

task_jti0uzudcmg4u22t_with_calculation

Student Group

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Exercise E1 Analyzing complex Impedances (written test, approx. 14 % of a 60-minute written test, WS2022)

2. Calculate the phasor voltage \underline{U} and the current \underline{I} in the circuit shown in the figure. The components (R and X_L) shall be given.

After analysis, the full width dimensioned phasor voltage \underline{U} and current \underline{I} in phase (in Z) are $\underline{U} = 10 \sqrt{2} \cos(\omega t + 45^\circ)$ V and $\underline{I} = 5 \sqrt{2} \cos(\omega t - 45^\circ)$ A.

Solution
.. Calculation of physical values of the components.
Solution $R = 10 \sqrt{2} \cos(\omega t + 45^\circ)$ V and $X_L = 10 \sqrt{2} \cos(\omega t - 45^\circ)$ A

Solution
$$\underline{I} = \frac{\underline{U}}{Z} \quad \text{with } Z = R + jX_L = 10 \sqrt{2} \cos(\omega t + 45^\circ) + j 10 \sqrt{2} \cos(\omega t - 45^\circ)$$

The current and voltage across the capacitor is $\underline{U}_C = \underline{U} \cdot \frac{1}{1 + j}$
resulting in $\underline{U}_C = 0.24 \sqrt{2} \cos(\omega t + 45^\circ)$ V and $\underline{I}_C = 0.24 \sqrt{2} \cos(\omega t - 45^\circ)$ A
The voltage across the resistor is $\underline{U}_R = \underline{U} \cdot \frac{1}{1 - j}$
resulting in $\underline{U}_R = 0.24 \sqrt{2} \cos(\omega t - 45^\circ)$ V and $\underline{I}_R = 0.24 \sqrt{2} \cos(\omega t + 45^\circ)$ A
The current through the resistor is $\underline{I}_R = \frac{\underline{U}_R}{R} = \frac{0.24 \sqrt{2} \cos(\omega t - 45^\circ)}{10 \sqrt{2}} = 0.024 \cos(\omega t - 45^\circ)$ A
The current through the capacitor is $\underline{I}_C = \frac{\underline{U}_C}{X_L} = \frac{0.24 \sqrt{2} \cos(\omega t + 45^\circ)}{10 \sqrt{2}} = 0.024 \cos(\omega t + 45^\circ)$ A
The total current is $\underline{I} = \underline{I}_R + \underline{I}_C = 0.024 \sqrt{2} \cos(\omega t - 45^\circ) + 0.024 \sqrt{2} \cos(\omega t + 45^\circ)$ A
Using the phasor method, the total current is $\underline{I} = 0.24 \sqrt{2} \cos(\omega t - 45^\circ)$ A
The voltage across the resistor is $\underline{U}_R = \underline{I} \cdot R = 0.24 \sqrt{2} \cos(\omega t - 45^\circ) \cdot 10 \sqrt{2} = 2.4 \cos(\omega t - 45^\circ)$ V
The voltage across the capacitor is $\underline{U}_C = \underline{I} \cdot X_L = 0.24 \sqrt{2} \cos(\omega t - 45^\circ) \cdot 10 \sqrt{2} = 2.4 \cos(\omega t - 45^\circ)$ V
The total voltage is $\underline{U} = \underline{U}_R + \underline{U}_C = 2.4 \cos(\omega t - 45^\circ) + 2.4 \cos(\omega t - 45^\circ) = 4.8 \cos(\omega t - 45^\circ)$ V
Using the phasor method, the total voltage is $\underline{U} = 10 \sqrt{2} \cos(\omega t + 45^\circ)$ V

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