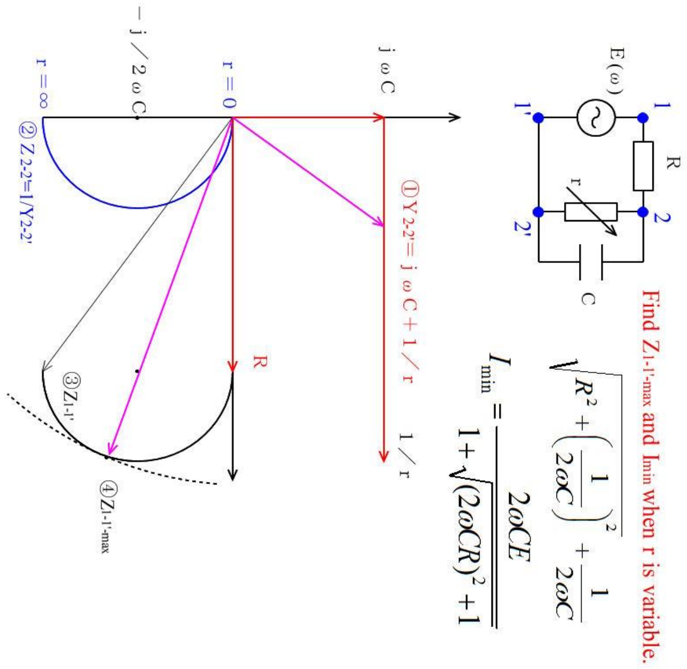
National Institute of Technology, Gifu College
Electrical and Computer Engineering
by T.Tokoro



$r>0$

$$Z(r):=\boxed{R}+\frac{1}{\frac{1}{r}+1\mathrm{i}\cdot\omega\cdot C}$$

The answer I want to get.

$$Z(R,r,C,\omega):=R+\frac{1}{\frac{1}{r}+1\mathrm{j}\cdot\omega\cdot C}\xrightarrow{rectangular}\frac{R\cdot\omega^2\cdot C^2\cdot r^2+r+R}{\omega^2\cdot C^2\cdot r^2+1}-\frac{\omega\cdot C\cdot r^2}{\omega^2\cdot C^2\cdot r^2+1}\cdot 1\mathrm{i}$$

$$Z_{mag}(R,r,C,\omega):=\sqrt{\left(\frac{R\cdot\omega^2\cdot C^2\cdot r^2+r+R}{\omega^2\cdot C^2\cdot r^2+1}\right)^2+\left(\frac{\omega\cdot C\cdot r^2}{\omega^2\cdot C^2\cdot r^2+1}\right)^2}\xrightarrow{simplify}\sqrt{\frac{\omega^2\cdot C^2\cdot R^2\cdot r^2+R^2+2\cdot R\cdot r+r^2}{\omega^2\cdot C^2\cdot r^2+1}}$$

$$Z_r(R,r,C,\omega):=\frac{\mathrm{d}}{\mathrm{d}r}\sqrt{\left(\frac{R\cdot\omega^2\cdot C^2\cdot r^2+r+R}{\omega^2\cdot C^2\cdot r^2+1}\right)^2+\left(\frac{\omega\cdot C\cdot r^2}{\omega^2\cdot C^2\cdot r^2+1}\right)^2}\xrightarrow{simplify}\frac{r-R\cdot\omega^2\cdot C^2\cdot r^2+R}{\sqrt{\frac{\omega^2\cdot C^2\cdot R^2\cdot r^2+R^2+2\cdot R\cdot r+r^2}{\omega^2\cdot C^2\cdot r^2+1}}\cdot\left(\omega^2\cdot C^2\cdot r^2+1\right)^2}$$

$$Z_r(R,r,C,\omega):=\frac{r-R\cdot\omega^2\cdot C^2\cdot r^2+R}{\sqrt{\frac{\omega^2\cdot C^2\cdot R^2\cdot r^2+R^2+2\cdot R\cdot r+r^2}{\omega^2\cdot C^2\cdot r^2+1}}\cdot\left(\omega^2\cdot C^2\cdot r^2+1\right)^2}\xrightarrow{solve,r}\begin{bmatrix}\frac{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1}{2\cdot\omega^2\cdot C^2\cdot R}\\-\frac{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}-1}{2\cdot\omega^2\cdot C^2\cdot R}\end{bmatrix}$$

$$\frac{r-R\cdot\omega^2\cdot C^2\cdot r^2+R}{\sqrt{\frac{\omega^2\cdot C^2\cdot R^2\cdot r^2+R^2+2\cdot R\cdot r+r^2}{\omega^2\cdot C^2\cdot r^2+1}}\cdot\left(\omega^2\cdot C^2\cdot r^2+1\right)^2}\xrightarrow{solve,r}\begin{bmatrix}\frac{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1}{2\cdot\omega^2\cdot C^2\cdot R}\\-\frac{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}-1}{2\cdot\omega^2\cdot C^2\cdot R}\end{bmatrix}$$

$$r:=\frac{\sqrt{4\cdot\boxed{\omega}^2\cdot C^2\cdot R^2+1}+1}{2\cdot\omega^2\cdot C^2\cdot R}$$

The value of r of the answer.

[redacted]

National Institute of Technology, Gifu College
Electrical and Computer Engineering
by T.Tokoro

$$R+\frac{1}{\dfrac{1}{\left(\dfrac{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1}{2\cdot\omega^2\cdot C^2\cdot R}\right)}+1j\cdot\omega\cdot C}=R+\frac{1}{\dfrac{2\cdot\omega^2\cdot C^2\cdot R}{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1}+1j\cdot\omega\cdot C}=R+\frac{1}{\dfrac{2\cdot\omega^2\cdot C^2\cdot R}{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1}+\dfrac{1j\cdot\omega\cdot C\cdot\left(\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1\right)}{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1}}=R+\frac{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1}{2\cdot\omega^2\cdot C^2\cdot R+1j\cdot\omega\cdot C\cdot\left(\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1\right)}$$

$$R+\frac{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1}{2\cdot\omega^2\cdot C^2\cdot R+1j\cdot\omega\cdot C\cdot\left(\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1\right)}\xrightarrow{rectangular}\frac{2\cdot R\cdot\left(\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+2\cdot\omega^2\cdot C^2\cdot R^2+1\right)}{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+4\cdot\omega^2\cdot C^2\cdot R^2+1}-\frac{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+2\cdot\omega^2\cdot C^2\cdot R^2+1}{\omega\cdot C+4\cdot\omega^3\cdot C^3\cdot R^2+\omega\cdot C\cdot\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}}\cdot 1i$$

Thiis is the answer solved by Mathcad.

The answer I want to get. (Absolute value by Circle diagram)

$$Zmax:=\sqrt{R^2+\left(\frac{1}{2\cdot\omega\cdot C}\right)^2}+\frac{1}{2\cdot\omega\cdot C}$$

$$Zmax\_real:=Zmax\cdot\frac{R}{\sqrt{R^2+\left(\dfrac{1}{2\cdot\omega\cdot C}\right)^2}}\xrightarrow{simplify}R+\frac{R}{\omega\cdot C\cdot\sqrt{4\cdot R^2+\dfrac{1}{\omega^2\cdot C^2}}}$$

Real part of the answer

$$cos\theta:=\frac{R}{\sqrt{R^2+\left(\dfrac{1}{2\cdot\omega\cdot C}\right)^2}}$$

$$R+\frac{1}{2\cdot\omega\cdot C}\cdot cos\theta\rightarrow R+\frac{R}{2\cdot\omega\cdot C\cdot\sqrt{R^2+\dfrac{1}{4\cdot\omega^2\cdot C^2}}}$$

$$2\cdot\omega\cdot C\cdot\sqrt{R^2+\frac{1}{4\cdot\omega^2\cdot C^2}}\xrightarrow{simplify}\omega\cdot C\cdot\sqrt{4\cdot R^2+\frac{1}{\omega^2\cdot C^2}}$$

$$\frac{2\cdot R\cdot\left(\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+2\cdot\omega^2\cdot C^2\cdot R^2+1\right)}{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+4\cdot\omega^2\cdot C^2\cdot R^2+1}\xrightarrow{simplify}2\cdot R-\frac{4\cdot\omega^2\cdot C^2\cdot R^3}{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+4\cdot\omega^2\cdot C^2\cdot R^2+1}$$

$$2\cdot R-\frac{4\cdot\omega^2\cdot C^2\cdot R^3}{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+4\cdot\omega^2\cdot C^2\cdot R^2+1}=R+X\xrightarrow[factor]{solve,X}\frac{R\cdot\left(\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1\right)}{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+4\cdot\omega^2\cdot C^2\cdot R^2+1}$$

$$\frac{R\cdot\left(\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1\right)}{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+4\cdot\omega^2\cdot C^2\cdot R^2+1}=\frac{R}{\dfrac{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+4\cdot\omega^2\cdot C^2\cdot R^2+1}{\left(\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1\right)}}$$

$$\frac{\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+4\cdot\omega^2\cdot C^2\cdot R^2+1}{\left(\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}+1\right)}\xrightarrow{simplify}\sqrt{4\cdot\omega^2\cdot C^2\cdot R^2+1}$$

Real part of the answer is same!

[redacted]

$$Zmax := \sqrt{R^2 + \left(\frac{1}{2 \cdot \omega \cdot C}\right)^2} + \frac{1}{2 \cdot \omega \cdot C}$$

$$sin\theta := \frac{\frac{1}{2 \cdot \omega \cdot C}}{\sqrt{R^2 + \left(\frac{1}{2 \cdot \omega \cdot C}\right)^2}} \qquad Zmax\_imag := Zmax \cdot sin\theta \xrightarrow{simplify} \frac{\omega \cdot C + \left(4 \cdot R^2 + \frac{1}{\omega^2 \cdot C^2}\right)^{\frac{-1}{2}}}{2 \cdot \omega^2 \cdot C^2}$$

The magnitude of the imaginary part of the answer

$$\frac{1}{2 \cdot \omega \cdot C} + \frac{1}{2 \cdot \omega^2 \cdot C^2 \cdot \left(\sqrt{4 \cdot R^2 + \frac{1}{\omega^2 \cdot C^2}}\right)}$$

$$\frac{\omega \cdot C + \left(4 \cdot R^2 + \frac{1}{\omega^2 \cdot C^2}\right)^{\frac{-1}{2}}}{2 \cdot \omega^2 \cdot C^2} = \frac{\omega \cdot C + \frac{1}{\sqrt{4 \cdot R^2 + \frac{1}{\omega^2 \cdot C^2}}}}{2 \cdot \omega^2 \cdot C^2} = \frac{1}{2 \cdot \omega \cdot C} + \frac{1}{2 \cdot \omega^2 \cdot C^2 \cdot \left(\sqrt{4 \cdot R^2 + \frac{1}{\omega^2 \cdot C^2}}\right)}$$

$$\frac{\sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1} + 2 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}{\omega \cdot C + 4 \cdot \omega^3 \cdot C^3 \cdot R^2 + \omega \cdot C \cdot \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}} = \frac{\sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1} + 2 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}{\omega \cdot C \cdot \left(1 + 4 \cdot \omega^2 \cdot C^2 \cdot R^2\right) + \omega \cdot C \cdot \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}}$$

This is the magnitude of the imaginary part of the answer solved by Mathcad.

$$\frac{\sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1} + 2 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}{\omega \cdot C \cdot \left(\left(1 + 4 \cdot \omega^2 \cdot C^2 \cdot R^2\right) + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}\right)} = \frac{2 \cdot \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1} + \left(4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1\right) + 1}{2 \cdot \omega \cdot C \cdot \left(\left(1 + 4 \cdot \omega^2 \cdot C^2 \cdot R^2\right) + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}\right)} = \frac{\sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1} + \left(4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1\right) + 1 + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}}{2 \cdot \omega \cdot C \cdot \left(\left(1 + 4 \cdot \omega^2 \cdot C^2 \cdot R^2\right) + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}\right)} = \frac{1}{2 \cdot \omega \cdot C} + \frac{1 + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 \cdots}}{2 \cdot \omega \cdot C \cdot \left(\left(1 + 4 \cdot \omega^2 \cdot C^2 \cdot R^2\right) + \sqrt{4 \cdots}\right.}$$

$$\frac{1 + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}}{2 \cdot \omega \cdot C \cdot \left(\left(1 + 4 \cdot \omega^2 \cdot C^2 \cdot R^2\right) + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}\right)} = \frac{1}{2 \cdot \omega \cdot C \cdot \frac{\left(\left(1 + 4 \cdot \omega^2 \cdot C^2 \cdot R^2\right) + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}\right)}{1 + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}}}$$

$$2 \cdot \omega \cdot C \cdot \frac{\left(\left(1 + 4 \cdot \omega^2 \cdot C^2 \cdot R^2\right) + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}\right)}{1 + \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}} \xrightarrow{simplify} 2 \cdot \omega \cdot C \cdot \sqrt{4 \cdot \omega^2 \cdot C^2 \cdot R^2 + 1}$$

The magnitude of the imaginary part of the answer is same!

[redacted]

National Institute of Technology, Gifu College
Electrical and Computer Engineering
by T.Tokoro

$R := 1 \quad \omega := 1 \quad C := 1$

$$Zmax := \sqrt{R^2 + \left(\frac{1}{2\cdot\omega\cdot C}\right)^2} + \frac{1}{2\cdot\omega\cdot C} = 1.618 \qquad \sqrt{\frac{5}{4}} + \frac{1}{2} = 1.618$$

$r := 1.61803$

$$Z(r) := R + \frac{1}{\frac{1}{r} + 1i\cdot\omega\cdot C} \qquad |Z(r)| = 1.618$$

$$\arg\left(\frac{1}{\frac{1}{r} + 1i\cdot\omega\cdot C} - \frac{1}{2i\cdot\omega\cdot C}\right) = -26.565\ \mathit{deg}$$

$$\arg\left(R + \frac{1}{2i\cdot\omega\cdot C}\right) = -26.565\ \mathit{deg}$$

$\mathbf{clear}(r) \quad R := 10 \quad C := 1 \quad \omega := 1 \quad r > 0$

$$Z(r) := R + \frac{1}{\frac{1}{r} + 1i\cdot\omega\cdot C} \qquad \mathrm{Re}(Z(r)) \to \mathrm{Re}\left(\frac{1}{\frac{1}{r} + 1i}\right) + 10 \qquad \mathrm{Im}(Z(r)) \to \mathrm{Im}\left(\frac{1}{\frac{1}{r} + 1i}\right)$$

推定値

$r := 100 \quad R := 10 \quad C := 1 \quad \omega := 1$

$$Z(r) := \sqrt{\left(\mathrm{Re}\left(\frac{1}{\frac{1}{r} + 1i\cdot\omega\cdot C}\right) + R\right)^2 + \left(\mathrm{Im}\left(\frac{1}{\frac{1}{r} + 1i\cdot\omega\cdot C}\right)\right)^2}$$

ソルバ制約条件

$r > 0$

$r_{Zmax} := \mathbf{maximize}(Z, \mathrm{r}) = 1.05125$

$$Zmax := \sqrt{R^2 + \left(\frac{1}{2\cdot\omega\cdot C}\right)^2} + \frac{1}{2\cdot\omega\cdot C} = 10.512 \qquad r := 1.05125$$

$$Z(r) := R + \frac{1}{\frac{1}{r} + 1i\cdot\omega\cdot C} \qquad |Z(r)| = 10.512$$

$$\arg\left(\frac{1}{\frac{1}{r} + 1i\cdot\omega\cdot C} - \frac{1}{2i\cdot\omega\cdot C}\right) = -2.862\ \mathit{deg} \qquad \arg\left(R + \frac{1}{2i\cdot\omega\cdot C}\right) = -2.862\ \mathit{deg}$$

[redacted]

$\mathbf{clear}(r)$ $\quad R := 10 \quad C := 10 \quad \omega := 1 \quad r > 0$

$$Z(r) := R + \frac{1}{\frac{1}{r} + 1\mathrm{i} \cdot \omega \cdot C} \qquad \mathrm{Re}(Z(r)) \rightarrow \mathrm{Re}\left(\frac{1}{\frac{1}{r} + 10\mathrm{i}}\right) + 10 \qquad \mathrm{Im}(Z(r)) \rightarrow \mathrm{Im}\left(\frac{1}{\frac{1}{r} + 10\mathrm{i}}\right)$$

推定値

$r := 100 \quad R := 10 \quad C := 10 \quad \omega := 1$

$$Z(r) := \sqrt{\left(\mathrm{Re}\left(\frac{1}{\frac{1}{r} + 1\mathrm{i} \cdot \omega \cdot C}\right) + R\right)^2 + \left(\mathrm{Im}\left(\frac{1}{\frac{1}{r} + 1\mathrm{i} \cdot \omega \cdot C}\right)\right)^2}$$

ソルバ制約条件

$r > 0$

$r_{Zmax} := \mathbf{maximize}(Z, r) = 0.100501$

$$Zmax := \sqrt{R^2 + \left(\frac{1}{2 \cdot \omega \cdot C}\right)^2} + \frac{1}{2 \cdot \omega \cdot C} = 10.05$$

$r := 0.100501$

$$Z(r) := R + \frac{1}{\frac{1}{r} + 1\mathrm{i} \cdot \omega \cdot C} \qquad |Z(r)| = 10.05$$

$$\arg\left(\frac{1}{\frac{1}{r} + 1\mathrm{i} \cdot \omega \cdot C} - \frac{1}{2\mathrm{i} \cdot \omega \cdot C}\right) = -0.286\ deg$$

$$\arg\left(R + \frac{1}{2\mathrm{i} \cdot \omega \cdot C}\right) = -0.286\ deg$$

[redacted]

$\mathbf{clear}(r) \qquad R := 10 \qquad C := 10 \qquad \omega := 10 \qquad r > 0$

$$Z(r) := R + \frac{1}{\frac{1}{r} + 1\mathrm{i} \cdot \omega \cdot C} \quad \operatorname{Re}(Z(r)) \rightarrow \operatorname{Re}\left(\frac{1}{\frac{1}{r} + 100\mathrm{i}}\right) + 10 \quad \operatorname{Im}(Z(r)) \rightarrow \operatorname{Im}\left(\frac{1}{\frac{1}{r} + 100\mathrm{i}}\right)$$

推定値

$r := 10 \qquad R := 10 \qquad C := 10 \qquad \omega := 10$

$$Z(r) := \sqrt{\left(\operatorname{Re}\left(\frac{1}{\frac{1}{r} + 1\mathrm{i} \cdot \omega \cdot C}\right) + R\right)^2 + \left(\operatorname{Im}\left(\frac{1}{\frac{1}{r} + 1\mathrm{i} \cdot \omega \cdot C}\right)\right)^2}$$

ソルバ制約条件

$r > 0$

$$r_{Zmax} := \mathbf{maximize}(Z, r) = 0.010005$$

$$Zmax := \sqrt{R^2 + \left(\frac{1}{2 \cdot \omega \cdot C}\right)^2} + \frac{1}{2 \cdot \omega \cdot C} = 10.005$$

$r := 0.010005$

$$Z(r) := R + \frac{1}{\frac{1}{r} + 1\mathrm{i} \cdot \omega \cdot C} \qquad |Z(r)| = 10.005$$

$$\arg\left(\frac{1}{\frac{1}{r} + 1\mathrm{i} \cdot \omega \cdot C} - \frac{1}{2\mathrm{i} \cdot \omega \cdot C}\right) = -0.029\ deg$$

$$\arg\left(R + \frac{1}{2\mathrm{i} \cdot \omega \cdot C}\right) = -0.029\ deg$$

[redacted]