall layout and style of the document.
2. **\begin{document}** and **\end{document}**: Everything between these commands will be included in the output document.

## 2. Writing Basic Mathematical Expressions

### Inline vs. Display Math

1. **Inline Math:** For mathematical expressions that appear within a line of text, use  $...$ .
  1. E.g.  $E = mc^2$  is written as  $E = mc^2$  in LaTeX.

2. **Display Math:** For standalone equations, use  $...$ .
  1. E.g. To display  $E = mc^2$  on its own line, use  $E = mc^2$ .

### Example

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

The equation  $E = mc^2$  is famous in physics. It is so important that we can highlight  $E = mc^2$  by putting it to a separate line.

```
\end{document}
```

This code will become:

The equation  $E = mc^2$  is famous in physics. It is so important that we can highlight

$$E = mc^2$$

by putting it to a separate line.

### Basic Mathematical Symbols

1. **Exponents (superscripts):** Use  $^$  for superscripts.
  1. E.g.  $x^2$  is written as  $x^2$ .
2. **Subscripts:** Use  $_$  for subscripts.
  1. E.g.  $a_1$  is written as  $a_1$ .
3. **Fractions:** Use  $\frac{\text{numerator}}{\text{denominator}}$ .
  1. E.g.  $\frac{a}{b}$  is written as  $\frac{a}{b}$ .

### Examples

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

```
% Exponent and subscript
```

The formula for the area of a circle is  $A = \pi r^2$ .

```
% Fraction
```

The equation  $\frac{a}{b} = c$  represents a fraction.

```
% Combined
```

The equation for kinetic energy is  $K = \frac{1}{2}mv^2$ .

```
\end{document}
```

This code will become:

The formula for the area of a circle is  $A = \pi r^2$ .

The equation  $\frac{a}{b} = c$  represents a fraction.

The equation for kinetic energy is  $K = \frac{1}{2}mv^2$ .

## Aligning Equations

### Align Environment

1. The `\align` environment is used to align multiple equations. Each line of the equation is aligned using the `&` symbol, typically before the equal sign or any other operator.
2. Use `\\` to separate lines.

### Example

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

\begin{align}
3x + 2y + 0z &= 6 \\
4x - y &= 25
\end{align}

\end{document}
```

This code will become:

$$3x + 2y + 0z = 6 \tag{1}$$

$$4x - y = 25 \tag{2}$$

### Explanation:

1. `\usepackage{amsmath}`: The `amsmath` package is required for advanced mathematical typesetting features, including the `\align` environment.
2. `&`: This symbol is used to align equations at the specified point, usually before an operator like `=`.

### Tips:

1. You can label equations using the `\label{}` command and refer to them later with `\ref{}`.
2. Example:

```
\begin{equation} \label{eq:quadratic}
x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}
\end{equation}
```

To refer to this equation later, use Equation `\ref{eq:quadratic}`.

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