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 became:

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{numerator}{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 $K = \frac{1}{2}mv^2$.

4. 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:

$$3x + 2y + 0z = 6 \quad (1)$$
$$4x - y = 25 \quad (2)$$

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}`.