LaTeX: Online module 8

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September 2, 2011

Topics to be covered

- Spacing
- Mathematical typeface
- Alignment
- Labels and references
- Examples and exercises

Spacing

Following are the spacing rules used in equations:

```
\! - negative thin space
\, - thin space
\: - medium space
\; - thick space
\quad- extra space
\qquad- doubled extra space
```

Example

Simple example:

```
\begin{eqnarray}
f(x) = a\!b
f(x) = a\,b
f(x) = a\:b
f(x) = a\;b
f(x) = a\quad b
f(x) = a\qquad b
\end{eqnarray}
```

Note: Observe that there is a space between the commands quad and variable b; qquad and variable b. If there is no white space between the command and variable, then LaTeX takes quadb or qquadb as a command and throws an error.

contd...

Output of previous slide is:

$$f(x) = ab,$$
$$f(x) = a\,b,$$
$$f(x) = a\,b,$$
$$f(x) = a\ b,$$
$$f(x) = a \quad b$$
$$f(x) = a \qquad b$$

Fonts in equations

Several mathematical fonts are listed below:

```
\mathnormal: Normal typeface
\mathcal: Calligraphic
\mathbf: Bold
\mathit: Italics
\mathtt: Typewriter type
\mathrm: Roman typeface
\mathsf: Sans serif
```

Typeface in equations

Simple example:

```
Normal: $f(x)+g(x)=\mathnormal{h(x)}$
Calligraphic: $\mathcal{Z}$
Bold: $\mathbf{F}=(f(x),g(x),h(x))$
Italic: $F(x)+\mathit{G(x)}=H(x)$
Typewriter:$H(x)=f(\mathtt{g}(x))$
Roman: $\mathrm{x+y+z}$
Sans serif: $\mathsf{f(x)}^2$
```

contd...

$$
\begin{aligned}
f(x) + g(x) &= h(x) \\
\mathcal{N} & \\
\mathbf{F} &= (f(x), g(x), h(x)) \\
F(x) + G(x) &= H(x) \\
H(x) &= f(\mathrm{g}(x)) \\
\mathrm{x} + \mathrm{y} + \mathrm{z} &= 1 \\
\mathrm{f}(\mathrm{x})\mathrm{g}(\mathrm{x}) &= F(x)
\end{aligned}
$$

contd...

- We denote fractions, integers, natural numbers, real numbers, complex numbers, etc by their symbols
- amssymb and amsmath packages are developed by the American Mathematical Society (AMS)
- These packages have more mathematical symbols and typeface changing commands

Input:

```
$\mathbb{N}$, $\mathbb{Z}$, $\mathbb{R}$, $\mathbb{C}$
```

Output: $\mathbb{N}$, $\mathbb{Z}$, $\mathbb{R}$, $\mathbb{C}$

Alignment of equations

- We can align a set of equations with ampersand symbol
- Every equation is separated by a double back slash (\\)

Input:

```
\begin{eqnarray}
f(x)+g(x) &=& \mathnormal{h(x)} \nonumber \\
\mathbf{F} &=& (f(x),g(x),h(x))\nonumber \\
F(x)+\mathit{G(x)} &=& H(x) \nonumber \\
\mathrm{x+y+z} &=& 1\nonumber \\
\mathsf{f(x)g(x)} &=&  F(x) \nonumber
\end{eqnarray}
```

contd...

Command \nonumber suppresses numbering equations,

$$
\begin{aligned}
f(x) + g(x) &= h(x) \\
\mathbf{F} &= (f(x), g(x), h(x)) \\
F(x) + G(x) &= H(x) \\
\mathrm{x} + \mathrm{y} + \mathrm{z} &= 1 \\
\mathrm{f(x)g(x)} &= F(x)
\end{aligned}
$$

contd...

Following environment is used if you want to suppress numbering equations:

```
\begin{align*}
⋮
\end{align*}
```

or,

```
\begin{eqnarray*}
⋮
\end{eqnarray*}
```

contd...

Recall from module 7- alignment can be done as displayed below
Code 1: Single ampersand is used

```
\begin{align*}
x &= y + z \\
a + b &= \alpha^{2} \\
x^{2} + y^{2} &= \frac{\alpha}{\beta}
\end{align*}
```

Code 2: Double ampersands is used

```
\begin{eqnarray*}
x &=& y + z \\
a + b &=& \alpha^{2} \\
x^{2} + y^{2} &=& \frac{\alpha}{\beta}\end{eqnarray*}
```

contd...

Observe the difference in output between code 1 and code 2 of the previous slide.
Code1:

$$a + b = \alpha^2$$
$$x = y + z$$
$$x^2 + y^2 = \frac{\alpha}{\beta}$$

Code 2:

$$\begin{aligned} a + b &= \alpha^2 \\ x &= y + z \\ x^2 + y^2 &= \frac{\alpha}{\beta} \end{aligned}$$

Alignment- two sets of equations

If you want two sets of equations side by side, use the following environment:

```
\begin{alignat*}{2}
f(x) &= 2x;  &\qquad g(y)&= y^2 \\
f(x) &= x^2;  &\qquad g(y)&= y \\
f(x) &= 2;  &\qquad g(y)&=  y^2+y
\end{alignat*}
```

(Number 2 in the above code denotes two columns of equations)

contd...

Output from the previous slide:

$$f(x) = 2x; \qquad g(y) = y^2$$
$$f(x) = x^2; \qquad g(y) = y$$
$$f(x) = 2; \qquad g(y) = y^2 + y$$

Continued fractions

Following environment is used to type continued fractions, say Euler's continued fraction.

1. Without \displaystyle command:

```
\begin{equation*}
F(x) = \frac{x}{e + \frac{x}{e + \frac{x}{e + x}}}
\end{equation*}
```

2. With \displaystyle command:

```
\begin{equation*}
 F(x) = \frac{x}{\displaystyle e+ \frac{x}{\displaystyle
           e + \frac{x}{\displaystyle e+x}}}
\end{equation*}
```

Continued fractions

Output of previous slide for both scenarios:

$$F(x) = \cfrac{x}{e + \cfrac{x}{e + \cfrac{x}{e+x}}}$$

and,

$$F(x) = \cfrac{x}{e + \cfrac{x}{e + \cfrac{x}{e + x}}}$$

Boxed equations

If you want important equations to be displayed within a box, use the following environment:

```
\begin{equation*}
\boxed{x+y=z}
\end{equation*}
```

Output:

$$\boxed{x + y = z}$$

Refer an equation

- One can always refer to any equation later in the document by its equation number
- Use the command \label{*labelname*} to label an equation
- Use the command \eqref{*labelname*} to refer

```
\begin{equation} \label{sample equation}
Z = x+y
\end{equation}

Using \eqref{sample equation} we obtain the following
set of equations.
```

contd...

Output of previous slide:

1. Here is a sample equation, which we refer later in the document:

$$Z = x + y \tag{1}$$

2. Refer to an equation: Using (1) we obtain the following set of equations
3. Remember to run your LaTeX file twice for the equation number to appear in your sentence (question mark symbols will appear in the place of equation number if you run the file only once)

Refer to set of equations

- Labels can be included into a set of equations

```
\begin{eqnarray}
Z &=& x+y \label{sample equation1} \\
A^2 &=& B^2 + C^2 \label{sample equation2} \\
f(x)+g(A) &=& h(x) \label{sample equation3}
\end{eqnarray}
```

Input: Here is a sample sentence

```
Substitute equations \eqref{sample equation1} and
 \eqref{sample equation2} in
\eqref{sample equation3} to obtain the following....
```

contd...

Output of set of equations from previous slide:

$$Z = x + y \tag{2}$$
$$A^2 = B^2 + C^2 \tag{3}$$
$$f(x) + g(x) = h(x) \tag{4}$$

Output of sample sentence from previous slide:
Substitute equations (2) and (3) in equation (4) to obtain the following result....
(Observe the alignment of equations)

Sub equations

- Sub equations can be included in the equation environment in the following way:

```
\begin{subequations}\label{sample sub equation}
\begin{eqnarray}
Z &=& x+y  \\
A^2 &=& B^2 + C^2  \\
f(x)+g(A) &=& h(x)
\end{eqnarray}
\end{subequations}
```

contd...

- Sub equations can be included in the equation environment in the following way:

$$
\begin{aligned}
Z &= x + y && \text{(5a)} \\
A^2 &= B^2 + C^2 && \text{(5b)} \\
f(x) + g(A) &= h(x) && \text{(5c)}
\end{aligned}
$$

Common functions

1. Input:

   ```
   \arg, \deg, \exp, \log, \inf, \sup, \lim, \liminf,
    \limsup
   ```

   Output: $\arg, \deg, \exp, \log, \inf, \sup, \lim, \liminf, \limsup$

2. Input:

   ```
   $\inf_x, \sup_y, \liminf_x, \limsup_y,\gcd_x$
   ```

   Output: $\inf_x, \sup_y, \liminf_x, \limsup_y, \gcd_x$

Arrow operators

1. Input:

```
$A \rightarrow B, A \leftarrow B$
$A \Rightarrow B, A \Leftarrow B$
$A \Leftrightarrow B, A \nrightarrow B$
$A \nleftarrow B, A \nRightarrow B$
$A \nLeftarrow B, A \nLeftrightarrow B$.
```

2. Output:

$A \rightarrow B, A \leftarrow B,$
$A \Rightarrow B, A \Leftarrow B,$
$A \Leftrightarrow B, A \nrightarrow B,$
$A \nleftarrow B, A \nRightarrow B,$
$A \nLeftarrow B, A \nLeftrightarrow B.$

contd...

1. Input:

```
\begin{eqnarray*}
A &\xrightarrow{\lambda}& B  \\
A &\xrightarrow{\alpha}& C \\
B &\xrightarrow{\zeta}& D
\end{eqnarray*}
```

2. Output:

$$
\begin{aligned}
A &\xrightarrow{\lambda} B \\
B &\xrightarrow{\alpha} C \\
C &\xrightarrow{\zeta} D
\end{aligned}
$$

Exercises

Try to reproduce the following equations:

1. Simple equation:

$$ax^2 + bx + c = 0 \tag{6}$$

2. Set of equations with alignment

$$x = \sqrt{x + \frac{y}{2}} \tag{7}$$

$$y + z = a^2 + 1 \tag{8}$$

3. Boxed equation:

$$\boxed{ax^2 + bx + c = 0} \tag{9}$$

contd...

1. Continued fraction:

$$F(x) = \cfrac{\exp(x)}{\tan(x) + \cfrac{\exp(x)}{\tan(x) + \cfrac{\exp(x)}{\tan(x) + \exp(x)}}} \tag{10}$$

2. Label all the equations in exercises and refer to them. Try to generate the following output:
   Solving set of equations (6), (8), (10) and substituting into equations (7), (9), we obtain the following.....

contd...

Generate set of sub equations:

$$f(x) = \sqrt[n]{x+y}; \qquad g(y) = \exp(y) \tag{11a}$$

$$f(x) = \frac{1+\frac{1}{x}}{1+y}; \qquad g(y) = \log(y) \tag{11b}$$

$$f(x) = 0; \qquad g(y) = \cos(y) \tag{11c}$$