Answer Question#61364 Physics – Electromagnetism

13) An ac circuit consists of voltage source $V = 200 \sin 120\pi t$ and a $6\mu F$ capacitor in series. Calculate the current establish in the circuit

a) 0.32A

b) 1.24A

c) 0.64A

d) 2.13A

Solution. Capacitive reactance can be calculate using formula $X_C = \frac{1}{\omega C}$ (where $\omega = 2\pi f$, f – frequency, C – capacitance). Using Ohm's law $I = \frac{V}{X_C}$. Hence $I = \frac{V}{X_C} = \frac{200 \sin 120\pi t}{\frac{1}{\omega C}} = 200\omega C \sin 120\pi t$.

$I = 200\omega C \sin 120\pi t = 200 \cdot 120\pi \cdot 6 \cdot 10^{-6} \sin 120\pi t = 0.452 \sin 120\pi t$

$\mathrm{I_{max}} = 0.452\mathrm{A}$. The current establish in the circuit $I = \frac{\mathrm{I_{max}}}{\sqrt{2}} = \frac{0.452}{\sqrt{2}} \approx 0.32A$.

Answer. a) 0.32A

14) An RLC circuit contains an as voltage source with rms value of 50V and has frequency of 600Hz. Suppose that a resistance $R = 20\Omega$, capacitance $C = 10.0\mu F$ and an inductance $L = 4.0mH$ are connected in series to the source. Find the current in the circuit and the voltmeter reading across the inductor.

a) 2.17A and 32.8V

b) 1.6A and 24.2V

c) 0.13A and 12.1V

d) 4.0A and 23.1V

Solution. We can find capacitive reactance and inductive reactance using formula:

$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$, $X_L = \omega L = 2\pi f L$.

According to the condition of the problem $f = 600Hz$ – frequency; $L = 4 \cdot 10^{-3}H$ – inductance, $C = 10.0 \cdot 10^{-6}F$ – capacitance. Substituting these values get

$X_C = \frac{1}{2\pi \cdot 600 \cdot 10.0 \cdot 10^{-6}} \approx 26.5\Omega$

$X_L = 2\pi \cdot 600 \cdot 4 \cdot 10^{-3} \approx 15.1\Omega$

We can find impedance of an RLC series circuit using formula:

$Z = \sqrt{R^2 + (X_L - X_C)^2} \to Z = \sqrt{20^2 + (15.1 - 26.5)^2} \approx 23\Omega$.

Find current using Ohm's law formula: $I = \frac{V}{z} \to I = \frac{50V}{23\Omega} \approx 2.17A$.

Using Ohm's law formula for inductor get $I = \frac{V_L}{X_L} \to V_L = IX_L = 2.17 \cdot 15.1 \approx 32.8V$. (current same because in series).

Answer. a) 2.17A and 32.8V.