

task_7el8zljglaazxtw_with_calculation

Student Group

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Table of Contents

Exercise E9 Series Resonant Circuit (written test, approx. 10 % of a 120-minute written test, SS2022)	2
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resonant circuit, exam ee2 SS2022

Exercise E9 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 $v(t) = 100 \sin(2\pi \cdot 100 \cdot 10^6 t)$ V, a resistor $R = 10 \text{ m}\Omega$, an inductor $L = 60 \text{ nH}$, and a capacitor $C = 10 \text{ nF}$.

At resonance, the total impedance Z_{RLC} would be $Z_{RLC} = R$. Which value would C have for the given f_0 ?

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

$R = 10 \text{ m}\Omega$

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

$R = 10 \text{ m}\Omega$

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

$f_r = \frac{1}{2\pi\sqrt{60 \cdot 10^{-12} \cdot C}}$

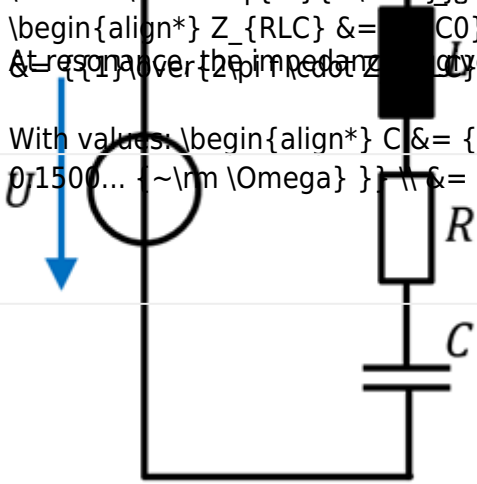
What is the total impedance Z_{RLC} at resonance?

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

At resonance, the impedance is purely real.

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

$C = 10.6 \text{ nF}$



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:

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

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

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

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

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

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

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

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

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