

task_jti0uzudcmg4u22t_with_calculation

Student Group

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Exercise E1.1 Analyzing complex Impedances

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

2. Calculate the complex impedance $\underline{Z}$ of the circuit in Fig. 1. The voltage $\underline{U}$ and the current $\underline{I}$ shall be given.

After analysis, the full bridge is one of the impedances that is extracted and brought into phase. Calculate the voltage $\underline{U}$ and the current $\underline{I}$ in the circuit.

... Calculate the physical values of the components.

Solution: $\underline{Z} = \frac{\underline{U}}{\underline{I}} = \frac{10 \angle 0^\circ}{0.67 \angle -2.6^\circ} = 14.93 \angle 2.6^\circ \Omega$

Solution

$\underline{I} = \frac{\underline{U}}{\underline{Z}} = \frac{10 \angle 0^\circ}{14.93 \angle 2.6^\circ} = 0.67 \angle -2.6^\circ \text{ A}$

The current $\underline{I}$ and voltage $\underline{U}$ are in phase. The voltage $\underline{U}$ is the sum of the voltage drops across the components. The voltage drop across the resistor is $\underline{U}_R = \underline{I} \cdot R = 0.67 \angle -2.6^\circ \cdot 10 = 6.7 \angle -2.6^\circ \text{ V}$. The voltage drop across the inductor is $\underline{U}_L = \underline{I} \cdot j\omega L = 0.67 \angle -2.6^\circ \cdot j \cdot 2\pi \cdot 300 \cdot 0.01 = 12.8 \angle 67.4^\circ \text{ V}$. The voltage drop across the capacitor is $\underline{U}_C = \underline{I} \cdot \frac{1}{j\omega C} = 0.67 \angle -2.6^\circ \cdot \frac{1}{j \cdot 2\pi \cdot 300 \cdot 10^{-6}} = -3.6 \angle 87.4^\circ \text{ V}$. The total voltage drop is $\underline{U} = \underline{U}_R + \underline{U}_L + \underline{U}_C = 6.7 \angle -2.6^\circ + 12.8 \angle 67.4^\circ - 3.6 \angle 87.4^\circ = 10 \angle 0^\circ \text{ V}$.

With the complex exponent φ (comes from the physical values) $\varphi = \arctan\left(\frac{\text{Im}(\underline{Z})}{\text{Re}(\underline{Z})}\right) = \arctan\left(\frac{4.68}{0.24}\right) = 87.4^\circ$.

The phase φ can be calculated as $\varphi = \arctan\left(\frac{\text{Im}(\underline{Z})}{\text{Re}(\underline{Z})}\right) = \arctan\left(\frac{4.68}{0.24}\right) = 87.4^\circ$.

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