

# task\_7el8zljglaazxtw\_with\_calculation

## Student Group

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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 with an inductor of inductance  $L$  and a capacitor of capacitance  $C$ ?

At this resonance frequency, the impedance of the series resonant circuit would be  $X_{C0} = Z_{RLC}$ . Which value would  $C_0$  have for the given  $f_0$ ?

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

$R = 88.6 \text{ m}\Omega$

Path:  $L = 60 \text{ pH}$

$Z_{RLC} = 250.5 \text{ M}\Omega$

$R = 88.6 \text{ m}\Omega$

The resonance frequency is given as  $f_r = \frac{1}{2\pi\sqrt{LC}}$   $\Leftrightarrow f_r = \frac{1}{2\pi\sqrt{60 \cdot 10^{-12} \cdot 10^{-8}}}$

What is the impedance of the series resonant circuit at the resonance frequency?

$Z_{RLC} = R + j\omega C - \frac{j}{\omega L}$   $\Leftrightarrow Z_{RLC} = R$   $\rightarrow C = \frac{1}{2\pi f \cdot (Z_{RLC} - R)}$

At resonance, the impedance is given purely by the resistor.

With values:  $C = \frac{1}{2\pi \cdot 100 \cdot 10^6 \cdot 10.6 \cdot 10^{-9}}$

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:  $Z_{RLC} = R + j\omega L - \frac{j}{\omega C}$   $\Leftrightarrow Z_{RLC} = R + j(\omega L - \frac{1}{\omega C})$

Putting in the numbers, only for the reactive part  $X_{LC}$ :  $X_{LC} = 2\pi \cdot 100 \cdot 10^6 \cdot 60 \cdot 10^{-12} - \frac{1}{2\pi \cdot 100 \cdot 10^6 \cdot 10 \cdot 10^{-9}}$

$\Leftrightarrow X_{LC} = 2\pi \cdot 100 \cdot 10^6 \cdot 60 \cdot 10^{-12} - \frac{1}{2\pi \cdot 100 \cdot 10^6 \cdot 10 \cdot 10^{-9}}$

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

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

$$Z_{RLC} = \sqrt{R^2 + X_{LC}^2} = \sqrt{(88 \text{ m}\Omega)^2 + (-121.45 \text{ m}\Omega)^2} = 150.0... \text{ m}\Omega$$
$$\varphi = \arctan\left(\frac{X_{LC}}{R}\right) = \arctan\left(\frac{-121.45 \text{ m}\Omega}{88 \text{ m}\Omega}\right) = -0.9437... = -54.07...^\circ$$

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