1. Matrices

The package \texttt{amsmath} includes several useful macros for writing matrices. For example, we can easily typeset complicated matrices like

\[
\begin{pmatrix}
a_{11} & a_{12} & \cdots & a_{1n} \\
a_{21} & a_{22} & \cdots & a_{2n} \\
\vdots & & \ddots & \vdots \\
a_{n1} & a_{n2} & \cdots & a_{nn}
\end{pmatrix}
\]

This matrix was produced using the \texttt{pmatrix} macro. Several matrix types are possible, including \texttt{matrix}, \texttt{pmatrix}, \texttt{bmatrix}, \texttt{Bmatrix}, \texttt{vmatrix}, \texttt{Vmatrix}, which produce, respectively

\[
\begin{pmatrix}
  r & s & t \\
u & v & w \\
x & y & z
\end{pmatrix}
\]

\[
\begin{bmatrix}
  r & s & t \\
u & v & w \\
x & y & z
\end{bmatrix}
\]

\[
\begin{vmatrix}
  r & s & t \\
u & v & w \\
x & y & z
\end{vmatrix}
\]

\[
\begin{Vmatrix}
  r & s & t \\
u & v & w \\
x & y & z
\end{Vmatrix}
\]

\[
\begin{vmatrix}
  r & s & t \\
u & v & w \\
x & y & z
\end{vmatrix}
\]

\[
\begin{vmatrix}
  r & s & t \\
u & v & w \\
x & y & z
\end{vmatrix}
\]

Each matrix is produced with the commands

\begin{xmatrix}
  r & s & t \\
u & v & w \\
x & y & z
\end{xmatrix}

where \texttt{xmatrix} is one of the 6 possibilities listed above. There is a separate macro for producing small matrices within a line of text, such as \(\alpha = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix}\). The environment here is the \texttt{smallmatrix} environment. Unlike the other matrix macros, \texttt{smallmatrix} does not produce any brackets, so these have to be added separately. Edit the file \texttt{omath.tex} to get a feel for producing more complex matrices like the first example at the beginning of this section.

2. Aligning Equations

Several \texttt{amsmath} extensions exist for aligning longer, more complex equations. Apart from the \texttt{align} environment, which is probably the most useful, there are several others, most notably the \texttt{multiline} environment. The format of \texttt{multiline} is simple: the first line is left justified, the last is right justified, and all others are centered. Line breaks occur only when forced by the user with the \texttt{\\} command. The commands \texttt{\shoveleft{}}, and \texttt{\shoveright{}}, which both take a formula as their argument, can be used to left or right justify an individual line. Using the \texttt{multiline} environment, we can produce things like
(1) \[ \sum_{m=1}^{\infty} \frac{c_m}{m^\nu} \left\{ \cos(mx - \frac{1}{2} \nu \pi - \frac{1}{3} \pi - \eta_m) - \frac{4\nu^2 - 1}{8mx} \sin(mx - \frac{1}{2} \nu \pi - \frac{1}{3} \pi - \eta_m) \right\} + b_m \left( \frac{1}{m^\nu} \frac{(\frac{1}{2}mx)^{\nu-1}}{\Gamma(\nu + \frac{1}{2})} \right) \]

and

(2) \[ \sum_{m,n=0}^{\infty} e^{-a^m b^nx} = \frac{\log^2 x}{2 \log a \log b} + \log x \left( \frac{\gamma}{\log a \log b} - \frac{1}{2 \log a} - \frac{1}{2 \log b} \right) + \frac{1}{12} \left( \frac{\log a}{\log b} + \frac{\log a}{\log b} + \frac{\pi^2 + 6\gamma^2}{\log a \log b} \right) - \frac{\gamma}{2} \left( \frac{1}{\log a} + \frac{1}{\log b} \right) + \frac{1}{4} \]

\[ + \sum_{n=1}^{\infty} \frac{(-1)^n}{n!(a^n - 1)(b^n - 1)} + \frac{1}{\log a} \sum_{n=-\infty}^{\infty} \frac{\Gamma\left(-\frac{2n\pi i}{\log a}\right) x^{2n\pi i/\log a}}{1 - b^{2n\pi i/\log a}} \]

\[ + \frac{1}{\log b} \sum_{n=-\infty}^{\infty} \frac{\Gamma\left(-\frac{2n\pi i}{\log b}\right) x^{2n\pi i/\log b}}{1 - a^{2n\pi i/\log b}}. \]

The code for both of the above formulae appears in \texttt{omath.tex}.

Certainly, \LaTeX{} has many other specialized capabilities. Consult one of the references for further help.