

task_pdkggyexxy1ktu3_with_calculation

Student Group

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Exercise E7 Impedances at different Frequencies

(written test, approx. 18 % of a 60-minute written test, WS2022)

2. A series circuit consists of a resistor $R_1 = 1.00 \text{ k}\Omega$, an inductor $L = 4.7 \text{ }\mu\text{H}$, and a capacitor $C = 40 \text{ nF}$. The circuit is connected to an AC voltage source $U = 10.0 \text{ V}$ at a frequency $f = 4 \text{ MHz}$. Calculate the absolute value of the impedance $|Z|$ of the circuit.

Solution

$$R_1 = 1.00 \text{ k}\Omega$$

$$R_2 = 10.0 \text{ }\Omega$$

A series circuit means that the current is constant on every component.

The equivalent impedance for R and L combined is given by

$$Z_{RL} = R + j\omega L$$

$$Z_{RL} = 1.00 \text{ k}\Omega + j(2\pi \cdot 4 \text{ MHz} \cdot 4.7 \text{ }\mu\text{H})$$

$$Z_{RL} = 1.00 \text{ k}\Omega + j118 \text{ }\Omega$$

$$|Z_{RL}| = \sqrt{R^2 + (X_L)^2} = \sqrt{(1.00 \text{ k}\Omega)^2 + (118 \text{ }\Omega)^2} = 1.00 \text{ k}\Omega$$

$$Z_{LC} = -j\omega C = -j(2\pi \cdot 4 \text{ MHz} \cdot 40 \text{ nF}) = -j100 \text{ }\Omega$$

$$Z = Z_{RL} + Z_{LC} = 1.00 \text{ k}\Omega - j100 \text{ }\Omega$$

$$|Z| = \sqrt{R^2 + (X_C)^2} = \sqrt{(1.00 \text{ k}\Omega)^2 + (100 \text{ }\Omega)^2} = 1.00 \text{ k}\Omega$$

$$I = \frac{U}{|Z|} = \frac{10.0 \text{ V}}{1.00 \text{ k}\Omega} = 10.0 \text{ mA}$$

$$I_{R1} = I = 10.0 \text{ mA}$$

$$I_{R2} = I = 10.0 \text{ mA}$$

$$I_{L1} = I = 10.0 \text{ mA}$$

$$I_{L2} = I = 10.0 \text{ mA}$$

$$I_{C1} = I = 10.0 \text{ mA}$$

$$I_{C2} = I = 10.0 \text{ mA}$$

$$I_{C3} = I = 10.0 \text{ mA}$$

$$I_{C4} = I = 10.0 \text{ mA}$$

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