task_kricv9fh7haauo6q_with_calculation

Student Group

First Name	Surname	Matrikel Nr.

Table of Contents

complex impedance, exam ee1 WS2022

Exercise E1.1 Complex Impedance Circuit
(written test, approx. 15 % of a 60-minute written test, WS2022)

A linear source is given by the voltage source $u(t) = 3.0 ~{\rm V} \cdot \sin(2\pi \cdot 15 ~{\rm kHz} \cdot t)$ with an internal resistance of $10 ~\Omega$.
This linear source is connected with an inductor of $330 ~ {\rm µH}$ and a capacitor of $0.22 ~{\rm µF}$, all in series.

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

2. Calculate the complex impedances $\underline{Z}_R$, $\underline{Z}_L$, $\underline{Z}_C$ and $\underline{Z}$.

Solution

$$\begin{align*} Z_L &= 2\pi \cdot f \cdot L \\ &= 2\pi \cdot 15 ~{\rm kHz} \cdot 330 ~{\rm µH} \end{align*}$$

$$\begin{align*} Z_C &= {{1}\over{2\pi \cdot f \cdot C}}\\ &= {{1}\over{2\pi \cdot 15 ~{\rm kHz} \cdot 0.22 ~{\rm µF}}}\\ \end{align*}$$

$$\begin{align*} \underline{Z} &= R + \underline{Z}_L + \underline{Z}_C \\ &= R + j \cdot {Z}_L - j \cdot {Z}_C \\ &= R + j \cdot ({Z}_L - {Z}_C) \\ |\underline{Z}| &= \sqrt{R^2 + (\underline{Z}_L - \underline{Z}_C)^2 }\\ \end{align*}$$

Result

$$\begin{align*} Z_L &= 31.1 ~\Omega \\ Z_C &= 48.2 ~\Omega \\ Z &= 19.8 ~\Omega \end{align*}$$

3. Calculate the current.

Solution

$$\begin{align*} Z &= {{\hat{U}}\over{\hat{I}}} \\ \hat{I} &= {{\hat{U}}\over{Z}} \\ \end{align*}$$

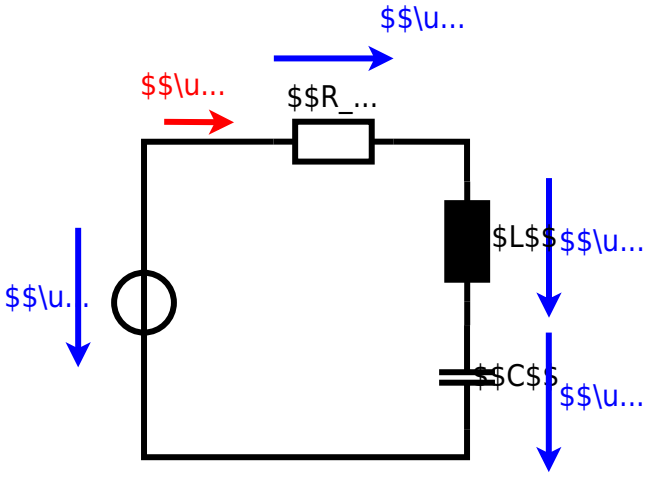
With $I = {{1}\over{\sqrt{2}}}\cdot \hat{I}$: $$\begin{align*} I &= {{1}\over{\sqrt{2}}}\cdot {{\hat{U}}\over{Z}} \\ &= {{1}\over{\sqrt{2}}}\cdot {{3.0 ~{\rm V}}\over{19.28 ~\Omega}} \\ \end{align*}$$

Result

$$\begin{align*} I = 107.3 ~{\rm mA} \end{align*}$$

4. Draw the ... diagram ... Choose an appropriate scaling factor and write it down.

Result


$$\u...
$$\u...
$$R_...
$L$$
$$\u...
$$\u...
$$C$$
$$\u...