ISGS LaTeX Beginner's Workshop 2016

Session 2 – Math

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1. Recap of Session 1

– Exercise Sheet –

Time for a Break

– 5 Minutes –

2. Math Mode

Inline Mode

Inline Mode

`$ ... $`

- Mode for quick typing of small formulas
- Can change the line height

Inline Mode

Inline Mode

`$ ... $`

- Mode for quick typing of small formulas
- Can change the line height

Good Use

The relation between the three sides a, b, c of a right-angled triangle ($a^2 + b^2 = c^2$) was discovered by the Greek mathematician Pythagoras.

Inline Mode – Bad Use

Bad Use

For a very big natural number n the quotient $\frac{1}{n}$ becomes very small. We often write $\lim_{n\to\infty} \frac{1}{n} = 0$ to express this in a very mathematical fashion. Unfortunately, the text looks very crowded when overly complex formulas are set using inline mode. Also, the line height is not uniform.

Equation Environment

Quick Equation (not numbered)

```
\[ a^2+b^2=c^2 \]  $$ a^2+b^2=c^2 $$
```

$$a^2 + b^2 = c^2$$

Equation Environment

Quick Equation (not numbered)

```
\[ a^2+b^2=c^2 \]  $$ a^2+b^2=c^2 $$
```

$$a^2 + b^2 = c^2$$

Equation

```
\begin{equation} ... \end{equation}
```

$$a^2 + b^2 = c^2 \tag{1}$$

Equation Environment – Example

Example

For a very big natural number n the quotient $\frac{1}{n}$ becomes very small. We often write

$$\lim_{n \to \infty} \frac{1}{n} = 0$$

to express this in a very mathematical fashion. Note how nice and much more professional this looks.

Referencing Equations

```
\begin{equation}
  \label{eq:pythagoras}
  a^2+b^2=c^2
\end{equation}
```

$$a^2 + b^2 = c^2 \tag{2}$$

- `\ref{eq:pythagoras}` = 2
- `\eqref{eq:pythagoras}` = (2)

3. Math Symbols

Greek Letters

$\alpha\ \beta\ \gamma\ldots$ `\alpha \beta \gamma...`

$\Gamma\ \Delta\ \Theta\ldots$ `\Gamma \Delta \Theta...`

Greek Letters

$\alpha\ \beta\ \gamma\ldots$	`\alpha \beta \gamma...`
$\Gamma\ \Delta\ \Theta\ldots$	`\Gamma \Delta \Theta...`

$\epsilon\ \varepsilon$	`\epsilon`	`\varepsilon`
$\theta\ \vartheta$	`\theta`	`\vartheta`
$\pi\ \varpi$	`\pi`	`\varpi`
$\rho\ \varrho$	`\rho`	`\varrho`
$\sigma\ \varsigma$	`\sigma`	`\varsigma`
$\phi\ \varphi$	`\phi`	`\varphi`

Note

Greek letters which look exactly like Latin letters have no special command.

Useful Symbols

$\cdot$ `\cdot`

$\times$ `\times`

$\pm$ $\mp$ `\pm \mp`

Useful Symbols

$\cdot$	`\cdot`
$\times$	`\times`
$\pm \mp$	`\pm \mp`
$\leq \geq \neq \approx$	`\leq \geq \neq \approx`
$\subset \subseteq \in$	`\subset \subseteq \in`
$\supset \supseteq \ni$	`\supset \supseteq \ni`

Useful Symbols

$\cdot$	`\cdot`
$\times$	`\times`
$\pm \mp$	`\pm \mp`
$\leq \geq \neq \approx$	`\leq \geq \neq \approx`
$\subset \subseteq \in$	`\subset \subseteq \in`
$\supset \supseteq \ni$	`\supset \supseteq \ni`
$\Leftarrow \rightarrow$	`\Leftarrow \rightarrow`
∞	`\infty`

Useful Symbols

$\mathbb{R}\ \mathbb{C}$	`\mathbb{R} \mathbb{C}`
$\mathcal{O}(n)$	`\mathcal{O}(n)`
$\Theta(n)$	`\Theta(n)`
$\Omega(n)$	`\Omega(n)`

Math Accents

$\hat{a}\ \bar{a}\ \tilde{a}$ `\hat{a} \bar{a} \tilde{a}`

$\dot{a}\ \ddot{a}\ \vec{a}$ `\dot{a} \ddot{a} \vec{a}`

Math Accents

$\hat{a}$ $\bar{a}$ $\tilde{a}$ `\hat{a}` `\bar{a}` `\tilde{a}`

$\dot{a}$ $\ddot{a}$ $\vec{a}$ `\dot{a}` `\ddot{a}` `\vec{a}`

Dotted Letters

The letters *i* and *j* are available in a dot-less version `\imath` = $\imath$ and `\jmath` = $\jmath$.

$\vec{\imath}$ looks nicer than $\vec{i}$.

Indices & Exponents

Index

```
x_{n}
```

x_n

Exponent

```
x^{a}
```

x^a

Indices & Exponents

Combined

```
x^{a}_{n} = x_{n}^{a}
```

$$x^{a}_{n} = x_{n}^{a}$$

Indices & Exponents

Combined

```
x^{a}_{n} = x_{n}^{a}
```

$$x^{a}_{n} = x_{n}^{a}$$

Nested

```
x^{a_n} \neq x_{n^a}
```

$$x^{a_n} \neq x_{n^a}$$

In Front

```
^{14}_{2}{He}
```

$$^{14}_{2}He$$

Fractions

Simple Fraction

```
\frac{1}{n}
```

$$\frac{1}{n}$$

The size of a formula depends on the mode you are in, you get $\frac{1}{n}$ in inline mode

Fractions

Simple Fraction

```
\frac{1}{n}
```

$$\frac{1}{n}$$

The size of a formula depends on the mode you are in, you get $\frac{1}{n}$ in inline mode

Nested Fraction

```
\frac{a}{b + \frac{c}{d} }
```

$$\frac{a}{b + \frac{c}{d}}$$

Roots

```
\sqrt{x+y} = \sqrt{x+y}
```

$$\sqrt{x+y} = \sqrt{x+y}$$

```
\sqrt[2]{x+y} = \sqrt{x+y}
```

$$\sqrt[2]{x+y} = \sqrt{x+y}$$

```
\sqrt[3]{x+y} = \sqrt{x+y}
```

$$\sqrt[3]{x+y} = \sqrt{x+y}$$

Operators I

Basic

```
\sin \cos \tan \ln \log \lim
```

$$\sin \quad \cos \quad \tan \quad \ln \quad \log \quad \lim$$

Sum, etc.

```
\sum \prod \int \iint \oint
```

$$\sum \quad \prod \quad \int \quad \iint \quad \oint$$

Operators II

Limits

```
\sum_{n=0}^{N} {a_{n} }
\int_{0}^{2} {x^{2} dx}
\int \limits_{0}^{2} {x^{2} dx}
```

$$\sum_{n=0}^{N} a_n \qquad \int_0^2 x^2 dx \qquad \int\limits_0^2 x^2 dx$$

Braces I

Normal Braces

```
a_n = (\frac{1}{n})
```

$$a_n = (\frac{1}{n})$$

Braces I

Normal Braces

```
a_n = (\frac{1}{n})
```

$$a_n = (\frac{1}{n})$$

Automatic Size

```
a_n = \left( \frac{1}{n} \right)
```

$$a_n = \left(\frac{1}{n} \right)$$

Braces II

More examples:

```
x \in \left] \frac{1}{n} ; n \right] = ...
```

$$x \in \left]\frac{1}{n}; n\right] = \left(\frac{1}{n}; n\right]$$

An error is reported when number of `\left` and `\right` braces does not match.

Overbrace & Underbrace

Underbrace

```
\underbrace{1+2+3+\cdots+n}_{abc}
```

$$\underbrace{1+2+3+\cdots+n}_{abc}$$

Overbrace & Underbrace

Underbrace

```
\underbrace{1+2+3+\cdots+n}_{abc}
```

$$\underbrace{1+2+3+\cdots+n}_{abc}$$

Overbrace

```
= \over{1+2+3+\cdots+n}_{abc}
```

$$= \overbrace{1+2+3+\cdots+n}^{abc}$$

Time for a Break

– 5 Minutes –

4. Advanced Math Environments

AMS Math Package

LaTeX math extensions from the American Mathematical Society.

- Include `\usepackage{amsmath}` into the preamble
- Additional symbols
- New environments for equation spanning multiple lines and for equation alignment
- Some handy commands for vectors and matrices

Equation/Split

```
\begin{equation}
  \begin{split}
  a = & b + c \\ & + d + f
  \end{split}
\end{equation}
```

$$\begin{aligned} a =& b + c \\ &+ d + f \end{aligned} \tag{3}$$

- Alignment is done using &
- You always get only one equation number (centered vertically)

Matrices

```
\begin{equation}
  \begin{pmatrix}
    a & b & c \\ d & e & f \\ g & h & i
  \end{pmatrix}
\end{equation}
```

$$\begin{pmatrix} a & b & c \\ d & e & f \\ g & h & i \end{pmatrix} \tag{4}$$

Other delimiter styles: `bmatrix`: $\begin{bmatrix} \end{bmatrix}$
`Bmatrix`: $\begin{Bmatrix} \end{Bmatrix}$
`vmatrix`: $\begin{vmatrix} \end{vmatrix}$
`Vmatrix`: $\begin{Vmatrix} \end{Vmatrix}$

Multline

```
\begin{multline}
  a = b+c+d+e\\+f+g+h+k+l\\+m\\+n+o+p+q+r+s
\end{multline}
```

$$a = b + c + d + e \\ + f + g + h + k + l \\ + m \\ + n + o + p + q + r + s \quad (5)$$

- First line is aligned left, last line is aligned right
- Equation number in the last line

Gather

```
\begin{gather}
  a = b+c\\ d = e+f+g+h \\
  g=h+i \notag \\ j+k=l
\end{gather}
```

$$a = b + c \tag{6}$$

$$d = e + f + g + h \tag{7}$$

$$g = h + i$$

$$j + k = l \tag{8}$$

- Just a simple collection of equations
- `\notag` command skips numbering

Align

```
\begin{align}
  a   &= b+c & d     &= e+f+g+h \notag \\
  j+k&=l     & z+y =& x
\end{align}
```

$$a = b + c \qquad d = e + f + g + h$$
$$j + k = l \qquad z + y = x \tag{9}$$

- The & symbol serves as both alignment marker and column separator

Text in Equations

Writing text in an equation using `\text{...}`:

```
$$
  \text{If } a<b
  \text{ and } b<c
  \text{ then } a<c
$$
```

$$\text{If } a<b \text{ and } b<c \text{ then } a<c$$

Note

You have to take care of the spaces!

5. Theorems

Theorems & Definitions

Package

```
\usepackage{amsthm}
```

Scheme for usage

```
\newtheorem{<name>}{<output>}
```

Theorems & Definitions

Example

```
% in preamble
\usepackage{amsthm}
\newtheorem{mydefinition}{Definition}

% in text
\begin{mydefinition}
   This is a definition.
\end{mydefinition}
```

Result

Definition

This is a definition.