task_kricv9fh7haauo6q_with_calculation

Student Group

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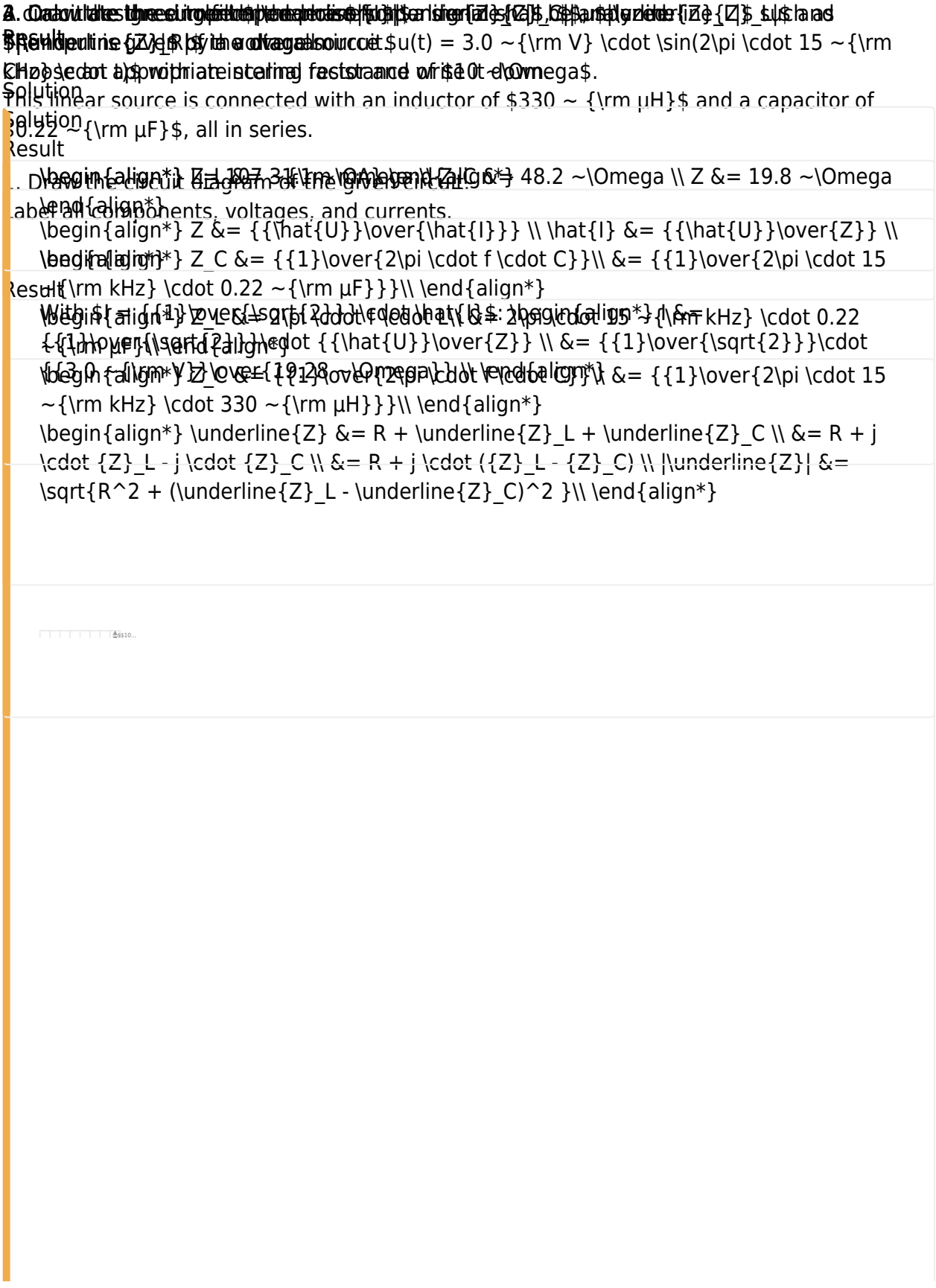
complex impedance, exam ee1 WS2022

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



2. Calculate the complex impedance $\underline{Z}$ and its magnitude $|\underline{Z}|$ and phase angle φ_Z of the circuit.
3. Calculate the current $\underline{I}$ and its magnitude $|\underline{I}|$ and phase angle φ_I of the current flowing through the circuit.
4. 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

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

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

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

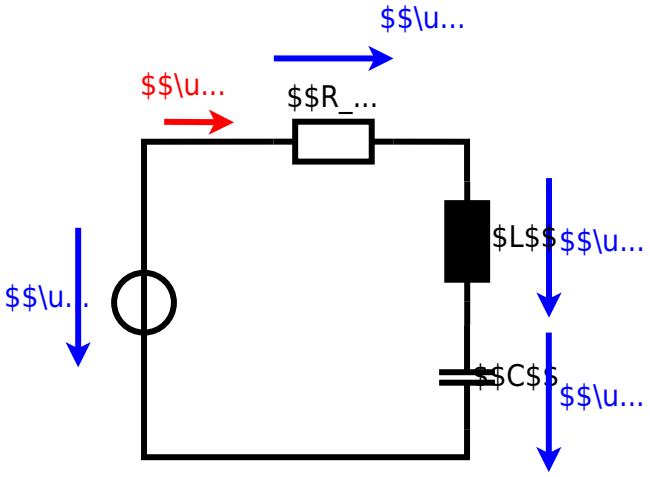
With $\hat{U} = {{1}\over{\sqrt{2}}}\cdot \hat{U}$:

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

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

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

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