systeq - manual

Syntax

We can render a simple system (like `math.cases`) which is `inline` by default.

```
This is a simple 2x2 linear system:
#render-systeq(systeq($5x - 4y = 8$, $2x + 5y = 1$))
```

This is a simple 2x2 linear system: $\begin{cases} 5x - 4y = 8 \\ 2x + 5y = 1 \end{cases}$

Simply put it between $ ... $ to make it into a `block`:

```
This is a simple 2x2 linear system:
$ #render-systeq(systeq($5x - 4y = 8$, $2x + 5y = 1$)) $
```

This is a simple 2x2 linear system:

$$\begin{cases} 5x - 4y = 8 \\ 2x + 5y = 1 \end{cases}$$

The function `sys` represents a system, which needs to be rendered via `render-sys`. Multiple systems can be rendered at once and will be rendered in a `grid` with default symbol `sep-symbol`: $<==>$ and default column number `columns`: `4` (counting separators).

```
#render-systeq(
    systeq($5x - 4y = 8$, $2x + 5y = 1$),
    systeq($-10x + 8y = -16$, $10x + 25y = 5$),
    systeq($2x + 5y = 1$, $"" "" 33y = -11$),
    systeq($2x + 5y = 1$, $"" "" y = -1/3$),
)
```

$$\begin{cases} 5x - 4y = 8 \\ 2x + 5y = 1 \end{cases} \iff \begin{cases} -10x + 8y = -16 \\ 10x + 25y = 5 \end{cases}$$

$$\iff \begin{cases} 2x + 5y = 1 \\ 33y = -11 \end{cases} \iff \begin{cases} 2x + 5y = 1 \\ y = -\dfrac{1}{3} \end{cases}$$

Usual alignment operator & cannot be used in `sys`. You should use spaces to create the alignment points instead and empty strings `""` to get empty placeholders.

Alignments

Alignments can be customized at different levels. First we can change the alignment inside the grid (default: `align: horizon`).

```
#render-systeq(
  align: center + horizon,
  systeq($5x - 4y = 8$, $2x + 5y = 1$),
  systeq($-10x + 8y = -16$, $10x + 25y = 5$),
  systeq($2x + 5y = 1$, $"" "" 33y = -11$),
  systeq($2x + 5y = 1$, $"" "" y = -1/3$),
)
```

$$
\begin{cases} 5x - 4y = 8 \\ 2x + 5y = 1 \end{cases}
\iff
\begin{cases} -10x + 8y = -16 \\ 10x + 25y = 5 \end{cases}
$$

$$
\iff
\begin{cases} 2x + 5y = 1 \\ 33y = -11 \end{cases}
\iff
\begin{cases} 2x + 5y = 1 \\ y = -\dfrac{1}{3} \end{cases}
$$

You can also change the alignment inside the systems (default: `align: right`).

```
#render-systeq(
  sys-align: left,
  systeq($5x - 4y = 8$, $2x + 5y = 1$),
  systeq($-10x + 8y = -16$, $10x + 25y = 5$),
  systeq($2x + 5y = 1$, $"" "" 33y = -11$),
  systeq($2x + 5y = 1$, $"" "" y = -1/3$),
)
```

$$
\begin{cases} 5x - 4y = 8 \\ 2x + 5y = 1 \end{cases}
\iff
\begin{cases} -10x + 8y = -16 \\ 10x + 25y = 5 \end{cases}
$$

$$
\iff
\begin{cases} 2x + 5y = 1 \\ 33y = -11 \end{cases}
\iff
\begin{cases} 2x + 5y = 1 \\ y = -\dfrac{1}{3} \end{cases}
$$

Spacing

You can customize the grid gutters with defaults `column-gutter:` `2em` and `row-gutter:` `2em`.

```
#render-systeq(
  column-gutter: 4em,
  systeq($5x - 4y = 8$, $2x + 5y = 1$),
  systeq($-10x + 8y = -16$, $10x + 25y = 5$),
  systeq($2x + 5y = 1$, $"" "" 33y = -11$),
  systeq($2x + 5y = 1$, $"" "" y = -1/3$),
)
```

$$
\begin{cases} 5x - 4y = 8 \\ 2x + 5y = 1 \end{cases}
\qquad \Longleftrightarrow \qquad
\begin{cases} -10x + 8y = -16 \\ 10x + 25y = \quad 5 \end{cases}
$$

$$
\Longleftrightarrow \qquad
\begin{cases} 2x + 5y = \quad 1 \\ \qquad 33y = -11 \end{cases}
\qquad \Longleftrightarrow \qquad
\begin{cases} 2x + 5y = \quad 1 \\ \qquad y = -\dfrac{1}{3} \end{cases}
$$

You can customize the spacing inside the system with defaults `sys-col-gap:` `.4em` and `sys-row-gap:` `.4em`.

```
#render-systeq(
  sys-col-gap: 1em,
  systeq($5x - 4y = 8$, $2x + 5y = 1$),
  systeq($-10x + 8y = -16$, $10x + 25y = 5$),
  systeq($2x + 5y = 1$, $"" "" 33y = -11$),
  systeq($2x + 5y = 1$, $"" "" y = -1/3$),
)
```

$$
\begin{cases} 5x \quad - \quad 4y \quad = \quad 8 \\ 2x \quad + \quad 5y \quad = \quad 1 \end{cases}
\qquad \Longleftrightarrow \qquad
\begin{cases} -10x \quad + \quad 8y \quad = \quad -16 \\ 10x \quad + \quad 25y \quad = \quad 5 \end{cases}
$$

$$
\Longleftrightarrow \qquad
\begin{cases} 2x \quad + \quad 5y \quad = \quad 1 \\ \qquad 33y \quad = \quad -11 \end{cases}
\qquad \Longleftrightarrow \qquad
\begin{cases} 2x \quad + \quad 5y \quad = \quad 1 \\ \qquad y \quad = \quad -\dfrac{1}{3} \end{cases}
$$

Annotations

You can annotate each equation of a system using the `annot` parameter of `sys`.

```
#render-systeq(
  systeq($5x - 4y = 8$, $2x + 5y = 1$, annot: ($dot (-2)$, $dot 5$)),
  systeq($-10x + 8y = -16$, $10x + 25y = 5$),
  systeq($2x + 5y = 1$, $"" "" 33y = -11$, annot: ("",$div 33$)),
  systeq($2x + 5y = 1$, $"" "" y = -1/3$),
)
```

$$
\begin{cases} 5x - 4y = 8 \\ 2x + 5y = 1 \end{cases} \begin{matrix} \cdot(-2) \\ \cdot 5 \end{matrix} \quad \Longleftrightarrow \quad \begin{cases} -10x + 8y = -16 \\ 10x + 25y = 5 \end{cases}
$$

$$
\Longleftrightarrow \quad \begin{cases} 2x + 5y = 1 \\ 33y = -11 \end{cases} \begin{matrix} \\ \div 33 \end{matrix} \quad \Longleftrightarrow \quad \begin{cases} 2x + 5y = 1 \\ y = -\dfrac{1}{3} \end{cases}
$$

The annotation color, size, offset and bar stroke can be changed with following defaults `annot-color: red`, `annot-size: 1em`, `annot-spacing: (left: 1em, right: .2em)` and `annot-bar: (paint: annot-color, thickness: .8pt, dash: "solid")`. The latter accepts any stroke as argument and the `annot-bar` is removed when set to `none`. Each of these parameters can be passed to `render-sys` to be applied to every underlying system and can individually be overridden by passing them to `sys`.

```
#render-systeq(
  annot-color: blue.darken(10%),
  annot-size: .9em,
  annot-spacing: (left: 2em, right: 0em),
  annot-bar: (dash: "dashed"),
  systeq($5x - 4y = 8$, $2x + 5y = 1$, annot: ($dot (-2)$, $dot 5$)),
  systeq($-10x + 8y = -16$, $10x + 25y = 5$),
  systeq($2x + 5y = 1$, $"" "" 33y = -11$, annot: ("",$div 33$), annot-bar:
purple),
  systeq($2x + 5y = 1$, $"" "" y = -1/3$),
)
```

$$
\begin{cases} 5x - 4y = 8 \\ 2x + 5y = 1 \end{cases} \begin{matrix} \cdot(-2) \\ \cdot 5 \end{matrix} \quad \Longleftrightarrow \quad \begin{cases} -10x + 8y = -16 \\ 10x + 25y = 5 \end{cases}
$$

$$
\Longleftrightarrow \quad \begin{cases} 2x + 5y = 1 \\ 33y = -11 \end{cases} \begin{matrix} \\ \div 33 \end{matrix} \quad \Longleftrightarrow \quad \begin{cases} 2x + 5y = 1 \\ y = -\dfrac{1}{3} \end{cases}
$$

Addition and substractions modes

One last feature of the *systeq* package is to display addition or substraction operations between equations of one system. This can be used by changing the systems mode with default `mode: "normal"` to `mode: "add"` or `mode: "sub"`. This uses the last `sys` entry as result of the addition / substraction and adds a $+$ or $-$ sign on the bottom left. In this case, it is not possible to annotate the system and the `annot-bar` style is applied to the horizontal bar. The result and sign colors and size are inherited from `annot-color` and `annot-size`.

```
  #render-systeq(
    align: top,
    systeq($5x - 4y = 8$, $2x + 5y = 1$, annot: ($dot (-2)$, $dot 5$)),
    systeq($-10x + 8y = -16$, $10x + 25y = 5$, $"" "" 33y = -11$, mode: "add",
 annot-color: blue)
  )
```

$$
\begin{cases} 5x - 4y = 8 \\ 2x + 5y = 1 \end{cases} \begin{matrix} \cdot(-2) \\ \cdot 5 \end{matrix} \qquad \Longleftrightarrow \qquad + \begin{cases} -10x + 8y = -16 \\ 10x + 25y = 5 \end{cases}
$$
$$
\underline{\qquad\qquad\qquad\qquad}
$$
$$
{\color{blue} 33y = -11}
$$

Display

In `"normal"` mode, you can choose whether your math content is sized with display or not. This makes sense for example when fraction arise in your equations. For `"add"` and `"sub"` mode there is no display option. The default for normal mode is `display: true`. This parameter can be passed to `render-sys` or `sys`, the latter overriding the former.

```
  #render-systeq(
    display: true, // default
    systeq($"" "" y = x + 1$, $(x + 1) / 3 - y / 6 = 1$),
    systeq($"" "" y = x + 1$, $(x + 1) / 3 - (x+1) / 6 = 1$, display: false)
  ) \
  #render-systeq(
    display: false,
    systeq($"" "" y = x + 1$, $(x + 1) / 3 - y / 6 = 1$),
    systeq($"" "" y = x + 1$, $(x + 1) / 3 - (x+1) / 6 = 1$)
  )
```

$$
\begin{cases} x + 1 = y \\ \dfrac{x+1}{3} - \dfrac{y}{6} = 1 \end{cases} \qquad \Longleftrightarrow \qquad \begin{cases} x + 1 = y \\ \frac{x+1}{3} - \frac{x+1}{6} = 1 \end{cases}
$$

$$
\begin{cases} x + 1 = y \\ \frac{x+1}{3} - \frac{y}{6} = 1 \end{cases} \qquad \Longleftrightarrow \qquad \begin{cases} x + 1 = y \\ \frac{x+1}{3} - \frac{x+1}{6} = 1 \end{cases}
$$

Further examples

ignore system alignment

```
#render-systeq(
  sys-align: left,
  systeq($5x-4y=8$, $2x=1$),
  systeq($10x+8y=-16$, $x=1/2$),
)
```

$$\begin{cases} 5x - 4y = 8 \\ 2x = 1 \end{cases} \quad \Longleftrightarrow \quad \begin{cases} 10x + 8y = -16 \\ x = \dfrac{1}{2} \end{cases}$$

change number of system per line

```
#render-systeq(
  sys-align: left,
  columns: 8,
  column-gutter: 1.5em,
  systeq($5x-4y=8$, $2x=4$),
  systeq($10x+italic(8dot 2)=-16$, $x=2$),
  systeq($10x=0$, $x=2$),
  systeq($x=0$, $x=2$),
)
```

$$\begin{cases} 5x - 4y = 8 \\ 2x = 4 \end{cases} \Longleftrightarrow \begin{cases} 10x + 8 \cdot 2 = -16 \\ x = 2 \end{cases} \Longleftrightarrow \begin{cases} 10x = 0 \\ x = 2 \end{cases} \Longleftrightarrow \begin{cases} x = 0 \\ x = 2 \end{cases}$$

change separator

```
#render-systeq(
  sys-align: left,
  columns: 6,
  sep-symbol: $==>$,
  systeq($5x-4y=8$, $sqrt(y-5)=4$),
  systeq($5x-4y=8$, $y-5=4$),
  systeq($5x-4y=8$, $y=9$),
)
```

$$\begin{cases} 5x - 4y = 8 \\ \sqrt{y - 5} = 4 \end{cases} \Longrightarrow \begin{cases} 5x - 4y = 8 \\ y - 5 = 4 \end{cases} \Longrightarrow \begin{cases} 5x - 4y = 8 \\ y = 9 \end{cases}$$

3x3 system

```
$ #render-systeq(
  annot-color: red.darken(20%),
  annot-size: 10pt,
  row-gutter: 2.9em,
  align: left + horizon,
  systeq($2x + 3y - z = 24$, $4x - 2y + 3z = 6$, $6x - y + 2z = 22$,
    annot: ($+ thin 3 dot L_3$,$- 2 dot L_3$)
  ),
  systeq($20x "" "" + 5z = 90$, $-8x "" "" - z = -38$, $6x - y + 2z = 22$,
    annot: ($div 5$,)
  ),
  systeq($4x "" "" + z = 18$, $-8x "" "" - z = -38$, $6x - y + 2z = 22$,
    annot: ($+ thin L_2$,)
  ),
  systeq($-4x "" "" "" ""  = -20$, $-8x "" "" - z = -38$, $6x - y + 2z = 22$,
    annot: ($div (-4)$,)
  ),
  systeq($x "" "" "" ""  = 5$, $-8x "" "" - z = -38$, $6x - y + 2z = 22$,
    annot: ("",$x = 5$, $x = 5$)
  ),
  systeq($x "" "" "" ""  = 5$, $-40 "" "" - z = -38$, $30 - y + 2z = 22$,
    annot: ("",$+ thin 38 - z$)
  ),
  systeq($x "" "" "" ""  = 5$, $"" "" "" "" z = -2$, $30 - y + 2z = 22$,
    annot: ("","",$z = -2$)
  ),
  systeq($x "" "" "" ""  = 5$, $"" "" "" "" z = -2$, $30 - y - 4 = 22$,
    annot: ("","",$ + thin y - 22$)
  ),
  systeq($x = 5$, $z = -2$, $y = 4$),
) $
```

$$
\begin{cases} 2x + 3y - z = 24 \\ 4x - 2y + 3z = 6 \\ 6x - y + 2z = 22 \end{cases} \begin{array}{l} {\color{red} +3 \cdot L_3} \\ {\color{red} -2 \cdot L_3} \\ \\ \end{array} \iff \begin{cases} 20x + 5z = 90 \\ -8x - z = -38 \\ 6x - y + 2z = 22 \end{cases} {\color{red} \div 5}
$$

$$
\iff \begin{cases} 4x + z = 18 \\ -8x - z = -38 \\ 6x - y + 2z = 22 \end{cases} {\color{red} +L_2} \iff \begin{cases} -4x = -20 \\ -8x - z = -38 \\ 6x - y + 2z = 22 \end{cases} {\color{red} \div (-4)}
$$

$$
\iff \begin{cases} x = 5 \\ -8x - z = -38 \\ 6x - y + 2z = 22 \end{cases} \begin{array}{l} \\ {\color{red} x = 5} \\ {\color{red} x = 5} \end{array} \iff \begin{cases} x = 5 \\ -40 - z = -38 \\ 30 - y + 2z = 22 \end{cases} {\color{red} +38 - z}
$$

$$
\iff \begin{cases} x = 5 \\ z = -2 \\ 30 - y + 2z = 22 \end{cases} {\color{red} z = -2} \iff \begin{cases} x = 5 \\ z = -2 \\ 30 - y - 4 = 22 \end{cases} {\color{red} +y - 22}
$$

$$
\iff \begin{cases} x = 5 \\ z = -2 \\ y = 4 \end{cases} \iff \begin{cases} x = 5 \\ z = -2 \\ y = 4 \end{cases}
$$