

task_7el8zljglaazxtw_with_calculation

Student Group

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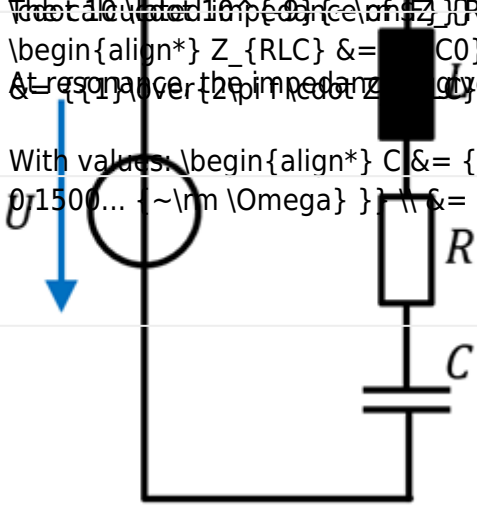
Exercise E14 Series Resonant Circuit
(written test, approx. 10 % of a 120-minute written test, SS2022)

2. What is the resonance frequency of the series RLC circuit shown in the circuit diagram? The resistance of an RLC circuit is $R = 10 \text{ } \Omega$, the inductance $L = 60 \text{ } \mu\text{H}$ and the capacitance $C = 10 \text{ nF}$.

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

- Path: $C = 10 \text{ nF}$
- $R = 10 \text{ } \Omega$
 - $Z_{RLC} = 10 \text{ } \Omega$
 - $L = 60 \text{ } \mu\text{H}$
 - $R = 10 \text{ } \Omega$

The resonance frequency is given as $f_r = \frac{1}{2\pi\sqrt{LC}}$ and $Z_{RLC} = R$.
 For $f_0 = 100 \text{ MHz}$, $Z_{RLC} = 10 \text{ } \Omega$.
 $Z_{RLC} = R + j(\omega L - \frac{1}{\omega C}) = 10 \text{ } \Omega$
 $10 = 10 + j(2\pi \cdot 100 \cdot 10^6 \cdot 60 \cdot 10^{-6} - \frac{1}{2\pi \cdot 100 \cdot 10^6 \cdot C})$
 $0 = j(1200\pi - \frac{1}{2\pi \cdot 10^8 \cdot C})$
 $\frac{1}{2\pi \cdot 10^8 \cdot C} = 1200\pi$
 $C = \frac{1}{2\pi \cdot 10^8 \cdot 1200\pi} = 10 \text{ nF}$



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: $Z_{RLC} = R + j\omega L - \frac{j}{\omega C}$
 $Z_{RLC} = 10 + j(2\pi \cdot 100 \cdot 10^6 \cdot 60 \cdot 10^{-6}) - \frac{j}{2\pi \cdot 100 \cdot 10^6 \cdot 10 \cdot 10^{-9}}$
 $Z_{RLC} = 10 + j(1200\pi - 1200\pi) = 10 \text{ } \Omega$

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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