



Class XII : Physics  
Chapter 7 : Alternating Current

Questions and Solutions | Exercises - NCERT Books

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

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

**Ans:** It is given that,

Resistance,  $R = 100\Omega$

Voltage,  $V = 220V$

Frequency,  $f = 50Hz$

It is known that,

$$I_{rms} = \frac{V_{rms}}{R}$$

$$= \frac{220}{100} = 2.2A$$

Therefore, the rms value of current in the circuit is  $I_{rms} = 2.2A$ .

**(b) What is the net power consumed over a full cycle?** **Ans:** It is known that,

$$Power = VI$$

$$Power = 220 \times 2.2$$

$$Power = 484W$$

Therefore, the net power consumed over a full cycle is 484W.

**2.**

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

**Ans:** It is given that,

Peak voltage of the ac supply,  $V_0 = 300V$  It is known that,

$$V_{\text{rms}} = \frac{V_0}{\sqrt{2}}$$

$$= \frac{300}{\sqrt{2}}$$

$$= 212.1 \text{ V}$$

Therefore, the rms voltage is 212.1V.

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

**Ans:** It is given that,

Rms value of current in an ac circuit,  $I_{\text{rms}} = 10 \text{ A}$  It

is known that,

$$I_0 = \sqrt{2} I_{\text{rms}}$$

$$= 1.414 \times 10$$

$$= 14.14 \text{ A}$$

Therefore, the peak current is 14.14A.

**3. A 44mH inductor is connected to 220V ,50Hz ac supply. Determine the rms value of the current in the circuit.**

**Ans:** It is known that,

Inductance,  $L = 44 \text{ mH} = 44 \times 10^{-3} \text{ H}$

Voltage,  $V = 220 \text{ V}$

Frequency,  $f_L = 50 \text{ Hz}$

Angular frequency,  $\omega = 2\pi f_L$

It is known that,

Inductive reactance,  $X_L = \omega L = 2\pi f L$

$$= 2 \times 3.14 \times 50 \times 44 \times 10^{-3}$$

$$= 13.8$$

$$I_{\text{rms}} = \frac{V}{X_L}$$



$$X_L = 220$$

$$I_{rms} = \frac{V}{X_L} = \frac{110}{13.82}$$

$$I_{rms} = 15.92A$$

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

**4. A 60  $\mu$ F capacitor is connected to a 110V,60Hz ac supply. Determine the rms value of the current in the circuit.**

**Ans:** It is given that,

$$\text{Capacitance, } C = 60 \mu\text{F} = 60 \times 10^{-6}\text{F}$$

$$\text{Voltage, } V = 110\text{V}$$

$$\text{Frequency, } f_c = 60\text{Hz}$$

It is known that,

$$I_{rms} = \frac{V}{X_C}$$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$$

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

$$X_C = 44.248 \Omega$$

$$I_{rms} = \frac{110}{44.28}$$

$$I_{rms} = 2.488A$$

Therefore, the rms value of the current in the circuit is 2.488A.

**5. In exercises 7.3 and 7.4 What is the net power absorbed by each circuit over a complete cycle? Explain your answer.**

**Ans:** From the inductive circuit,

Rms value of current,  $I_{\text{rms}} = 15.92\text{A}$

Rms value of voltage,  $V_{\text{rms}} = 220\text{V}$

It is known that,

Net power absorbed,  $P = V_{\text{rms}} I_{\text{rms}} \cos\phi$

Where,

$\phi$  is the phase difference between voltage and current

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

$$P = 220 \times 15.92 \times \cos 90^\circ = 0$$

Therefore, net power absorbed is zero in a pure inductive circuit. In a capacitive circuit,

Rms value of current,  $I_{\text{rms}} = 2.49\text{A}$

Rms value of voltage,  $V_{\text{rms}} = 110\text{V}$

It is known that,

Net power absorbed,  $P = V_{\text{rms}} I_{\text{rms}} \cos\phi$

Where,

$\phi$  is the phase difference between voltage and current

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

$$P = 110 \times 2.49 \times \cos 90^\circ = 0$$

Therefore, net power absorbed is zero in a pure capacitive circuit.



**6. A charged  $30\mu\text{F}$  capacitor is connected to a  $27\text{mH}$  inductor. What is the angular frequency of free oscillations of the circuit? Ans:** It is given that,

Capacitance,  $C = 30 \times 10^{-6}\text{F}$

Inductance,  $L = 27\text{mH} = 27 \times 10^{-3}\text{H}$

It is known that,

Angular frequency of free oscillations,  $\omega = \frac{1}{\sqrt{LC}}$

$$\omega = \frac{1}{\sqrt{27 \times 10^{-3} \times 30 \times 10^{-6}}}$$

$$\omega = \frac{1}{9 \times 10^{-4}}$$

$$\omega = 1.11 \times 10^3 \text{ rad / s}$$

Therefore, the angular frequency of free oscillations of the circuit is  $1.11 \times 10^3 \text{ rad / s}$ .



**7. A series LCR circuit with  $R = 20\Omega$ ,  $L = 1.5H$  and  $C = 35 \mu F$  is connected to a variable frequency 200V ac supply. When the frequency of the supply equals the natural frequency of the circuit, what is the average power transferred to the circuit in one complete cycle?**

**Ans:** It is known that,

Resistance,  $R = 20\Omega$

Inductance,  $L = 1.5H$

Capacitance,  $C = 35 \times 10^{-6}F$

Voltage,  $V = 200V$

It is known that,

Impedance,  $Z = \sqrt{R^2 + (X_L - X_C)^2}$

At resonance,  $X_L = X_C$

$Z = R = 20\Omega$

$V = 200$

$I = \frac{V}{Z}$

$Z = 20$

$I = 10A$

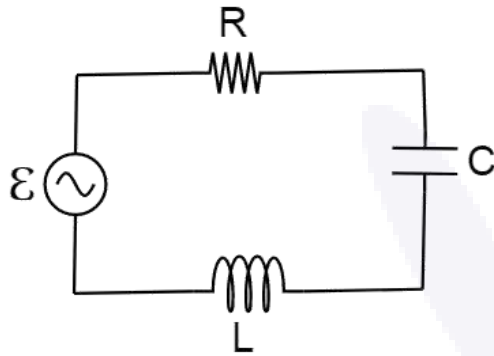
Average power,  $P = I^2 R$

$P = 10^2 \times 20$

$P = 2000W$

Therefore, the average power transferred is 2000W.

8. Figure shows a series LCR circuit connected to a variable frequency 230V source.  $L = 5.0\text{H}$ ,  $C = 80\text{ }\mu\text{F}$ ,  $R = 40\text{ }\Omega$ .



(a) Determine the source frequency which drives the circuit in resonance.

**Ans:** It is given that,

Voltage,  $V = 230\text{V}$

Inductance,  $L = 5.0\text{H}$

Capacitance,  $C = 80\text{ }\mu\text{F} = 80 \times 10^{-6}\text{F}$

Resistance,  $R = 40\text{ }\Omega$

It is known that,

$$\text{Source frequency at resonance} = \frac{1}{\sqrt{LC}}$$



$$\frac{1}{\sqrt{58010}} \omega^6 = 50 \text{ rad / s}$$

Therefore, the source frequency of the circuit in resonance is 50 rad / s.

**b) Obtain the impedance of the circuit and the amplitude of current at the resonating frequency.**

**Ans:** It is known that,

At resonance, Impedance,  $Z = \text{Resistance, } R$

$$Z = R = 40 \Omega$$

$V$

$$I = \frac{V}{Z}$$

$Z$

$$I = \frac{230}{40} = 5.75 \text{ A}$$

Amplitude,  $I_0 = 1.414 I$

$$I_0 = 1.414 \times 5.75$$

$$I_0 = 8.13 \text{ A}$$

Therefore, the impedance of the circuit is  $40 \Omega$  and the amplitude of current at resonating frequency is 8.13 A.

**c) Determine the rms potential drops across the three elements of the circuit. Show that the potential drop across the LC combination is zero at the resonating frequency.**

**Ans:** It is known that,

Potential drop,  $V = IR$

Across resistor,  $V_R = IR$

$$V_R = 5.75 \times 40 = 230 \text{ V}$$

$I$

Across capacitor,  $V_C = IX_C = \frac{V}{C}$

$C$

$$V_C = 5.75 \times \frac{1}{50 \times 80 \times 10^{-6}}$$





$$V_C = 1437.5V$$

Across Inductor,  $V_L = I X_L = I L$

$$V_L = 5.75 \times 505$$

$$V_L = 1437.5V$$

Across LC combination,  $V_{LC} = I(X_L - X_C)$

At resonance,  $X_L = X_C$

$$V_{LC} = 0$$

Therefore, the rms potential drop across Resistor is 230V, Capacitor is 1437.5V, Inductor is 1437.5V and the potential drop across LC combination is zero at resonating frequency.