

task_jti0uzudcmg4u22t_with_calculation

Student Group

First Name	Surname	Matrikel Nr.

Table of Contents

complex impedance, exam ee1 WS2022

Exercise 1.1 : Analyzing complex Impedances

(written test, approx. 14% of a 60-minute written test, WS2022)

A circuit with an ideal voltage source ($U=50 \text{ V}$, $f=330 \text{ Hz}$) and two components (R and X_1) shall be given.

After analysis, the following formula for the impedance was extracted:
$$\underline{Z} = \left(\frac{2}{3+4j} + 5j \right) \Omega$$

1. Calculate the physical values of the two components.

Solution

$$\begin{aligned} \underline{Z} &= \left(\frac{2}{3+4j} + 5j \right) \Omega \quad \&= \left(\frac{2}{3+4j} \cdot \frac{3-4j}{3-4j} + 5j \right) \Omega \quad \&= \left(\frac{2}{9+16} \cdot (3-4j) + 5j \right) \Omega \quad \&= (0.24 - 0.32j + 5j) \Omega \quad \&= 0.24 \Omega + j \cdot 4.68 \Omega \quad \&= R + j X_L \end{aligned}$$

With the complex part comes the physical value:
$$X_L = \omega L \quad \&= \frac{X_L}{2\pi \cdot f} \quad \&= \frac{4.68 \Omega}{2\pi \cdot 330 \text{ Hz}}$$

Final result

$$R = 0.24 \Omega \quad L = 2.26 \text{ mH}$$

2. Calculate the phase and absolute value of complex current $\underline{I}$ through the circuit.

Solution

$$\underline{I} = \frac{\underline{U}}{\underline{Z}} \quad \&= \frac{50 \text{ V}}{0.24 \Omega + j \cdot 4.68 \Omega} \quad \&= \frac{50 \text{ V}}{0.24 \Omega}$$

$$\frac{\sim\Omega + j \cdot 4.68 \sim\Omega}{0.24 \sim\Omega - j \cdot 4.68 \sim\Omega} \cdot \frac{0.24 \sim\Omega - j \cdot 4.68 \sim\Omega}{0.24 \sim\Omega - j \cdot 4.68 \sim\Omega} \parallel \&= \frac{50 \sim V}{0.24 \sim\Omega^2 + (4.68 \sim\Omega)^2} \cdot (0.24 \sim\Omega - j \cdot 4.68 \sim\Omega) \\ \parallel \end{align*}$$

The absolute value $|\underline{I}|$ can be calculated as:
$$|\underline{I}| \&= \frac{|\underline{U}|}{|\underline{Z}|} \parallel \&= \frac{50 \sim V}{0.24 \sim\Omega + j \cdot 4.68 \sim\Omega} \parallel \&= \frac{50 \sim V}{\sqrt{0.24 \sim\Omega^2 + (4.68 \sim\Omega)^2}} \end{align*}$$

The phase φ_i can be calculated as
$$\varphi_i \&= \arctan \left(\frac{\operatorname{Im}()}{\operatorname{Re}()} \right) \parallel \&= \arctan \left(\frac{-4.68 \sim\Omega}{0.24 \sim\Omega} \right) \parallel \end{align*}$$

Final result

$$\begin{align*} |\underline{I}| \&= 10.67 \sim A \parallel \varphi_i \&= -87.06^\circ \end{align*}$$

3. Now an additional component $\underline{X}_2$ shall be added in series to the two components.

This component shall be dimensioned in such a way that the current and voltage are in phase. Calculate these component value!

Solution

The current and voltage are in phase once there is only a pure ohmic (= pure real) resulting impedance $\underline{Z} + \underline{X}_2$.

Therefore, the component must be a capacitor with the same absolute value of impedance: $|\underline{X}_C| = |\underline{X}_L|$
$$X_C \&= \frac{1}{\omega \cdot C} = X_L \parallel C \&= \frac{1}{\omega \cdot X_L} \parallel \&= \frac{1}{2\pi \cdot 300 \sim \text{Hz} \cdot 4.68 \sim\Omega} \parallel \end{align*}$$

Final result

$$\begin{align*} C = 103 \sim \mu F \end{align*}$$

From:
<https://wiki.mexle.te.hs-heilbronn.de/> - **MEXLE Wiki**

Permanent link:
https://wiki.mexle.te.hs-heilbronn.de/electrical_engineering_1/task_jti0uzudcmg4u22t_with_calculation?rev=1678464096

Last update: **2023/03/10 17:01**

