task_kricv9fh7haauo6q_with_calculation

Student Group

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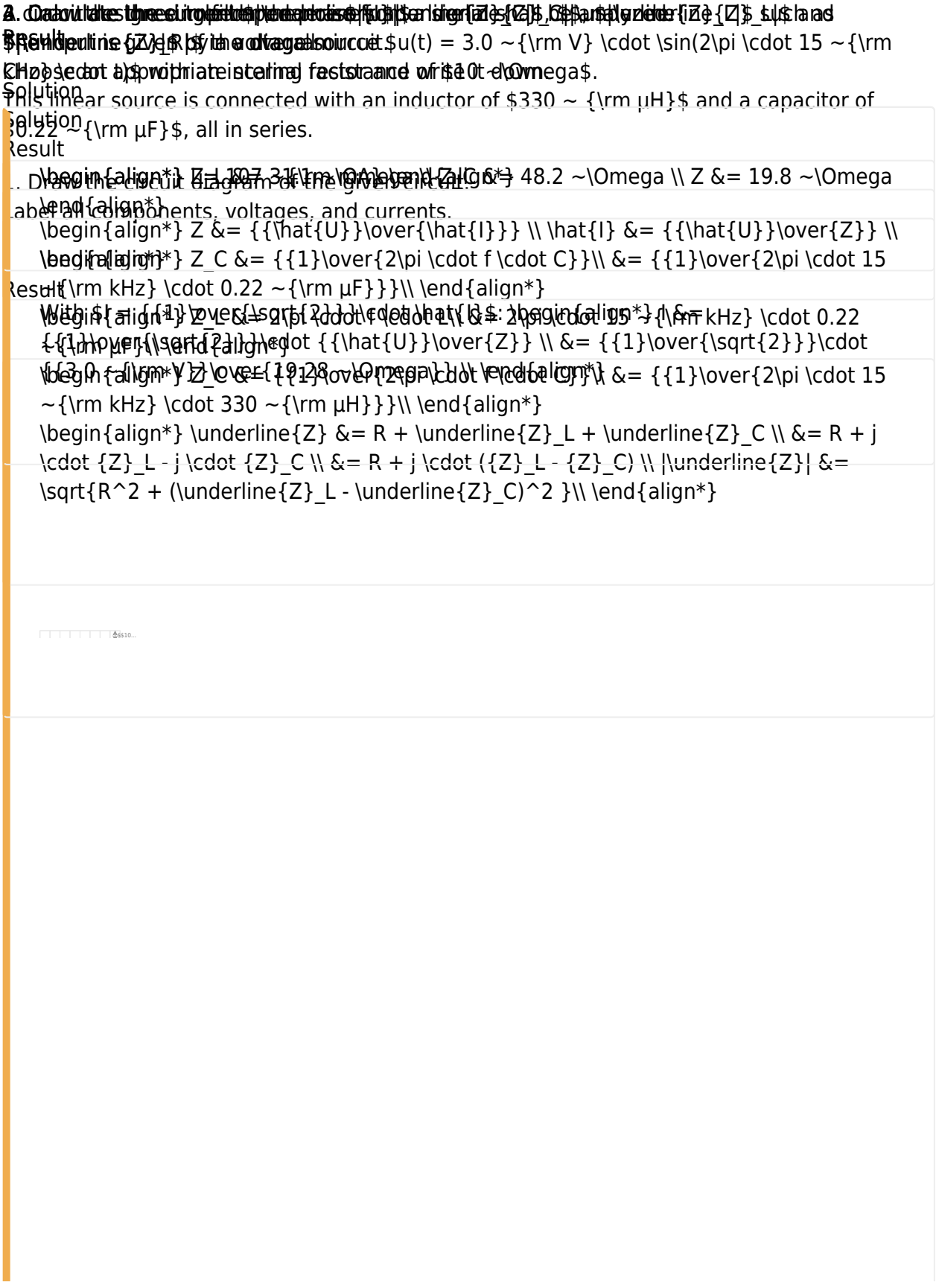
Table of Contents

complex impedance, exam ee1 WS2022

Exercise E14 Complex Impedance Circuit
(written test, approx. 15 % of a 60-minute written test, WS2022)



1. Draw the circuit diagram of the given circuit.
2. Label all components, voltages, and currents.
3. Calculate the complex impedance $\underline{Z}$ of the circuit.
4. Determine $|\underline{Z}|$ by the voltage source.
5. Choose a suitable coupling resistance of $10 ~\Omega$.

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

$$\begin{aligned} Z_L &= 307.31 ~\Omega \\ Z_C &= 48.2 ~\Omega \\ Z &= 19.8 ~\Omega \end{aligned}$$

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

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

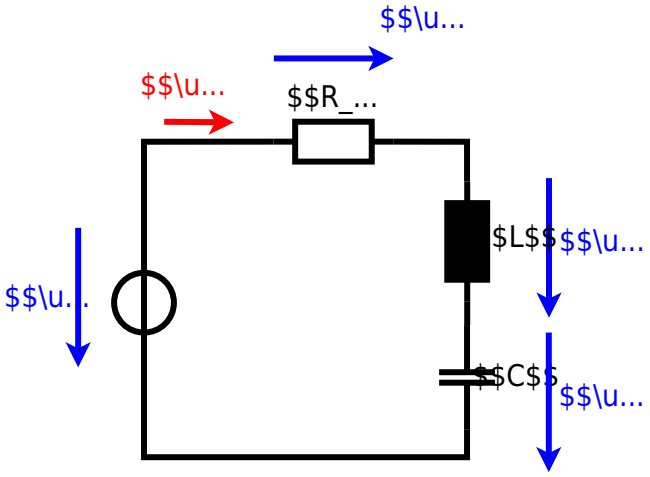
Result

$$\begin{aligned} Z_L &= 2\pi \cdot f \cdot L\\ &= 2\pi \cdot 15 ~{\rm kHz} \cdot 0.22 ~{\rm µF}\\ \end{aligned}$$

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

$$\begin{aligned} Z_C &= {{1}\over{2\pi \cdot f \cdot C}}\\ &= {{1}\over{2\pi \cdot 15 ~{\rm kHz} \cdot 330 ~{\rm µH}}}\\ \end{aligned}$$

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