

# task\_pdkggtyexxy1ktu3\_with\_calculation

## Student Group

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complex impedance, exam ee1 WS2022

**Exercise E9 Impedances at different Frequencies**  
**(written test, approx. 18 % of a 60-minute written test, WS2022)**

A series circuit consists of a resistor  $R_1 = 1.00 \text{ } \Omega$ , an inductor  $L = 4.7 \text{ } \mu\text{H}$ , and a capacitor  $C = 40 \text{ nF}$ . The circuit is connected to an AC voltage source  $v(t) = 450 \cos(2\pi \cdot 450 \cdot t)$  V. The current  $i(t)$  through the resistor  $R_1$  shall have the same absolute value of the impedance as a capacitor  $C_1 = 40 \text{ nF}$  at  $f_1 = 4 \text{ MHz}$ .

Solution

$R_1 = 1.00 \text{ } \Omega$

$R_2 = 10.0 \text{ } \Omega$

A series circuit means that the current is constant on every component.

The equivalent impedance for  $R$  and  $L$  combined is given by  $Z_{RL} = R + j\omega L$

Parallel circuit means that the voltage is the same on  $R_2$  and  $C_1$ .  $Z_{RC} = \frac{R_2 \cdot (-j/\omega C_1)}{R_2 - j/\omega C_1}$

Since  $\omega L$  and  $-j/\omega C_1$  are perpendicular to  $R_2$ , the resulting current of the parallel circuit is given as:

$I_{RC} = \sqrt{I_{R2}^2 + I_{C1}^2}$

Therefore, the resulting current of the parallel circuit is given as:

$I_{RC} = \sqrt{I_{R2}^2 + I_{C1}^2} = \sqrt{\left(\frac{U}{R_2}\right)^2 + \left(\frac{U}{1/\omega C_1}\right)^2}$

Back to the first formula:  $R_3 \cdot I_{RC} = X_{C3} \cdot I_{RC}$

$R_3 = X_{C3} \cdot \frac{I_{RC}}{I_{RC}} = X_{C3} \cdot \frac{\sqrt{I_{R2}^2 + I_{C1}^2}}{I_{RC}}$

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