

# task\_7el8zljglaazxtw\_with\_calculation

## Student Group

First Name	Surname	Matrikel Nr.

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

At this resonance frequency, the impedance of the 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:  $L = 60 \text{ pH}$

$X_{C0} = 250.5 \text{ M}\Omega$

$X_{L0} = 88.6 \text{ m}\Omega$

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

What is the impedance of the circuit at resonance?  $Z_{RLC} = R$

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

At resonance, the impedance is purely real.

With values:  $C = \frac{1}{2\pi \cdot 100 \cdot 10^6} = 1.59 \text{ nF}$

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:

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

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

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

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

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

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

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

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