task_yh4srwxu1bo1rdy4_with_calculation

Student Group

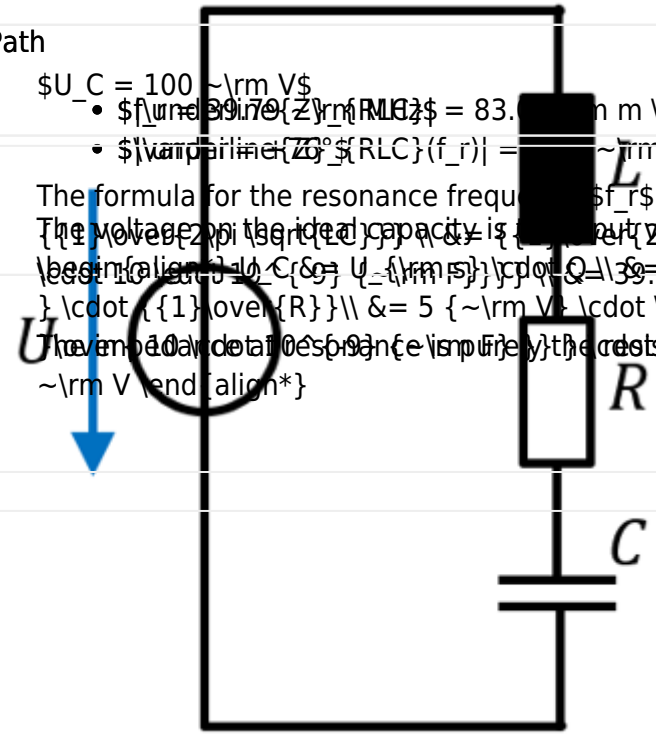
First Name	Surname	Matrikel Nr.

Table of Contents

resonance, impedance, resonant circuit, exam ee2 SS2024

Exercise E1 Magnetic Circuit
(written test, approx. 10 % of a 120-minute written test, SS2024)

2. What is the impedance Z_{RLC} of this real capacitor for $f_0=44 ~\rm MHz$? (Phase and magnitude)
3. What is the voltage on the ideal capacity C in the shown circuit?



A given capacitor shall have the following values:

- $C=10 ~\rm nF$
- $R=20 ~\rm m\Omega$
- $L=1.6 ~\rm nH$

1. What is the impedance Z_{RLC} of this real capacitor for $f_0=44 ~\rm MHz$? (Phase and magnitude)

Path

The impedance is based on the resistance R and the reactance $X_{LC}= {\rm j}\cdot (X_L - X_C)$: \begin{align*} \underline{Z}_{RLC} &= R + {\rm j}\cdot (X_L - X_C) \\ &= R + {\rm j}\cdot (\omega L - {{1}\over{\omega C}}) \\ &= R + {\rm j}\cdot (2\pi f \cdot L - {{1}\over{2\pi f \cdot C}}) \\ \end{align*}

The reactive part is \begin{align*} X_{LC} &= 2\pi f \cdot L - {{1}\over{2\pi f \cdot

C}} \\ &= 2\pi 44 \cdot 10^{6} {~\rm MHz} \cdot 1.6 \cdot 10^{-9} {~\rm H} - {{1}\over{2\pi \cdot 10^{6} {~\rm MHz} \cdot 10 \cdot 10^{-9} {~\rm F}}} \\ &= +0.08062... ~\Omega \\ \end{align*}

To get the magnitude of the impedance $|\underline{Z}_{RLC}|$ one can use the Pythagorean Theorem: \begin{align*} |\underline{Z}_{RLC}| &= \sqrt{R^2 + X_{LC}^2} \\ &= \sqrt{(0.020~\Omega)^2 + (0.08062... ~\Omega)^2} \\ &= 0.0830 ... ~\Omega \\ \end{align*}

For the phase φ the $\arctan$ can be applied: \begin{align*} \varphi &= \arctan \left({{X_{LC}}\over{R}} \right) \\ &= \arctan \left({{0.08062... ~\Omega}\over{0.020 ~\Omega}} \right) \\ &= 1.3276 ... \hat{=} +76° \\ \end{align*}