AMSLaTeX

Workshop #4

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– Typeset by FoilTEX –

$\mathcal{AMS}$LaTeX

$\mathcal{AMS}$LaTeX is a set of macros designed by the American Mathematics Society ($\mathcal{AMS}$). To use these macros, we must include them in our preamble with the `\usepackage` command.

Enter the following source code, save as `workshop4.tex`, LaTeX, then preview.

```
\documentclass{article}
\usepackage{amsmath}
\begin{document}
Note that the \texttt{equation} environment works
in \AmS\LaTeX\ exactly as it does in \LaTeX2e.
 \begin{equation}\label{eq:1}
  \frac{x}{x+1}-\frac{x+1}{x}=1
 \end{equation}
\end{document}
```

The `equation` environment displays and automatically numbers an equation, while `\begin{equation*} ... \end{equation*}` suppresses the numbering of the equation. Try it!

Eqnarray vs. Align

The $\mathcal{AMS}$ `align` environment uses better spacing around the equals sign.

```
\documentclass{article}
\usepackage{amsmath}
\begin{document}
Compare
 \begin{eqnarray}\label{eq:1}
  2x+3&=&7\\
  2x+3-3&=&7-3\\
  2x&=&4
 \end{eqnarray}
with
 \begin{align}\label{eq:2}
  2x+3&=7\\
  2x+3-3&=7-3\\
  2x&=4.
 \end{align}
\end{document}
```

You can suppress numbering of all equations with `\begin{align*}...\end{align*}`. Try it!

NoNumber and Referencing

You can suppress the numbering of an individual equation in an `align` environment with `\nonumber` and you can label and reference individual equations.

```
\documentclass{article}
\usepackage{amsmath}
\begin{document}
Consider
 \begin{align}
  2x+3&=7\label{david}\\
  2x+3-3&=7-3\nonumber \\
  2x&=4\nonumber \\
  \frac{2x}2&=\frac42\nonumber \\
  x&=2.\label{mary}
 \end{align}
The solution of Eq.~\eqref{david} is given in
Eq.~\eqref{mary}.
\end{document}
```

LaTeX your source twice to get references correct. Note that the equation label has nothing to do with the automatic numbering of the equation.

Subequations

You can format numbering for subequations. Simply surround your environment with \begin{subequations}...\end{subequations}.

```
\documentclass{article}
\usepackage{amsmath}
\begin{document}
Consider
 \begin{subequations}\label{system}
  \begin{align}
   2x+3y&=7\label{sys1}\\
   3x-4y&=11\label{sys2}
  \end{align}
 \end{subequations}
In system~\eqref{system}, first solve
Eq.~\eqref{sys1} for $x$.
\end{document}
```

A \label command immediately following \begin{subequations} will produce a reference of the parent number. Referencing individual equations produces subequation labels.

Numberwithin

To have equation numbering tied to section numbering, with automatic reset of the equation counter with each new section, use the $\mathcal{AMS}$ command `\numberwithin` in the document preamble.

```
\documentclass{article}
\usepackage{amsmath}
\numberwithin{equation}{section}
\begin{document}
\section{First Section}
Note the numbering on these centered equations.
 \begin{gather}
  z=\rho\cos\phi\\
  \rho=\sqrt{x^2+y^2+z^2}
 \end{gather}
\section{SecondSection}
Note the numbering on these centered equations.
 \begin{gather}
  z=\rho\cos\phi\\
  \rho=\sqrt{x^2+y^2+z^2}
 \end{gather}
\end{document}
```

Note that the `gather` environment centers equations in a display.

Multiple Line Displays

Use the $\mathcal{AMS}$LaTeX `multline` environment for displays that are too long to fit on one line. Although the following example is not close to being an identity, it does an admirable job of explaining the `multline` environment.

```
\documentclass{article}
\usepackage{amsmath}
\numberwithin{equation}{section}
\begin{document}
\section{The Exponential}
Use copy and paste to quickly create the following
display.
\begin{multline}
 e^x=1+x+\frac{x^2}{2!}+\frac{x^3}{3!}+\dots \\
    1+x+\frac{x^2}{2!}+\frac{x^3}{3!}+\dots \\
    1+x+\frac{x^2}{2!}+\frac{x^3}{3!}+\dots \\
    1+x+\frac{x^2}{2!}+\frac{x^3}{3!}+\dots
 \end{multline}
\end{document}
```

Note that in the resulting display, the first line is left-justified (with a small indent), the middle lines are displayed, and the last line is right-justified (also with a small indent).

Cases and TexT in Math

Piecewise functions are easily handled with the $\mathcal{AMS}$LaTeX cases environment. Also, the $\mathcal{AMS}$LaTeX \text command makes it easy to insert text in mathematical expressions.

```
\documentclass{article}
\usepackage{amsmath}
\begin{document}
Consider the piecewise function $f$, defined by
 \begin{equation}
  f(x)=
   \begin{cases}
    2x-3 & \text{if $x<0$}, \\
    3 & \text{if $x\ge 0$}.
   \end{cases}
 \end{equation}
The functions $f$ and $g$ are inverses of one
another if and only
if
$$
f(g(x))=x \quad\text{and}\quad g(f(x))=x.
$$
\end{document}
```

Theorems and Such

$\mathcal{AMS}$LaTeX provides the `\newtheorem` command to aid in the creation of theorem, corollary, definition, and other such environments. The `\newtheorem` command has two mandatory arguments. The first is the environment name that is used in the source, and the second is the header that is used in the output. For example,

```
\newtheorem{thm}{Theorem}
\begin{thm} Text, text, ...\end{thm}
```

will produce

Theorem 1. *Text, text, ...*

The `\newtheorem*` command produces un-numbered theorem environments. For example,

```
\newtheorem*{rol}{Rolle's Theorem}
\begin{rol} Text, text, ...\end{rol}
```

will produce

Rolle's Theorem. *Text, text, ...*

You have to load the package amsthm in the preamble in order to use the \newtheorem command.

```
\documentclass{article}
\usepackage{amsmath}
\usepackage{amsthm}
\newtheorem{thm}{Theorem}
\newtheorem{cor}{Corollary}
\begin{document}
\begin{thm} If $f$ is continuous on $[a,b]$ and
$K$ is some number between $f(a)$ and $f(b)$, then
 there exists a number $c$ in $(a,b)$ with $f(c)=K$.
\end{thm}
\begin{cor}
If $f$ is continuous on $[a,b]$ and $f(a)f(b)<0$,
then there exists a $c$ in $(a,b)$ with $f(c)=0$.
\end{cor}
\end{document}
```

$\mathcal{AMS}$LaTeX provides further assistance for different numbering schemes as well as formatting of the body of theorem environments.

Matrices in $\mathcal{AMS}$LaTeX

The amsmath package provides some environments for matrices beyond the basic array environment of LaTeX. The pmatrix, bmatrix, Bmatrix, vmatrix, and Vmatrix have (respectively) $()$, $[]$, $\{\}$, $||$, and $\|\|$ delimiters built in.

```
\documentclass{article}
\usepackage{amsmath}
\begin{document}
Let $A$ be the $m\times n$ matrix
$$
A=
\begin{pmatrix}
  a_{11} & a_{12} & \dots & a_{1n}\\
  a_{21} & a_{22} & \dots & a_{2n}\\
  \vdots & \vdots & \ddots & \vdots\\
  a_{m1} & a_{m2} & \dots & a_{mn}
\end{pmatrix}.
$$
\end{document}
```

Try replacing pmatrix with bmatrix, Bmatrix, vmatrix, or Vmatrix and preview the result.

WinEdt Article Template

You are now in a position to understand the LaTeX article template provided with WinEdt. Select New Document from the Project menu, then select LaTeX: Article. Scroll to the top of the source. The first difference you will note is the line

```
\documentclass{amsart}
```

which invokes the American Mathematical Society's article style (`amsart`). This is similar, yet quite different from the Standard LaTeX Article style.

Note the new theorem environments and command definitions. The first difference occurs in the `\title` command. The form `\title[short title]{long title}` allows the author to provide both a short title (used for headings and table of contents)and a longer title (used only on the title page). Use Ctrl+Spacebar to jump to this construct and fill in your long and short title.

Use Ctrl+Spacebar to jump from bullet to bullet, filling in the rest of the bullets with appropriate text as you go.

Comment out the `\usepackage[active]{srcltx}` at the beginning of the source file.

```
%\usepackage[active]{srcltx}
```

Also, comment out the bibliography lines at the end of the source.

```
%\bibliographystyle{amsplain}
%\bibliography
```

Written Homework Assignment

On the template begun on the previous slide, write an article that contains each of the following constructs:

- An abstract.
- A TOC.
- At least two sections and subsections.
- At least two uses of the provided theorem environments.
- At least two uses of the new commands defined in the preamble.
- Craft a `newcommand` with at least one parameter and use it in the source.
- An enumerated list.
- A bulleted (itemized) list.
- A descriptive list.
- A quotation.
- Some lines of computer code.
- At least two footnotes.
- Several occurrences of in-line mathematics.
- Incorporate each of the different font families, series, and shapes, where appropriate.

- A numbered equation and a reference to the equation in the source.
- At least one instance of a numbered `align` environment.
- A table.
- A bibliography containing at least two entries. Reference these entries in the source.

Homework assignments will be collected, changed to portable document format, then posted on our web server. Please let me know if you have difficulty with this assignment and/or you don't wish to participate. It is OK if this assignment takes more than one week.