

# Elegant Mathematics

S Rahulkrishnan



# Elegant Mathematics

S Rahulkrishnan

(English: Tech. notes)

© 2020, Sayahna Foundation

These electronic versions are released under the provisions of [Creative Commons Attribution Non-commercial No-derives Share Alike](#) license for free download and usage.

The electronic versions were generated from sources marked up in [L<sup>A</sup>T<sub>E</sub>X](#) after incorporating all the sketches provided by the author, in a computer running GNU/LINUX operating system. PDF was typeset using [X<sub>Y</sub>L<sup>A</sup>T<sub>E</sub>X](#) from [T<sub>E</sub>XLive](#) 2020. The base font used is Cormarant Garamond Medium at 10 pt.

Cover: Zen art by Ayisha Sasidharan specially for Sayahna.

[Sayahna Foundation](#)

JWRA 34, Jagathy, Trivandrum, India 695014

URL: [www.sayahna.org](http://www.sayahna.org)

# Typeset Mathematics elegantly and easily using L<sup>A</sup>T<sub>E</sub>X

Simply, an equality is an equation. This equation contains different components, variables, operators, subscript, superscript, fractions, roots, symbols etc. All of these can be easily and precisely typeset using L<sup>A</sup>T<sub>E</sub>X.

## Key points

- We are discussing about the main features and usage of `amsmath` package.
- Equations can be divided into two, in-line and displayed equations. In-line equations are those mentioned inside text area and displayed equation were mentioned outside text and begins in new line.
- Equation in between two dollar (\$) sign will typeset in-line equations.

ie., To typeset “Adding two variables  $x + y$  to get  $z$ .”, the code is

```
Adding two variable $x+y$
to get $z$.
```

- Displayed equation can be again classified into two, numbered and unnumbered equations.

### Numbered equation

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad (1)$$

#### Syntax:

```
\begin{equation}
x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}
\end{equation}
```

**Unnumbered equation** Adding star (\*) to equation environments will get unnumbered equations.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

#### Syntax:

```
\begin{equation*}
x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}
\end{equation*}
```

- Various equation environments are available according to the requirements.

1. **multiline**: Multi line equation with single equation number.

$$a + b + c + d + e + f + i + j \quad (2)$$

#### Syntax:

```
\begin{multiline}
a+b+c+d\
+e+f+i+j
\end{multiline}
```

2. **gather**: Multi line without alignment.

$$a_1 = b_1 + c_1 \quad (3)$$

$$a_2 = b_2 + c_2 - d_2 + e_2 \quad (4)$$

#### Syntax:

```
\begin{gather}
a_1=b_1+c_1\
a_2=b_2+c_2-d_2+e_2
\end{gather}
```

3. **align**: Multi line with mutually aligned equations.

$$a_1 = b_1 + c_1 \quad (5)$$

$$a_2 = b_2 + c_2 - d_2 + e_2 \quad (6)$$

#### Syntax:

```
\begin{align}
a_1 &= b_1+c_1 \label{eq:C}\
a_2 &= b_2+c_2-d_2+e_2 \label{eq:D}
\end{align}
```

4. **alignat**: Multi line with column based aligned equations (like tables).

$$x = y_1 - y_2 + \dots \quad \text{by (5)} \quad (7)$$

$$= y' \circ y^* \quad \text{by (6)} \quad (8)$$

$$= y(0)y' \quad \forall y \neq 0 \quad (9)$$

#### Syntax:

```
\begin{alignat}{2}
x &= y_1-y_2+\cdots && \text{by (5)} \\
&= y' \circ y^* && \text{by (6)} \\
&= y(0)y' && \forall y \neq 0
\end{alignat}
```

5. **flalign**: This one stretches the space between the equation columns to the maximum possible width and fill the line.

$$a_{11} + b_{11} = c_{11} \quad a_{12} = b_{12}$$

$$b_{21} = c_{21} \quad a_{22} = b_{22} + c_{22}$$

#### Syntax:

```
\begin{flalign*}
a_{11} + b_{11} &= c_{11} && a_{12} = b_{12} \\
b_{21} &= c_{21} && a_{22} = b_{22} + c_{22}
\end{flalign*}
```

6. **split**: Single line equations but need breaking and alignment, uses inside equation, gather and align environments.

$$a = b + c - d + e - f = g + h = i \quad (10)$$

#### Syntax:

```
\begin{equation} \label{eq:x}
\begin{split}
a &= b+c-d\
& \quad +e-f\
& =g+h\
& =i
\end{split}
\end{equation}
```

- Features in equation numbering.

1. Custom equation number can be done using `\tag{...}` and the vertical alignment can be adjusted using `\raisetag{opt}`.

$$(a + b)^2 = a^2 + 2ab + b^2 \quad (\beta')$$

#### Syntax:

```
\begin{equation}
(a + b)^2 = a^2 + 2ab + b^2
\tag{\beta'}
\end{equation}
```

2. Hierarchy can be achieved by using the command `\numberwithin{<counter>}{equation}`. Any counter can be used.

$$(a + b)^2 = a^2 + 2ab + b^2 \quad (I.II)$$

3. Cross referencing can be done using label-ref mechanism. To get the equation numbers with parenthesis, `\eqref{<label>}` can be used.

Example:

From equation (10), we can say that  $a = i$ .

#### Syntax:

```
From equation \eqref{eq:x},
we can say that $a=i$.
```

Syntax for the usage of `\label{}` can be found at (10). To enable hyperlink, use `\usepackage{hyperref}` package.

4. Subordinate numbering can be done using `subequations` environment.

$$a_1 = b_1 + c_1 \quad (12a)$$

$$a_2 = b_2 + c_2 - d_2 + e_2 \quad (12b)$$

#### Syntax:

```
\begin{subequations}
\begin{align}
a_1 &= b_1+c_1 \
a_2 &= b_2+c_2-d_2+e_2
\end{align}
\end{subequations}
```

- Miscellaneous features.

1. Matrices and determinants: There are five types of matrices can be typeset. `pmatrix`, `bmatrix`, `Bmatrix`, `vmatrix` and `Vmatrix` have  $(\dots)$ ,  $[\dots]$ ,  $\{\dots\}$ ,  $|\dots|$ , and  $\| \dots \|$  delimiters built in.

### Examples

Matrices	Output	Syntax
<code>pmatrix</code>	$\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$	<pre>\begin{pmatrix} 0&amp;1\ 1&amp;0 \end{pmatrix}</pre>
<code>bmatrix</code>	$\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$	<pre>\begin{bmatrix} 0&amp;1\ 1&amp;0 \end{bmatrix}</pre>
<code>Bmatrix</code>	$\begin{Bmatrix} 0 & 1 \\ 1 & 0 \end{Bmatrix}$	<pre>\begin{Bmatrix} 0&amp;1\ 1&amp;0 \end{Bmatrix}</pre>
<code>vmatrix</code>	$\begin{vmatrix} 0 & 1 \\ 1 & 0 \end{vmatrix}$	<pre>\begin{vmatrix} 0&amp;1\ 1&amp;0 \end{vmatrix}</pre>
<code>Vmatrix</code>	$\begin{Vmatrix} 0 & 1 \\ 1 & 0 \end{Vmatrix}$	<pre>\begin{Vmatrix} 0&amp;1\ 1&amp;0 \end{Vmatrix}</pre>

2. Boxed formulae.

$$a_2 = b_2 + c_2 - d_2 + e_2$$

#### Syntax:

```
\begin{equation*}
\boxed{a_2 = b_2+c_2-d_2+e_2}
\end{equation*}
```

3. Delimiters of various sizes. Just like matrices, all types of brackets and pipe can be used as delimiters. But the size matters. So to get proper size according to the content, some commands are available. See below table.

Delimiter size	Result
Text size	$(a) \left( \frac{a}{b} \right)$
<code>\left \right</code>	$(a) \left( \frac{a}{b} \right)$
<code>\bigl \bigr</code>	$(a) \left( \frac{a}{b} \right)$
<code>\Bigl \Bigr</code>	$(a) \left( \frac{a}{b} \right)$
<code>\biggl \bigger</code>	$(a) \left( \frac{a}{b} \right)$
<code>\Biggl \Bigger</code>	$(a) \left( \frac{a}{b} \right)$

4. Commutative diagrams can be typeset using `amscd` or `xypic` packages.

$$\begin{array}{ccc}
 S^{\mathcal{W}_\Lambda} \otimes T & \xrightarrow{j} & T \\
 \downarrow & & \downarrow_{\text{End}P} \\
 (S \otimes T)/I & \xlongequal{\quad} & (Z \otimes T)/J
 \end{array}$$

#### Syntax:

```
\begin{equation*}
\begin{CD}
S^{\mathcal{W}_\Lambda} \otimes T @>j>> T \\
@VVV @VVV_{\text{End}P} \\
(S \otimes T)/I @= (Z \otimes T)/J
\end{CD}
\end{equation*}
```

5. Equations having Sum, integral and their limits can be toggled using `\limits` and `\nolimits` commands. Normally in displayed equations, limits will be placed under the operator, to overcome this, `\nolimits` can be used and the converse is for `\limits` in in-line equations.

### Examples

**display**

$$\sum_{i=1}^n \quad \xrightarrow{\text{Normal}} \sum_{i=1}^n$$

$$\sum_{i=1}^n \quad \xrightarrow{\text{nolimits}} \sum_{i=1}^n$$

**inline**

$$\sum_{i=1}^n \quad \xrightarrow{\text{Normal}} \sum_{i=1}^n$$

$$\sum_{i=1}^n \quad \xrightarrow{\text{limits}} \sum_{i=1}^n$$

## Quick links

- CTAN `amsmath` package.
- The Comprehensive L<sup>A</sup>T<sub>E</sub>X Symbol List

## Epilog

- The content that Sayahna includes in these Phone PDFs are those that can be read in under thirty to forty minutes. Computers or Desktop applications are not necessary for reading them.
- The PDFs are made available in beautiful, rich formats and can be easily read from your smart phones. They are customized to adhere perfectly with the dimensions of your phone screen.
- Most smartphones these days are equipped with in-built readers for PDF content. However, the free Adobe Acrobat Reader application offers the best reading experience. We would recommend that you install Adobe readers in your phones and use them for reading our content.
- Anybody who is interested in open access publishing and want to submit their work to Sayahna may do so by mailing it to [<info@sayahna.org>](mailto:info@sayahna.org). The work could be anything from stories, memoirs, articles, interviews, movie reviews, poems, plays, sketches or paintings; the only stipulation being that they should be succinct enough to be read under thirty to sixty minutes.
- Sayahna welcomes all your thoughts on our efforts! You may either mail them to [<info@sayahna.org>](mailto:info@sayahna.org) or post them under the Comments section in this [web page](#). We eagerly await your feedbacks and hope to derive from them the necessary impetus to drive Sayahna to new heights.