

# task\_7el8zljglaazxtw\_with\_calculation

## Student Group

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resonant circuit, exam ee2 SS2022

**Exercise E10 Series Resonant Circuit**  
**(written test, approx. 10 % of a 120-minute written test, SS2022)**

2. What is the resonance frequency of the circuit shown in the figure on the right on the capacitor? What is the value of the inductance  $L$ ?

At this case, shall be given with the following values:  $f_0 = 100 \text{ MHz}$  would be  $X_{C0} = Z_{RLC}$ . Which value would  $C_0$  have for the given  $f_0$ ?

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

$R = 100 \text{ m}\Omega$

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

The resonance frequency is given as  $f_r = \frac{1}{2\pi\sqrt{LC}}$   $\Leftrightarrow L = \frac{1}{(2\pi f_r)^2 C}$

What is the value of the inductance  $L$  if  $f_r = 100 \text{ MHz}$  and  $C = 10 \text{ nF}$ ?

$Z_{RLC} = R + j\omega L - \frac{j}{\omega C} \xrightarrow{\text{resonance}} Z = R$

At resonance the impedance is given purely by the resistor.

With values:  $C = 10 \text{ nF}$   $f_0 = 100 \text{ MHz}$

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

Path

The impedance  $\underline{Z}_{RLC}$  is given by:  $\underline{Z}_{RLC} = R + j\omega L - \frac{j}{\omega C}$

Putting in the numbers, only for the reactive part  $X_{LC}$ :  $X_{LC} = 2\pi \cdot f_0 \cdot L - \frac{1}{2\pi \cdot f_0 \cdot C}$

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

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

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

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

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

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