

task_kricv9fh7haauo6q_with_calculation

Student Group

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Table of Contents

complex impedance, exam ee1 WS2022

Exercise 1.1 : Complex Impedance Circuit

(written test, approx. 15 % of a 60-minute written test, WS2022)

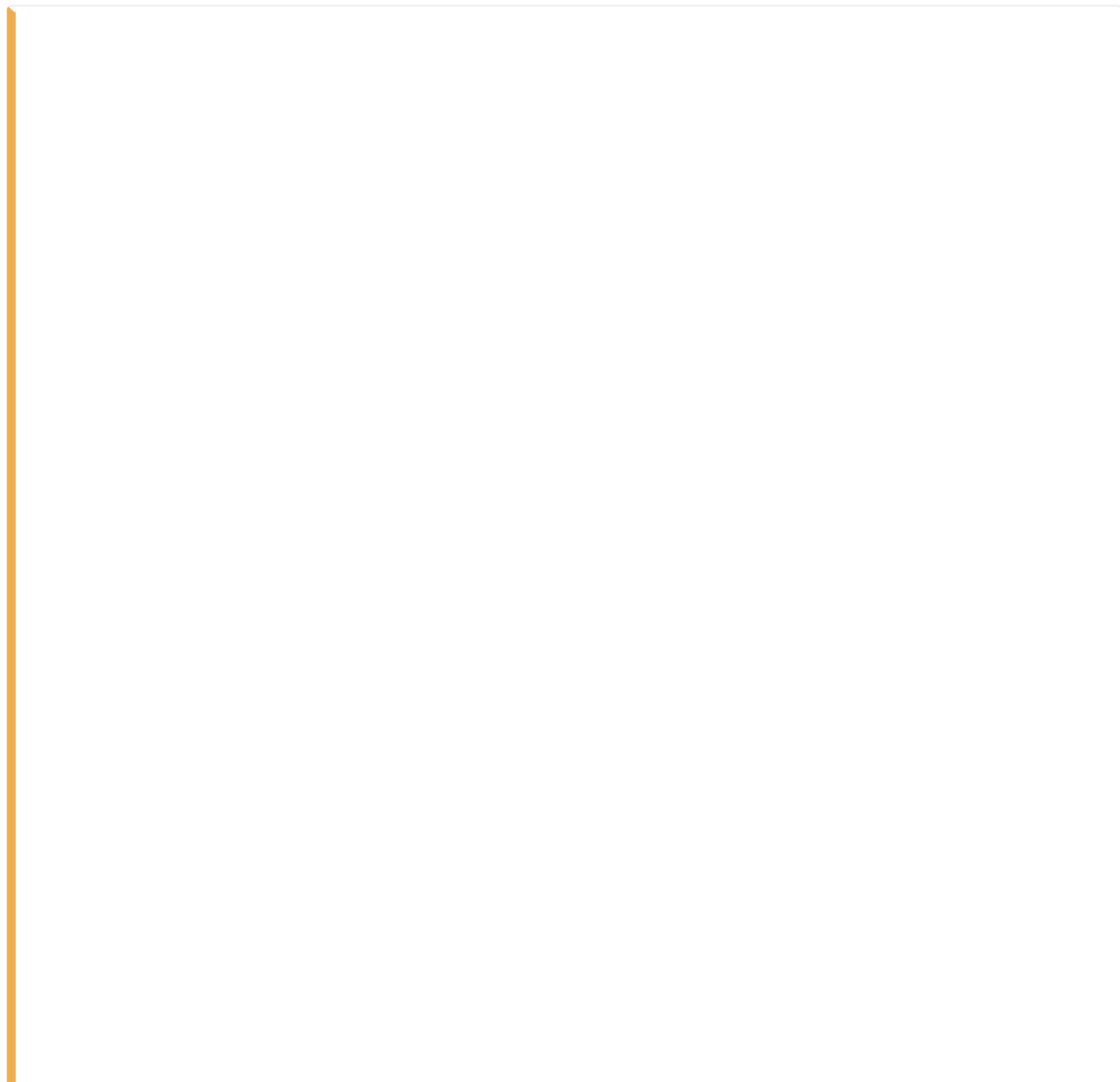
A circuit designed to filter the noise from a signal shall be analyzed.

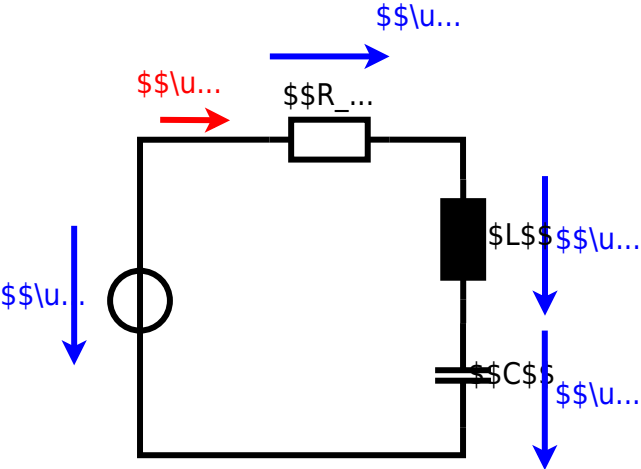
The input is given by a voltage source $u(t) = 3.0 \text{ V} \cdot \sin(2\pi \cdot 15 \text{ kHz} \cdot t)$ with an internal resistance of $10 \text{ } \Omega$.

This linear source is connected with an inductor of $330 \text{ } \mu\text{H}$ and a capacitor of $0.22 \text{ } \mu\text{F}$, all in series.

1. Draw the circuit diagram of the given circuit.
Label all components, voltages, and currents.

Result





2. Calculate the single impedance $\underline{Z}_C$, $\underline{Z}_L$ such as $\underline{Z}$ of the overall circuit.

Solution

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\begin{align*} Z_C &= \frac{1}{2\pi \cdot f \cdot C} \quad \&= \frac{1}{2\pi \cdot 15 \\ \sim \text{kHz} \cdot 0.22 \sim \text{μF}} \end{align*} \\ \begin{align*} Z_L &= 2\pi \cdot f \cdot L \quad \&= 2\pi \cdot 15 \sim \text{kHz} \cdot 0.22 \\ \sim \text{μF} \end{align*} \\ \begin{align*} Z_C &= \frac{1}{2\pi \cdot f \cdot C} \quad \&= \frac{1}{2\pi \cdot 15 \\ \sim \text{kHz} \cdot 330 \sim \text{μH}} \end{align*} \\ \begin{align*} \underline{Z} &= R + \underline{Z}_L + \underline{Z}_C \quad \&= R + j \\ \cdot \underline{Z}_L - j \cdot \underline{Z}_C \quad \&= R + j \cdot (\underline{Z}_L - \underline{Z}_C) \quad |\underline{Z}| &= \\ \sqrt{R^2 + (\underline{Z}_L - \underline{Z}_C)^2} \end{align*}
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Final result

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\begin{align*} Z_L &= 31.1 \sim \Omega \quad Z_C = 48.2 \sim \Omega \quad Z = 19.8 \sim \Omega \\ \end{align*}
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3. Draw the three impedance phasors $\underline{Z}_C$, $\underline{Z}_L$ and $\underline{Z}_R$ in a diagram.
Choose an appropriate scaling factor and write it down.

Result



4. Calculate the current $|\underline{I}|$.

Solution

$$\begin{aligned} Z &= \frac{\hat{U}}{\hat{I}} \quad \hat{I} = \frac{\hat{U}}{Z} \\ \end{aligned}$$

With $I = \frac{1}{\sqrt{2}} \cdot \hat{I}$:

$$\begin{aligned} I &= \frac{1}{\sqrt{2}} \cdot \frac{\hat{U}}{Z} = \frac{1}{\sqrt{2}} \cdot \frac{3.0 \text{ V}}{19.28 \text{ } \Omega} \\ \end{aligned}$$

Final result

$$I = 107 \text{ mA}$$

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