

# task\_7el8zljglaazxtw\_with\_calculation

## Student Group

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## Table of Contents

Exercise E1 Series Resonant Circuit (written test, approx. 10 % of a 120-minute written test, SS2022) ..... 2

resonant circuit, exam ee2 SS2022

**Exercise E1 Series Resonant Circuit**  
**(written test, approx. 10 % of a 120-minute written test, SS2022)**

2. What is the resonance frequency of the series resonant circuit shown in the figure? The circuit consists of an AC voltage source  $U_0$  with an effective value of  $U_0 = 100 \text{ V}$ , a resistor  $R = 10 \text{ }\Omega$ , an inductor  $L = 60 \text{ }\mu\text{H}$ , and a capacitor  $C = 10 \text{ nF}$ .

At resonance, the total impedance  $Z_{RLC}$  of the circuit is purely real and its magnitude is equal to the resistance  $R$ . Which value would  $C_0$  have for the given  $f_0$ ?

Path:  $C = 10 \text{ nF}$

$R = 10 \text{ }\Omega$

Path:  $L = 60 \text{ }\mu\text{H}$

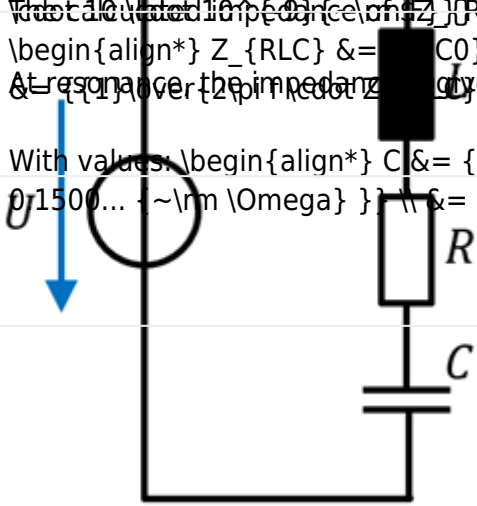
$R = 10 \text{ }\Omega$

The resonance frequency is given as  $f_r = \frac{1}{2\pi\sqrt{LC}}$

$f_r = \frac{1}{2\pi\sqrt{60 \cdot 10^{-12} \cdot 10^{-8}}} = 205.5 \text{ MHz}$

At resonance, the impedance  $Z_{RLC} = R$  is purely real.

With values:  $C = \frac{1}{2\pi \cdot 100 \cdot 10^6 \cdot 10} = 159.15 \text{ nF}$



1. What is the impedance  $Z_{RLC}$  of this real capacitor for  $f_0 = 100 \text{ MHz}$ ? (Phase and magnitude)

Path

The impedance  $Z_{RLC}$  is given by:

$$Z_{RLC} = R + j\omega L - \frac{j}{\omega C} = R + j\omega L - \frac{j}{\omega C}$$

Putting in the numbers, only for the reactive part  $X_{LC}$ :

$$X_{LC} = 2\pi \cdot 100 \cdot 10^6 \cdot 10 \cdot 10^{-9} - \frac{1}{2\pi \cdot 100 \cdot 10^6 \cdot 10 \cdot 10^{-9}}$$

$$X_{LC} = -121.45 \text{ m}\Omega$$

With the real and imaginary parts, we can derive the magnitude and phase:

$$Z_{RLC} = \sqrt{R^2 + X_{LC}^2} \quad \text{and} \quad \sqrt{(88 \text{ m}\Omega)^2 + (-121.45 \text{ m}\Omega)^2} = 150.0... \text{ m}\Omega$$

$$\varphi = \arctan\left(\frac{X_{LC}}{R}\right) = \arctan\left(\frac{-121.45 \text{ m}\Omega}{88 \text{ m}\Omega}\right) = -0.9437... = -54.07...^\circ$$

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Last update: **2024/07/05 02:21**

