CAMTEX

INSTRUCTIONAL REFERENCE

Workshop 2

CAMTEX Workshop 2 — Instructional Reference

1 Maths

1.1 Maths Packages

There are a number of very useful maths packages. A main one is `mathtools` or `amsmath` (the former being a superset of the latter), but others may also be imported as necessary.

1.2 The Basic Maths Environments

There are two main inserted maths in LaTeX: **inline** math, and **display** math.

Inline math is inserted by single dollar signs: `$math code here$`. This prints mathematical expressions in the paragraph such as $\sum n = \frac{1}{2}N(N+1)$. Most inline math will not mess up the spacing above and below that line, but some cases will.

Display math can be indicated by double dollar signs: `$$math code here$$`. Some people also use `\[math code here\]`. This puts the expression on a new centered line like so,

$$\sum_1^N n = \frac{N(N+1)}{2},$$

splitting the paragraph at that point. This does not automatically insert paragraph breaks—note the lack of indentation after the math. Inserting double line breaks before and after the `$$math$$` in the source *does* insert paragraph breaks and will make everything awful.

$$\sum_1^N n = \frac{N(N+1)}{2},$$

There are double line (paragraph) breaks before and after the math above. Notice the indent (due to the break after) and the too-close spacing to the math above (due to the break before).

1.3 Basic Mathematical Commands and Examples

Source	Output (inline)	Output (display)
`a^2+b`	a^2+b	$\displaystyle a^2+b$
`a^{2+b}`	a^{2+b}	$\displaystyle a^{2+b}$
`\frac 1 2`	$\frac 1 2$	$\displaystyle \frac 1 2$
`(\frac{a+2}{b+3})^2`	$(\frac{a+2}{b+3})^2$	$\displaystyle (\frac{a+2}{b+3})^2$
`\left( \frac{a+2}{b+3}^2 \right)`	$\left(\frac{a+2}{b+3} \right)^2$	$\displaystyle \left(\frac{a+2}{b+3} \right)^2$
`\sqrt{-1}`	$\sqrt{-1}$	$\displaystyle \sqrt{-1}$
`\sqrt[3]{\frac{1-x}{x+1}}`	$\sqrt[3]{\frac{1-x}{x+1}}$	$\displaystyle \sqrt[3]{\frac{1-x}{x+1}}$
`\sum_{1}^{\infty} f(x)`	$\sum_{1}^{\infty} f(x)$	$\displaystyle \sum_{1}^{\infty} f(x)$
`\int_{a+b}^{\infty} f(x) \, \mathrm{d}x`	$\int_{a+b}^{\infty} f(x) \, \mathrm{d}x$	$\displaystyle \int_{a+b}^{\infty} f(x) \, \mathrm{d}x$
`\sin{2x} + \cos{2x}`	$\sin{2x} + \cos{2x}$	$\displaystyle \sin{2x} + \cos{2x}$

Table 1: Examples of some mathematical commands.

Some general tips:

- Use `\left(` and `\right)` to create brackets that properly scale to the enclosing content and raise/lower superscripts/subscripts to the correct height. The symbols for `\left` and `right` don't have to match, and can even be *nothing*, by using a period (e.g. `\left.`). This lets you do things like:

  `\left. \frac{\mathrm{d}y}{\mathrm{d}x} \right|_{x=0}` $\implies$ $\left. \frac{\mathrm{d}y}{\mathrm{d}x} \right|_{x=0}$

- Non-italicised text can be created using `\mathrm{}` or `\text{}`. Check your department style guide if there is one, but it's not uncommon to do this for differential operators ($\frac{\mathrm{d}x}{\mathrm{d}y}$, $\int \mathrm{d}x$), and for dimensionless groups ($\mathrm{Re} = \frac{\rho u d}{\mu}$). Certain operators/functions such as sin and cos have existing commands `\sin{2x}` $\implies \sin{2x}$, so you don't have to `\textrm{sin}`.
- Mathematical symbols typically have commands to generate them. Greek letters are simply `\lettername` and `\Lettername` for lowercase and uppercase (e.g. `\rho`, `\Rho`), for example. Watch out for `\epsilon` (ϵ) versus `\varepsilon` (ε). A reference list can be found here.

1.4 More Advanced Environments

The `equation` environment numbers the expression as an equation, which can be labeled and referenced later on (see Workshop 3).

$$\sum_1^N n = \frac{N(N+1)}{2} \tag{1}$$

```
\begin{equation}
    \sum_1^N n = \frac{N(N+1)}{2}
\end{equation}
```

The `align*` lets you align many lines of math by preceding the symbol to be aligned with `&`:

$$\begin{aligned} 5! &= 5 \times 4 \times 3 \times 2 \times 1 \\ &= 20 \times 6 \\ &= 120 \end{aligned}$$

```
\begin{align*}
    5! &= 5  \times 4 \times 3 \times 2 \times 1 \\
       &= 20 \times 6                             \\
       &= 120
\end{align*}
```

The `align` environment (of which `align*` is a variant) of is numbered by default, which is why it is less used. If you only want specific lines numbered, use `align` and suppress the numbering of unwanted lines with `\nonumber`.

$$\begin{aligned} 5! &= 5 \times 4 \times 3 \times 2 \times 1 && (2) \\ &= 20 \times 6 \\ &= 120 \\ &= 5! && (3) \end{aligned}$$

```
\begin{align}
    5! &= 5  \times 4 \times 3 \times 2 \times 1 \\
       &= 20 \times 6                  \nonumber \\
       &= 120                          \nonumber \\
       &= 5!
\end{align}
```

The `array` environment, used within an existing math environment, creates a grid of math expressions. It is most useful for piecewise expressions when used with `\left` and `\right`.

$$f(x) = \left\{ \begin{array}{ll} x^2, & 0 \leq x < 5 \\ 10-x, & 5 \leq x < 10 \end{array} \right. \tag{4}$$

```
\begin{equation}
f(x) =
\left\{
\begin{array}{ll}
    x^2,  & 0 \leq x < 5  \\
    10-x, & 5 \leq x < 10 \\
\end{array}
\right.
\end{equation}
```

1.5 Matrices

`amsmath` provides a number of useful environments to create matrices.

$$\begin{matrix} a & b & c \\ d & e & f \end{matrix}$$

```
\begin{matrix}
    a & b & c \\
    d & e & f
\end{matrix}
```

$$\begin{pmatrix} a & b & c \\ d & e & f \end{pmatrix}$$

```
\begin{pmatrix}
    a & b & c \\
    d & e & f
\end{pmatrix}
```

$$\begin{bmatrix} a & b & c \\ d & e & f \end{bmatrix}$$

```
\begin{bmatrix}
    a & b & c \\
    d & e & f
\end{bmatrix}
```

$$\begin{vmatrix} \varepsilon_{xx} & \gamma_{xy} & \gamma_{xz} \\ \gamma_{xy} & \varepsilon_{yy} & \gamma_{yz} \\ \gamma_{zx} & \gamma_{yz} & \varepsilon_{zz} \end{vmatrix}$$

```
\begin{vmatrix}
    \varepsilon_{xx} & \gamma_{xy} & \gamma_{xz} \\
    \gamma_{xy} & \varepsilon_{yy} & \gamma_{yz} \\
    \gamma_{zx} & \gamma_{yz} & \varepsilon_{zz}
\end{vmatrix}
```

The & and \\ grid layout syntax is common in LaTeX, and is most notably used in tables. Some other matrix types can be found here. It is relatively easy to construct custom matrix brackets using the blank matrix environment and \left and \right:

$$\left\langle\begin{matrix} a & b & c \\ d & e & f \end{matrix}\right\rfloor$$

```
\left\langle
\begin{matrix}
    a & b & c \\
    d & e & f
\end{matrix}
\right\rfloor
```

For inline math, smaller equivalents are also provided via the smallmatrix environment (or by psmallmatrix, bsmallmatrix if you have the mathtools package): $\left(\begin{smallmatrix} a & b \\ c & d \end{smallmatrix}\right)$. Binomials can also be typeset with \binom{a}{b} $\implies \binom{a}{b}$.

1.6 Spacing

Sometimes you will want to specify exact spacings in math mode. LaTeX usually does a good job of this but you will occasionally have to add some commands to help it out.

Name	Command	Example
default space		$abc \to\leftarrow abc$
thin space	`\,`	$abc \to\,\leftarrow abc$
thin neg. space	`\!`	$abc \to\!\leftarrow abc$
medium space	`\:`	$abc \to\:\leftarrow abc$
large space	`\;`	$abc \to\;\leftarrow abc$
0.5em space	`\enspace`	$abc \to\enspace\leftarrow abc$
1em space	`\quad`	$abc \to\quad\leftarrow abc$
2em space	`\qquad`	$abc \to\qquad\leftarrow abc$
custom space	`\hspace{3em}`	$abc \to\hspace{3em}\leftarrow abc$
fill empty space	`\hfill`	$abc \to$ $\leftarrow abc$

Table 2: This table was created by https://texblog.org

2 Text Formatting

2.1 Lengths

LaTeX has a bunch of measurement units to help increase precision when editing documents. All of these units can specified under two-letter abbreviations. The point is the default unit.

Abbrev.	Definition	Value in points (pt)	in micrometers (µm)
pt	a point, $\frac{1}{72.27} \approx 0.0138$in	1	351.46
mm	a millimeter	$\frac{7227}{2540} \approx 2.84$	1000
cm	a centimeter	$\frac{7227}{254} \approx 28.4$	10000
in	an inch	72.27	25400
ex	the height of ‘x’ in current font	depends	depends
em	the width of an ‘M’ in current font	depends	depends
en	half width of an em (Width of ‘N’)	depends	depends
bp	a big point, $\frac{1}{72} \approx 0.0139$in	$\frac{803}{800} = 1.00375$	352.78
pc	a pica	12	4218
dd	a didot	$\frac{1238}{1157} \approx 1.070$	376
cc	a cicero (12 didots)	$\frac{14856}{1157} \approx 12.84$	4512
nd	a new didot	$\frac{685}{642} \approx 1.067$	375
nc	a new cicero (12 new didots)	$\frac{1370}{107} \approx 12.80$	4500
sp	a scaled point	$\frac{1}{65536} \approx 0.000015$	0.00536

2.2 vspace and hspace

As in math mode, sometimes you will also want to specify exact spacings in normal mode too. You can use `\vspace` and `\hspace` to specify vertical and horizontal spacings down to the pixel. See if you can spot these in the paragraphs below! As you can see, `\vspace` and `\hspace` can take negative inputs as well!

Lorem ipsum dolor sit amet, consectetur adipiscing elit, sed do eiusmod tempor incididunt ut labore et dolore magna aliqua. Duis aute irure dolor in reprehenderit in voluptate velit esse cillum dolore eu fugiat nulla pariatur.

Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo.

Ut enim ad minima veniam, quis nostrum exercitationem ullam corporis suscipit laboriosam, nisi ut aliquid ex ea commodi consequatur? quis in ea voluptate velit esse quam nihil molestiae consequatur, vel illum qui dolorem eum fugiat quo voluptas nulla pariatur?

2.3 Local Text Sizing

Sometimes you will want to temporarily change your text size. LaTeX has ten different text sizes to choose from and with these commands you are able to vary your text betweeen 20pt sizes!

Command	Output
\tiny{}	sample text
\scriptsize{}	sample text
\footnotesize{}	sample text
\small{}	sample text
\normalsize{}	sample text
\large{}	sample text
\Large{}	sample text
\LARGE{}	sample text
\huge{}	sample text
\Huge{}	sample text

3 Table Basics

This section will give an introduction to the basics of setting up tables and aligning characters within them

cell1	cell2	cell3
cell4	cell5	cell6
cell7	cell8	cell9

```
\begin{tabular}{ c c c }
    cell1 & cell2 & cell3 \\
    cell4 & cell5 & cell6 \\
    cell7 & cell8 & cell9
\end{tabular}
```

We can simply centre the table with the centre environment:

cell1	cell2	cell3
cell4	cell5	cell6
cell7	cell8	cell9

```
\begin{center}
\begin{tabular}{ c c c }
    cell1 & cell2 & cell3 \\
    cell4 & cell5 & cell6 \\
    cell7 & cell8 & cell9
\end{tabular}
\end{center}
```

3.1 Position Specifiers

In the previous example we have used the specifier c to show where the contents of each cell should fall. The c specifier previously used indicates centering. For a left or right justified column the letters l and r are used respectively.

For columns of text, it is more common and useful to use the p{‘width’} specifier, which is a top centred paragraph column of width specified within the command. It is also possible to use m and b (Still with width specification) for middle and bottom justified text though this requires the array package.

Vertical lines can also be placed in between the specifiers to give vertical lines in the table: {|c |c |c |}. The same applies to double vertical lines: {||c ||c ||c ||}

Bringing all of these together for an example:

cell1	cell2	cell3	cell4
cell5	cell6	cell7	cell8
cell9	cell10	cell11	cell12

```
\begin{tabular}{ c || l | r p{2em}|| }
    cell1 & cell2 & cell3 & cell4 \\
    cell5 & cell6 & cell7 & cell8 \\
    cell9 & cell10 & cell11 & cell12
\end{tabular}
```

3.2 Cell Separation

The number of specifiers given indicates the number of columns: for example { c c } gives a two column table

The `\hline` command allows for horizontal ruled lines to be input into the table

The specifier `&` separates a cell, whilst `\\` ends the line (as it would normally). Additional space may be specified after `\\` with square brackets (`\\[6pt]`).

Within paragraph columns, it is also possible to create line breaks within a cell. Outside a table this would be done with `\\`, but here that would create a new table line. We therefore use the command `\newline` to break text.

Finally, we can input partial lines only over certain columns (columns i to j), using the command: `\cline{i-j}`.

Bringing this together allows for more complete tables:

cell1	cell2	cell3	cell4
cell5	cell6	cell7	cell8 Ooh more text
cell9	cell10	cell11	cell12
cell13	cell 14	cell 15	cell 16 Did you see those partial lines!!

```
\begin{tabular}{||c||r|l|p{5em}||}
\hline
\hline\\
\cline{1-3}\\
\hline
\hline
cell1 & cell2 & cell3 & cell4 \\
\hline
cell5 & cell6 & cell7 & cell8
\newline Ooh more text \\
\hline
\hline
cell9 & cell10 & cell11 & cell12 \\
\cline{2-4}
cell13 & cell 14 & cell 15 & cell 16
\newline
Did you see those partial lines!! \\
\hline
\end{tabular}
```

3.3 Booktabs

The `booktabs` package is extremely simple: it introduces `toprule`, `bottomrule` and `midrule`, which may be used in place of `hline` at the top, bottom and anywhere else respectively. `booktabs` rules are not meant to be used with vertical rules.

h1	h2	h3
1.23	3.56	1.12
2.21	6.22	8.11
6.20	1.52	1.84

```
\begin{tabular}{ccc}
    \toprule
    h1 & h2 & h3 \\
    \midrule
    1.23 & 3.56 & 1.12 \\
    2.21 & 6.22 & 8.11 \\
    6.20 & 1.52 & 1.84 \\
    \bottomrule
\end{tabular}
```

3.4 Merging Columns and Rows

Rows and columns can be combined in a bigger cell. This is done using the `\multicolumn{}{}{}` and `\multirow{}{}{}` commands. The `\multirow{}{}{}` command requires the use of the package multirow (`\usepackage{multirow}`):

Some Filler Content			
Capital	Lower Case	Greek Lower Case	Number
A	a	α	1
B	b	β	2
C	c	γ	3

```
\begin{tabular}{ |p{3cm}||p{3cm}|p{3cm}|p{3cm}| }
 \hline
 \multicolumn{4}{|c|}{Some Filler Content} \\
 \hline
 Capital & Lower Case &  Greek Lower Case & Number\\
 \hline
 A & a & $\alpha$ & 1\\
 B & b & $\beta$ & 2 \\
 C & c & $\gamma$ & 3 \\
 \hline
\end{tabular}
```

Column 1	Column 2	Column 3
Multiple row cell	cell2	cell3
	cell5	cell6
	cell8	cell9

```
\begin{center}
\begin{tabular}{ |c|c|c|c| }
\hline
Column 1 & Column 2 & Column 3 \\
\hline
\multirow{3}{4em}{Multiple row cell}
& cell2 & cell3 \\
& cell5 & cell6 \\
& cell8 & cell9 \\
\hline
\end{tabular}
\end{center}
```

Note the importance of the & specifier in place of column 1 even when no further content is entered.