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 circuit consists of a voltage source $u(t) = 3.0 ~{\rm V} \cdot \sin(2\pi \cdot 15 ~{\rm kHz} \cdot t)$ with 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 $\underline{Z}_C$, $\underline{Z}_L$ and $\underline{Z}_R$ ... Choose an appropriate scaling factor and write it down.

Solution

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

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

Result

$$Z_L = 31.1 ~\Omega \\ Z_C = 48.2 ~\Omega \\ Z = 19.8 ~\Omega$$

3. Calculate the complex total impedance $\underline{Z}$ ...

Solution

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

4. Calculate the current ...

Solution

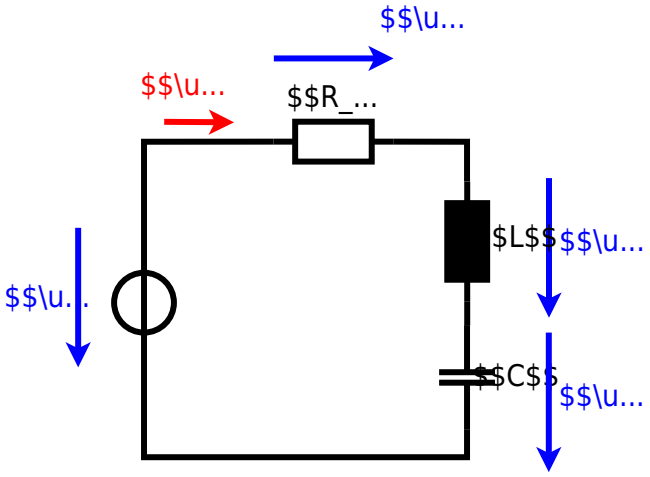
$$Z = {{\hat{U}}\over{\hat{I}}} \\ \hat{I} = {{\hat{U}}\over{Z}}$$

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

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

Result

$$I = 107.3 ~{\rm mA}$$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