Some Examples of Equation-Writing in \LaTeX

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1 Writing a Simple Equation

To display an unnumbered equation on a new line, just type: \[
x' = 2x - 3
\].
This will display as:

\[ x' = 2x - 3 \]

If we want to get a numbered equation, we must type:
\begin{equation}
x' = 2x - 3
\end{equation}
This will display as:

\[ x' = 2x - 3 \]  \hspace{1cm} (1)

Now, suppose we want to write a differential equation in another form. Try,
\[
\frac{dy}{dt} = 2y + 8
\].
This displays as:

\[
\frac{dy}{dt} = 2y + 8
\]
or, we may write $$y' = 2y + 8$$.

Now, suppose we have a partial differential equation. To write it with the partial derivatives, we just do:
$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$$.
This displays as:

\[
\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0
\]
Or, we may write $$u_{xx} + u_{yy} = 0$$, which displays as:

\[
u_{xx} + u_{yy} = 0
\]

To add text to an equation do for example;
$$y=mx+b, \ \text{where } m \text{ is the slope, } x \in (-\infty, \infty)$$.
This displays as:

\[ y = mx + b, \text{ where } m \text{ is the slope, } x \in (-\infty, \infty) \]
Note: You need to have included the `amsmath` package at the beginning of the document (after the `\documentclass` command.

If we want to write an equation with a two-line right-hand-side,

\[
y(0) = \begin{cases}
1 & \text{if } x \leq 0, \\
-1 & \text{if } x > 0.
\end{cases}
\] (2)

To write several equations together, we do the following:

\[
\begin{align*}
    u_t + u_x &= 0 \\
    u(x, 0) &= \begin{cases}
        1 & \text{if } x \leq 0, \\
        -1 & \text{if } x > 0.
    \end{cases}
\end{align*}
\] (3)

2 More complicated expressions

Here is how we would write a matrix: \( A = \begin{pmatrix}
a_{11} & a_{12} & \cdots & a_{1n} \\
a_{21} & a_{22} & \cdots & a_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
a_{n1} & a_{n2} & \cdots & a_{nn}
\end{pmatrix} \)

To write a system of equations:

\[
\begin{align*}
x' &= 3x - 2y + 3xy, \\
y' &= 2x - 3y - 2xy, \\
x(0) &= 0, \\
y(0) &= 1
\end{align*}
\] (1)