task_kricv9fh7haauo6q_with_calculation

Student Group

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complex impedance, exam ee1 WS2022

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

a. Calculate the complex impedance $\underline{Z}$ and its magnitude $|\underline{Z}|$ and phase angle φ_Z of the circuit.
b. Calculate the current $i(t)$ by the voltage source $u(t) = 3.0 ~{\rm V} \cdot \sin(2\pi \cdot 15 ~{\rm kHz} \cdot t)$ with appropriate scaling factors and units.
c. Draw the circuit diagram of the given circuit.
Label all components, voltages, and currents.

Solution

This linear source is connected with an inductor of $330 ~ {\rm µH}$ and a capacitor of $0.22 ~{\rm µF}$, all in series.

Result

$$\begin{aligned} Z &= 107.31 ~\Omega \angle 63.6° \\ R &= 48.2 ~\Omega \\ Z &= 19.8 ~\Omega \end{aligned}$$

Result

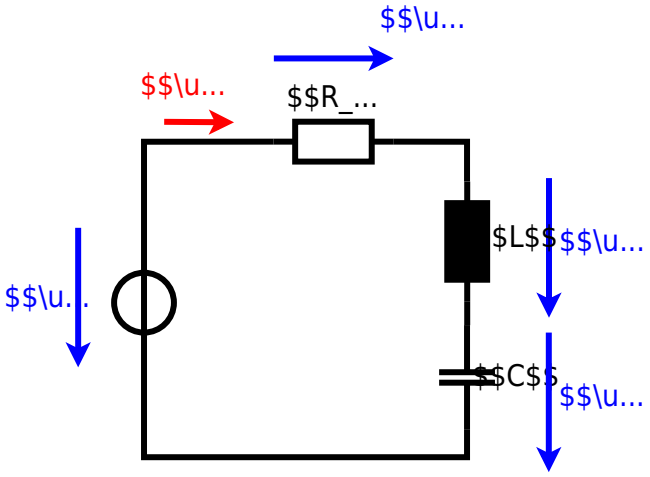
$$\begin{aligned} \hat{I} &= {{\hat{U}}\over{Z}} \\ &= {{\hat{U}}\over{\sqrt{2}}}\cdot {{1}\over{Z}} \\ &= {{1}\over{\sqrt{2}}}\cdot {{3.0 ~{\rm V}}\over{19.28 ~\Omega}} \end{aligned}$$

With $i = {{1}\over{\sqrt{2}}}\cdot \hat{I}$: $$\begin{aligned} i &= {{1}\over{\sqrt{2}}}\cdot {{3.0 ~{\rm V}}\over{19.28 ~\Omega}} \end{aligned}$$

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

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

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