

## Chapter Seven

# ALTERNATING CURRENT



### MCQ 1

- 7.1** If the rms current in a 50 Hz ac circuit is 5 A, the value of the current  $1/300$  seconds after its value becomes zero is
- (a)  $5\sqrt{2}$  A
  - (b)  $5\sqrt{3/2}$  A
  - (c)  $5/6$  A
  - (d)  $5/\sqrt{2}$  A
- 7.2** An alternating current generator has an internal resistance  $R_g$  and an internal reactance  $X_g$ . It is used to supply power to a passive load consisting of a resistance  $R_L$  and a reactance  $X_L$ . For maximum power to be delivered from the generator to the load, the value of  $X_L$  is equal to
- (a) zero.
  - (b)  $X_g$ .
  - (c)  $-X_g$ .
  - (d)  $R_g$ .

- 7.3** When a voltage measuring device is connected to AC mains, the meter shows the steady input voltage of 220V. This means
- input voltage cannot be AC voltage, but a DC voltage.
  - maximum input voltage is 220V.
  - the meter reads not  $v$  but  $\langle v^2 \rangle$  and is calibrated to read  $\sqrt{\langle v^2 \rangle}$ .
  - the pointer of the meter is stuck by some mechanical defect.
- 7.4** To reduce the resonant frequency in an LCR series circuit with a generator
- the generator frequency should be reduced.
  - another capacitor should be added in parallel to the first.
  - the iron core of the inductor should be removed.
  - dielectric in the capacitor should be removed.
- 7.5** Which of the following combinations should be selected for better tuning of an LCR circuit used for communication?
- $R = 20 \Omega$ ,  $L = 1.5 \text{ H}$ ,  $C = 35 \mu\text{F}$ .
  - $R = 25 \Omega$ ,  $L = 2.5 \text{ H}$ ,  $C = 45 \mu\text{F}$ .
  - $R = 15 \Omega$ ,  $L = 3.5 \text{ H}$ ,  $C = 30 \mu\text{F}$ .
  - $R = 25 \Omega$ ,  $L = 1.5 \text{ H}$ ,  $C = 45 \mu\text{F}$ .
- 7.6** An inductor of reactance  $1 \Omega$  and a resistor of  $2 \Omega$  are connected in series to the terminals of a 6 V (rms) a.c. source. The power dissipated in the circuit is
- 8 W.
  - 12 W.
  - 14.4 W.
  - 18 W.
- 7.7** The output of a step-down transformer is measured to be 24 V when connected to a 12 watt light bulb. The value of the peak current is
- $1/\sqrt{2} \text{ A}$ .
  - $\sqrt{2} \text{ A}$ .
  - 2 A.
  - $2\sqrt{2} \text{ A}$ .

## MCQ II

- 7.8** As the frequency of an ac circuit increases, the current first increases and then decreases. What combination of circuit elements is most likely to comprise the circuit?
- Inductor and capacitor.
  - Resistor and inductor.
  - Resistor and capacitor.
  - Resistor, inductor and capacitor.
- 7.9** In an alternating current circuit consisting of elements in series, the current increases on increasing the frequency of supply. Which of the following elements are likely to constitute the circuit ?
- Only resistor.
  - Resistor and an inductor.
  - Resistor and a capacitor.
  - Only a capacitor.
- 7.10** Electrical energy is transmitted over large distances at high alternating voltages. Which of the following statements is (are) correct?
- For a given power level, there is a lower current.
  - Lower current implies less power loss.
  - Transmission lines can be made thinner.
  - It is easy to reduce the voltage at the receiving end using step-down transformers.
- 7.11** For an *LCR* circuit, the power transferred from the driving source to the driven oscillator is  $P = I^2 Z \cos \phi$ .
- Here, the power factor  $\cos \phi \geq 0$ ,  $P \geq 0$ .
  - The driving force can give no energy to the oscillator ( $P = 0$ ) in some cases.
  - The driving force cannot syphon out ( $P < 0$ ) the energy out of oscillator.
  - The driving force can take away energy out of the oscillator.
- 7.12** When an AC voltage of 220 V is applied to the capacitor *C*
- the maximum voltage between plates is 220 V.
  - the current is in phase with the applied voltage.
  - the charge on the plates is in phase with the applied voltage.
  - power delivered to the capacitor is zero.

**7.13** The line that draws power supply to your house from street has

- (a) zero average current.
- (b) 220 V average voltage.
- (c) voltage and current out of phase by  $90^\circ$ .
- (d) voltage and current possibly differing in phase  $\phi$  such that

$$|\phi| < \frac{\pi}{2}.$$

**VSA**

**7.14** If a *LC* circuit is considered analogous to a harmonically oscillating spring block system, which energy of the *LC* circuit would be analogous to potential energy and which one analogous to kinetic energy?

**7.15** Draw the effective equivalent circuit of the circuit shown in Fig 7.1, at very high frequencies and find the effective impedance.

**7.16** Study the circuits (a) and (b) shown in Fig 7.2 and answer the following questions.

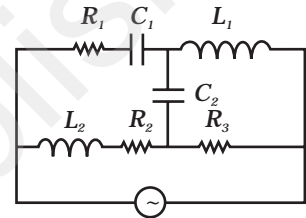
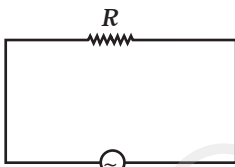
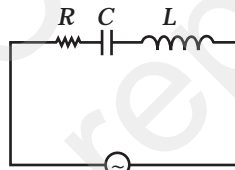


Fig. 7.1



(a)



(b)

Fig. 7.2

- (a) Under which conditions would the rms currents in the two circuits be the same?
- (b) Can the rms current in circuit (b) be larger than that in (a)?

**7.17** Can the instantaneous power output of an ac source ever be negative? Can the average power output be negative?

**7.18** In series LCR circuit, the plot of  $I_{\max}$  vs  $\omega$  is shown in Fig 7.3. Find the bandwidth and mark in the figure.

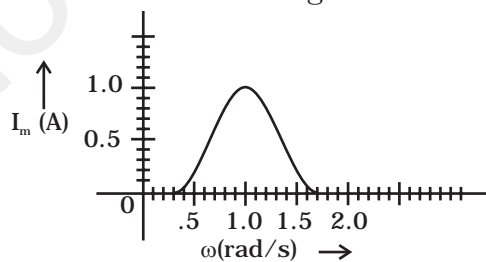


Fig. 7.3

- 7.19** The alternating current in a circuit is described by the graph shown in Fig 7.4 . Show rms current in this graph.

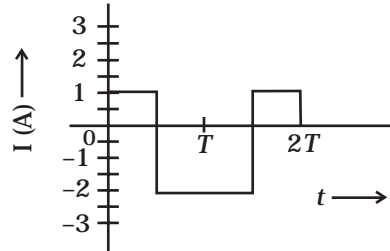


Fig. 7.4

- 7.20** How does the sign of the phase angle  $\phi$ , by which the supply voltage leads the current in an *LCR* series circuit, change as the supply frequency is gradually increased from very low to very high values.

### SA

- 7.21** A device 'X' is connected to an a.c source. The variation of voltage, current and power in one complete cycle is shown in Fig 7.5.
- Which curve shows power consumption over a full cycle?
  - What is the average power consumption over a cycle?
  - Identify the device 'X'.

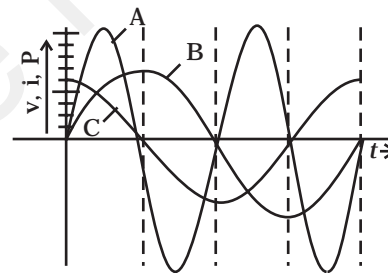


Fig. 7.5

- 7.22** Both alternating current and direct current are measured in amperes. But how is the ampere defined for an alternating current?
- 7.23** A coil of 0.01 henry inductance and 1 ohm resistance is connected to 200 volt, 50 Hz ac supply. Find the impedance of the circuit and time lag between max. alternating voltage and current.
- 7.24** A 60 W load is connected to the secondary of a transformer whose primary draws line voltage. If a current of 0.54 A flows in the

load, what is the current in the primary coil? Comment on the type of transformer being used.

- 7.25** Explain why the reactance provided by a capacitor to an alternating current decreases with increasing frequency.
- 7.26** Explain why the reactance offered by an inductor increases with increasing frequency of an alternating voltage.

**LA**

- 7.27** An electrical device draws 2kW power from AC mains (voltage 223V (rms) =  $\sqrt{50,000}$  V). The current differs (lags) in phase by  $\phi$  ( $\tan \phi = \frac{-3}{4}$ ) as compared to voltage. Find (i)  $R$ , (ii)  $X_C - X_L$ , and (iii)  $I_M$ . Another device has twice the values for  $R$ ,  $X_C$  and  $X_L$ . How are the answers affected?

- 7.28** 1MW power is to be delivered from a power station to a town 10 km away. One uses a pair of Cu wires of radius 0.5 cm for this purpose. Calculate the fraction of ohmic losses to power transmitted if
- (i) power is transmitted at 220V. Comment on the feasibility of doing this.
  - (ii) a step-up transformer is used to boost the voltage to 11000 V, power transmitted, then a step-down transformer is used to bring voltage to 220 V.
- ( $\rho_{Cu} = 1.7 \times 10^{-8}$  SI unit)

- 7.29** Consider the LCR circuit shown in Fig 7.6. Find the net current  $i$  and the phase of  $i$ . Show that  $i = \frac{v}{Z}$ . Find the impedance  $Z$  for this circuit.

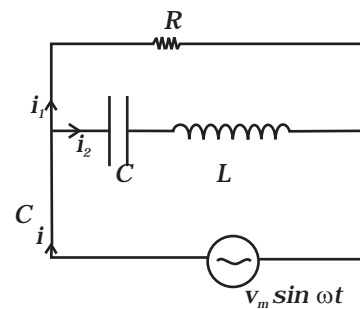


Fig. 7.6

- 7.30** For an LCR circuit driven at frequency  $\omega$ , the equation reads

$$L \frac{di}{dt} + Ri + \frac{q}{C} = v_i = v_m \sin \omega t$$

- (i) Multiply the equation by  $i$  and simplify where possible.
- (ii) Interpret each term physically.

- (iii) Cast the equation in the form of a conservation of energy statement.
- (iv) Integrate the equation over one cycle to find that the phase difference between  $v$  and  $i$  must be acute.

**7.31** In the  $LCR$  circuit shown in Fig 7.7, the ac driving voltage is  $v = v_m \sin \omega t$ .

- (i) Write down the equation of motion for  $q(t)$ .
- (ii) At  $t = t_0$ , the voltage source stops and  $R$  is short circuited. Now write down how much energy is stored in each of  $L$  and  $C$ .
- (iii) Describe subsequent motion of charges.

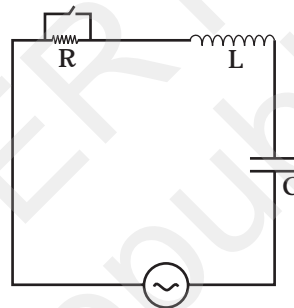


Fig. 7.7