LaTeX Seminar: Other Math

1. Matrices

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

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

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

$$\begin{matrix} r & s & t \\ u & v & w \\ x & y & z \end{matrix} \qquad \begin{pmatrix} r & s & t \\ u & v & w \\ x & y & z \end{pmatrix} \qquad \begin{bmatrix} r & s & t \\ u & v & w \\ x & y & z \end{bmatrix}$$

$$\begin{Bmatrix} r & s & t \\ u & v & w \\ x & y & z \end{Bmatrix} \qquad \begin{vmatrix} r & s & t \\ u & v & w \\ x & y & z \end{vmatrix} \qquad \begin{Vmatrix} r & s & t \\ u & v & w \\ x & y & z \end{Vmatrix}.$$

each matrix is produced with the commands

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

where `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 $\alpha = \left(\begin{smallmatrix} 1 & 1 \\ 0 & 1 \end{smallmatrix}\right)$. The environment here is the `smallmatrix` environment. Unlike the other matrix macros, `smallmatrix` does not produce any brackets, so these have to be added separately. Edit the file `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 *amsmath* extensions exist for aligning longer, more complex equations. Apart from the `align` environment, which is probably the most useful, there are several others, most notably the `multline` environment. The format of `multline` 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 `\\` command. The commands `\shoveleft{},` and `\shoveright{},` which both take a formula as their argument, can be used to left or right justify an individual line. Using the `multline` environment, we can produce things like

$$(1)\quad \sum_{m=1}^{\infty}\frac{c_m}{m^{\nu}}\sqrt{\left(\frac{2}{m\pi x}\right)}\Bigg\{\cos(mx-\tfrac{1}{2}\nu\pi-\tfrac{1}{4}\pi-\eta_m) - \frac{4\nu^2-1}{8mx}\sin(mx-\tfrac{1}{2}\nu\pi-\tfrac{1}{4}\pi-\eta_m)\Bigg\}+\frac{b_m}{m^{\nu}}\frac{(\frac{1}{2}mx)^{\nu-1}}{\Gamma(\nu+\frac{1}{2})\Gamma(\frac{1}{2})}$$

and

$$\begin{aligned}(2)\quad \sum_{m,n=0}^{\infty}e^{-a^n b^m x} &= \frac{\log^2 x}{2\log a\log b}+\log x\left(\frac{\gamma}{\log a\log b}-\frac{1}{2\log a}-\frac{1}{2\log b}\right)\\ &\quad+\frac{1}{12}\left(\frac{\log a}{\log b}+\frac{\log a}{\log b}+\frac{\pi^2+6\gamma^2}{\log a\log b}\right)-\frac{\gamma}{2}\left(\frac{1}{\log a}+\frac{1}{\log b}\right)+\frac{1}{4}\\ &\quad+\sum_{n=1}^{\infty}\frac{(-1)^n}{n!(a^n-1)(b^n-1)}+\frac{1}{\log a}\sum_{\substack{n=-\infty\\ n\neq 0}}^{\infty}\frac{\Gamma\left(-\frac{2n\pi i}{\log a}\right)x^{2n\pi i/\log a}}{1-b^{2n\pi i/\log a}}\\ &\quad+\frac{1}{\log b}\sum_{\substack{n=-\infty\\ n\neq 0}}^{\infty}\frac{\Gamma\left(-\frac{2n\pi i}{\log b}\right)x^{2n\pi i/\log b}}{1-a^{2n\pi i/\log b}}.\end{aligned}$$

The code for both of the above formulae appears in `omath.tex`.

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