ALTERNATIVE CURRENT PROBLEMS & ANSWERS

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سلسلة أينشتاين الخليج

A 100 Ω resistor is connected to a 220 V, 50 Hz ac supply.

(a) What is the rms value of current in the circuit?

(b) What is the net power consumed over a full cycle?

Answer

Resistance of the resistor, R = 100 Ω, Supply voltage, V = 220 V, Frequency, ν = 50 Hz

(a) The rms value of current in the circuit is given as

$$I = \frac{V}{R} = \frac{220}{100} = 2.20\ A$$

(b) The net power consumed over a full cycle is given as: P = VI = 220 × 2.2 = 484 W

(a) The peak voltage of an ac supply is 300 V. What is the rms voltage?

(b) The rms value of current in an ac circuit is 10 A. What is the peak current?

Answer

(a) Peak voltage of the ac supply, V_0 = 300 V_{rms} voltage is given as:

$$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{300}{\sqrt{2}} = 212.1\ V$$

(c) The rms value of current is given as: I = 10 A

Now, peak current is given as: $I_0 = \sqrt{2}I = \sqrt{2} \times 10 = 14.1\ A$

A 44 mH inductor is connected to 220 V, 50 Hz ac sup[illegible]. Determine the rms value of the current in the circuit.

Answer

Inductance of inductor, L = 44 mH = 44 × 10^{-3} H

Supply voltage, V = 220 V, Frequency, ν = 50 Hz, Angular frequency, ω = 2πν

Inductive reactance, $X_L = \omega L = 2\pi\nu L = 2\pi \times 50 \times 44 \times 10^{-3}\ \Omega$

rms value of current is given as:

$$I = \frac{V}{X_L} = \frac{220}{2\pi \times 50 \times 44 \times 10^{-3}} = 15.92\ A$$

Hence, the rms value of current in the circuit is 15.92 A.

A 60 μF capacitor is connected to a 110 V, 60 Hz ac supply. Determine the rms value of the current in the circuit.

Answer

Capacitance of capacitor, C = 60 μF = 60 × 10^{-6} F

Supply voltage, V = 110 V

Frequency, ν = 60 Hz

Angular frequency, ω = 2πν

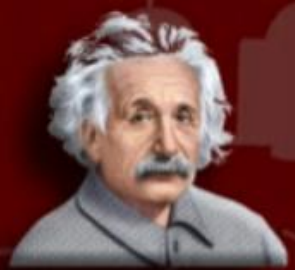
Capacitive reactance,

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi\nu C} = \frac{1}{2\pi \times 60 \times 60 \times 10^{-6}}\ \Omega$$

rms value of current is given as:

$$I = \frac{V}{X_C} = \frac{220}{2\pi \times 60 \times 60 \times 10^{-6}} = 2.49\ A$$

Hence, the rms value of current is 2.49 A.



In Exercises 7.3 and 7.4, what is the net power absorbed by each circuit over a complete cycle. Explain your answer.

Answer

In the inductive circuit,

rms value of current, I = 15.92 A

rms value of voltage, V = 220 V

Hence, the net power absorbed can be obtained by the relation,

$$P = VI \cos \Phi$$

Where, Φ = Phase difference between V and I.

For a pure inductive circuit, the phase difference between alternating voltage and current is 90° i.e., $\Phi = 90°$.

Hence, P = 0 i.e., the net power is zero.

In the capacitive circuit, rms value of current, I = 2.49 A, rms value of voltage, V = 110 V

Hence, the net power absorbed can be obtained as:

$$P = VI \, Cos \, \Phi$$

For a pure capacitive circuit, the phase difference between alternating voltage and current is 90° i.e., $\Phi = 90°$.

Hence, P = 0 i.e., the net power is zero.

Obtain the resonant frequency ω_r of a series LCR circuit with L = 2.0 H, C = 32 μF and R = 10 Ω. What is the Q-value of this circuit?

Answer

Inductance, L = 2.0 H

Capacitance, C = 32 μF = 32 × 10^{-6} F

Resistance, R = 10 Ω

Resonant frequency is given by the relation,

$$\omega_r = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2 \times 32 \times 10^{-6}}} = \frac{1}{8 \times 10^{-3}} = 125 \ rad/s.$$

Now, Q-value of the circuit is given as:

$$Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{10}\sqrt{\frac{2}{32 \times 10^{-6}}} = \frac{1}{10 \times 4 \times 1}$$

Hence, the Q-Value of this circuit is 25