CHAPTER : 7

ALTERNATING CURRENT

STUDY NOTES

- **Alternating Current:** The current whose magnitude changes with time and direction reverses periodically is called alternating current. Alternating emf E and current I at any time t is given by:

$$E = E_o \sin \omega t$$
$$E_o = NBA\omega$$

Where $I = I_0 \sin(\omega t - \phi)$; Where $I_o - \frac{NBA\omega}{R}$

$$\omega = 2\pi n = \frac{2\pi}{T}$$

Where T is the time period

- **Values of Alternating Current and Voltage**
  - (a) **Instantaneous value :** It is the value of alternating current and voltage at an instant t.
  - (b) **Peak value :** Maximum values of voltage E_0 and current I_0 in a cycle are called peak values.
  - (c) **Mean value :** For complete cycle

$$< E >= \frac{1}{T}\int_0^T Edt = 0$$

$$< I >= \frac{1}{T}\int_0^T Idt = 0$$

Mean value for half cycle : $E_{Mean} = \frac{2E_o}{\pi}$

  - (d) Root-mean-square (rms) value :

$$E_{rms} = \left(< E^2 >\right)^{1/2} = \frac{E_0}{\sqrt{2}} = 0.707E_0 = 70.7\%E_0$$

$$I_{rms} = \left(< I^2 >\right)^{1/2} = \frac{I_0}{\sqrt{2}} = 0.707I_0 = 70.7\%I_0$$

RMS values are also called apparent or effective values.

- **Phase difference between the EMF (Voltage) and the Current in an AC Circuit**
  - (a) **For pure resistance :** The voltage and the current are in same phase i.e., phase difference $\phi = 0$
  - (b) **For pure inductance :** The voltage is ahead of current by $\frac{\pi}{2}$ i.e; phase difference $\phi = +\frac{\pi}{2}$
  - (c) **For pure capacitance :** The voltage lags behind the current by $\frac{\pi}{2}$ i.e., phase difference $\phi = -\frac{\pi}{2}$
- **Reactance :**
  - (a) $X = \frac{E}{I} = \frac{E_0}{I_0} = \frac{E_{rms}}{I_{rms}}$
- **Inductive Reactance :**
  - (b) $X_L = \omega L = 2\pi nL$

- **Capacitive Reactance :**

  (c) $X_C = \frac{1}{\omega C} = \frac{1}{2\pi nC}$

- **Impedance:** Impedance is defined as,

$$Z = \frac{E}{I} = \frac{E_0}{I_0} = \frac{E_{rms}}{I_{rms}}$$

  Where ϕ is the phase difference of the voltage E relative to the current I.

  (a) **For L-R series circuit:**

  $Z_{RL} = \sqrt{R^2 + X_L^2} = \sqrt{R^2 + \omega L^2}$

  $\tan\phi = \frac{\omega L}{R}$ *or* $\phi = \tan^{-1}\left(\frac{\omega L}{R}\right)$

  (b) **For R-C series circuit:** $Z_{RC} = \sqrt{R^2 + X_C^2} = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$

  $\tan\phi = \frac{1}{\omega CR}$ *or* $\phi = \tan^{-1}\left(\frac{1}{\omega CR}\right)$

  (c) **For L-C series circuit :**

$$Z_{LCR} = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

$$\tan\phi = \frac{\left(\omega L - \frac{1}{\omega C}\right)}{R} \qquad \text{Or } \phi = \tan^{-1}\left(\frac{\omega L - \frac{1}{\omega C}}{R}\right)$$

- **Conductance:** Reciprocal of resistance is called conductance.

$$G = \frac{1}{R} mho$$

  Its SI unit is ℧ (mho)

- **Power in and AC Circuit**

  (a) Electric power = (current in circuit) × (Voltage in circuit)

$$P = IE$$

  (b) Instantaneous power :

  $P_{inst} = E_{inst} \times I_{inst}$

  (c) Average power :

  $P_0 = \frac{1}{2}E_0 I_0 \cos\phi = E_{rms} I_{rms} \cos\phi$

  (d) Virtual power (apparent power): $= \frac{1}{2}E_0 I_0 = E_{rms} I_{rms}$

- **Power Factor:**

  (a) Power factor, $\cos\phi = \frac{P_{av}}{P_v} = \frac{R}{Z}$

  (b) For pure inductance
  Power factor, $\cos\phi = 1$

  (c) For pure capacitance
  Power factor, $\cos\phi = 0$

(d) For LCR circuit

Power factor, $\cos\phi = \dfrac{R}{\sqrt{R^2 + \left(\omega L - \dfrac{1}{\omega C}\right)^2}}$

$$X = \omega L - \frac{1}{\omega C}$$

- **Wattless Current:** The component of current differing in phase by $\frac{\pi}{2}$ relative to the voltage, is called wattless current.
- **The rms value of wattless current :**

$$= \frac{I_0}{\sqrt{2}} \sin\phi = I_{rms} \sin\phi = \frac{I_0}{\sqrt{2}}\left(\frac{X}{Z}\right)$$

- **Choke Coil:**
  (a) An inductive coil used for controlling alternating current whose self-inductance is high and resistance is negligible, is called choke coil.
  (b) The power factor of this coil is approximately zero.
- **Series Resonant Circuit :**
  (a) When the inductive reactance (X_L) becomes equal to the capacitive reactance (X_C) in the circuit, the total impedance becomes purely resistive (Z = R).
  (b) In this state, the voltage and current are in same phase ($\phi = 0$), the current and power are maximum and impedance is minimum. This state is called resonance.
  (c) At resonance, $\omega_r L = \frac{1}{\omega_r C}$. Hence, resonance frequency is, $f_r = \frac{I}{2\pi\sqrt{LC}}$
  (d) In resonance, the power factor of the circuit is one.
- **Half-Power Frequencies :**

Those frequencies f_1 and f_2 at which the power is half of the maximum power (power at resonance) i.e. f_1 and f_2 are called half-power frequencies.

$$P = \frac{1}{2} P_{max}$$

$$I = \frac{I_{max}}{\sqrt{2}}$$

- **Band-Width :**
  (a) The frequency interval between half-power frequencies is called band-width.

  $\therefore$ Bandwidth, $\Delta f = f_2 - f_1$

  (b) For a series LCR resonant circuit,

$$\Delta f = \frac{1}{2\pi}\frac{R}{L}$$

- **Quality factor (Q)**

$$Q = 2\pi \times \frac{\textit{Maximum energy stored}}{\textit{Energy dissipated per cycle}} = \frac{2\pi}{T} \times \frac{\textit{Maximum energy stored}}{\textit{Mean Power dissipated}}$$

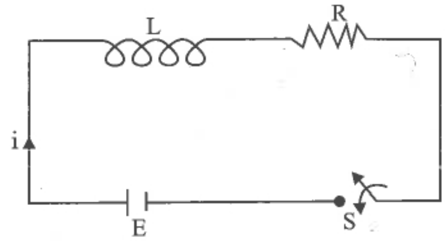
or

$$Q = \frac{\omega_r L}{R} = \frac{1}{\omega_r CR} = \frac{f_r}{(f_2 - f_1)} = \frac{f_r}{\Delta f}$$

QUESTION BANK

MULTIPLE CHOICE QUESTIONS

1. Consider the LR circuit shown in the figure. If the switch S is closed at $t = 0$ then the amount of charge that passes through the battery between $t = 0$ and $t = L/R$ is:



(a) $\frac{EL}{7.3 R^2}$ (b) $\frac{EL}{2.7 R^2}$ (c) $\frac{7.3 EL}{R^2}$ (d) $\frac{2.7 EL}{R^2}$

2. An alternating current i is given by $= i_0 \sin 2\pi(t/T + 1/4)$. Then the average current in the first one quarter time period is

(a) $\frac{2i_0}{\pi}$ (b) $\frac{i_0}{\pi}$ (c) $\frac{i_0}{2\pi}$ (d) $\frac{3i_0}{\pi}$

3. **Statement-I :** To get a steady dc output from the pulsating voltage received from a full wave rectifier we can connect a capacitor across the output parallel to the load R_L.

Statement-II : To get a steady dc output from the pulsating voltage received from a full wave rectifier we can connect an inductor in series with R_L.

In the light of the above statements, choose the most appropriate answer from the options given below :

(a) Statement I is true but statement II is false
(b) Statement I is false but statement II is true
(c) Both statement I and statement II are false
(d) Both statement I and statement II are true

4. A series LCR circuit driven by 300 V at a frequency of 50 Hz contains a resistance R = 3 kΩ, an inductor of inductive reactance $X_L = 250\ \pi\Omega$ and an unknown capacitor. The value of capacitance to maximize the average power should be : (Take $\pi^2 = 10$)

(a) 4 μF (b) 25 μF (c) 400 μF (d) 40 μF

5. A 1000 Ω resistance, a 0.1 μF capacitor and an inductor are connected in series across a 250 V supply at variable frequency. Calculate the value of inductance of inductor at which resonance will occur. Given that the resonant frequency is 60 Hz.

(a) 0.70 H (b) 70.3 mH (c) 7.03×10^{-5} H (d) 70.3 H

6. In LC circuit inductance L = 40 mL and capacitance C = 100 μF. If a voltage V(t) = 10 sin(314 t) is applied to the circuit, the current in the circuit is given as :

(a) 0.52 cos 314 t (b) 0.52 sin 314 t (c) 10 cos 314 t (d) 5.2 cos 314 t

7. The reactance of a capacitance C is X. If both the frequency and capacitance be doubled, then new reactance will be:

(a) X (b) 2X (c) 4X (d) X/4

8. What is the value of inductance L for which the current is maximum in a series LCR-circuit with C = 10μF and $\omega = 1000\ s^{-1}$?

(a) 100 mH
(b) 1 mH
(c) 10 mH
(d) cannot be calculated unless R is known.

9. A current $I = I_0 \sin(\omega t + \pi/2)$ flows in a circuit across which an alternating potential $E = E_o \sin \omega t$ is applied. The power consumed in the circuit is

(a) $E_0 I_0/2$ (b) $E_0 I_0$ (c) E (d) zero

10. An inductor may store energy in

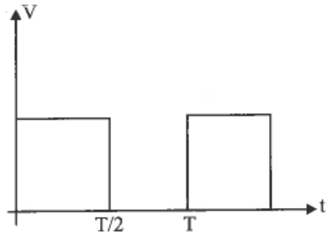
(a) its electric field (b) its coils

(c) its magnetic field (d) both in electric and magnetic fields.

11. In an ac circuit an alternating voltage $e = 200\sqrt{2}\ \sin 100t$ volts is connected to a capacitor of capacity 1 μF. The rms value of the current in the circuit is

(a) 10 mA (b) 100 mA (c) 200 mA (d) 20 mA

12. The rms value of potential difference V shown in figure is :



(a) $V_0/2$ (b) $V_0/\sqrt{3}$ (c) V_0 (d) $V_0/\sqrt{2}$

13. Power dissipated in an LCR series circuit connected to an a.c source of emf ε is

(a) $\dfrac{\varepsilon R}{\sqrt{R^2 + \left[L\omega - \dfrac{1}{C\omega}\right]^2}}$ (b) $\dfrac{\varepsilon^2 R}{\left[R^2 + \left[L\omega - \dfrac{1}{C\omega}\right]^2\right]}$

(c) $\dfrac{\varepsilon^2 \sqrt{\left[R^2 + \left[L\omega - \dfrac{1}{C\omega}\right]^2\right]}}{R}$ (d) $\dfrac{\varepsilon \left[R^2 + \left[L\omega - \dfrac{1}{C\omega}\right]^2\right]}{R}$

14. A 220 volt input is supplied to a transformer. The output circuit draws a current of 2 ampere at 440 volts. If the efficiency of the transformer is 80%, the current drawn by the primary windings of the transformer is

(a) 3.6 ampere (b) 2.8 ampere (c) 2.5 ampere (d) 5 ampere

15. For a series LCR circuit the power loss at resonance is :

(a) $\dfrac{V^2}{\left[\omega L - \dfrac{1}{\omega C}\right]}$ (b) $I^2 L\omega$ (c) $I^2 R$ (d) $\dfrac{V^2}{C\omega}$

16. An ac voltage is applied to a resistance R and an inductor L in series. If R and the inductive reactance are both equal to 3 Ω, the phase difference between the applied voltage and the current in the circuit is

(a) $\dfrac{\pi}{6}$ (b) $\dfrac{\pi}{4}$ (c) $\dfrac{\pi}{2}$ (d) zero

17. A coil has resistance 30 ohm and inductive reactance 20 ohm at 50 Hz frequency. If an ac source of 200 volt, 100 Hz, is connected across the coil, the current in the coil will be

(a) $\dfrac{20}{\sqrt{13}}$ A (b) 2 A (c) 4 A (d) 8 A

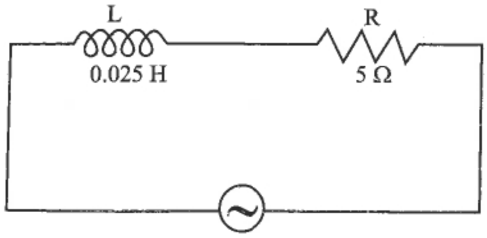
18. In the AC circuit, the current is expressed as $I = 100 \sin 200\pi t$. In this circuit the current rises from zero to peak value in time

(a) $\dfrac{1}{300}s$ (b) $\dfrac{1}{400}s$ (c) $\dfrac{1}{100}s$ (d) $\dfrac{1}{200}s$

19. Choose the correct statement.

(a) The capacitor can conduct in a d.c circuit but not an inductor
(b) In d.c circuit the inductor can conduct but not a capacitor
(c) In d.c circuit both the inductor and capacitor cannot conduct
(d) The inductor has infinite resistance in a d.c circuit.

20. For the LR-circuit shown in figure the phase angle, if frequency is $f = 100/\pi$ is



(a) 60°
(b) 45°
(c) 30°
(d) 90°

21. If resistance of 100 Ω, inductance of 0.5H and capacitance of 10×10^{-6} F are connected in series through 50 hertz AC supply, the impedence will be

(a) 1.87 Ω (b) 101.3 Ω (c) 18.7 Ω (d) 189.7 Ω

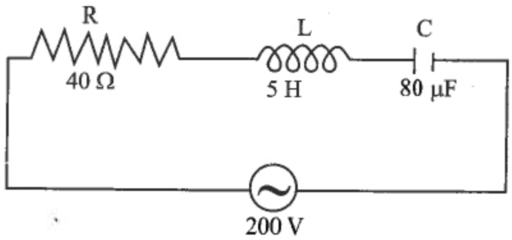
22. In an LR-circuit ; $L = \frac{0.4}{\pi}$ H and R= 30 Ω . If the circuit has an alternating emf of 220 volt 50 cycles per sec, the impedance and current in the circuit will be

(a) 40.4 Ω, 4.4 A (b) 50 Ω, 4.4 A (c) 3.07 Ω, 6.0 A (d) 11.40 Ω, 17.5 A

23. An a.c. is represented by E = 220 sin (100 π) t V and is applied over a resistance of 110 Ω. The heat produced in 7 min is

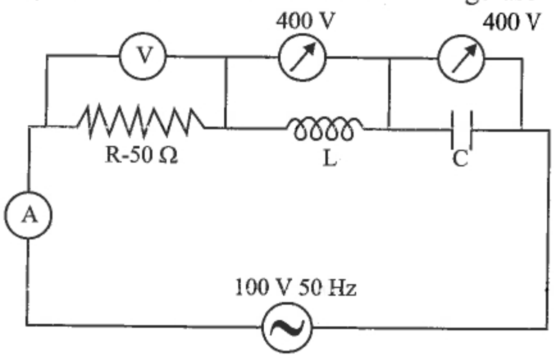
(a) 11×10^3 cal (b) 22×10^3 cal (c) 33×10^3 cal (d) 25×10^3 cal

24. Figure shows a series LCR circuit connected to a variable frequency 200 V source. The source frequency which drives the circuit at resonance is



(a) 50 Hz (b) (50/π) Hz (c) 25 Hz (d) (25/π) Hz

25. In the series L-C-R circuit figure, the voltmeter and ammeter readings are



(a) V = 100 volt, I = 2 amp (b) V = 100 volt, I = 5 amp
(c) V = 1000 volt, I = 2 amp (d) V = 300 Volt, I = 1 amp

26. If rotational velocity of a dynamo armature is doubled, then induced emf will become

(a) half (b) four times (c) two times (d) unchanged

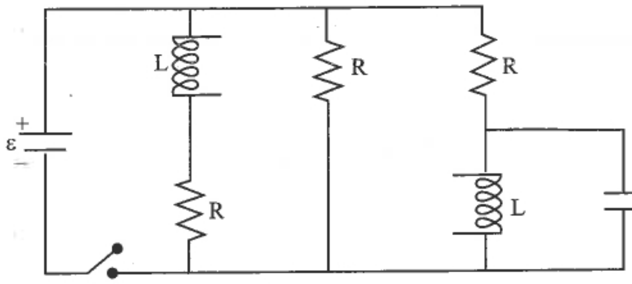
27. A series LCR circuit containing 5.0 H inductor, 80 μF capacitor and 40 Ω resistor is connected to 230 V variable frequency ac source. The angular frequencies of the source at which power transferred to the circuit is half the power at the resonant angular frequency are likely to be :

(a) 55 rad/s and 58 rad/s
(b) 25 rad/s and 75 rad/s
(c) 50 rad/s and 25 rad/s
(d) 46 rad/s and 54 rad/s

28. A series LCR circuit is connected to an ac voltage source. When L is removed from the circuit, the phase difference between current and voltage is $\pi/3$. The power factor of the circuit is :

(a) 0.5
(b) 1.0
(c) – 1.0
(d) zero

29. Figure shows a circuit that contains three identical resistors with resistance R = 9.0 Ω each, two identical inductors with inductance L = 2.0 mH each, and an ideal battery with emf ε = 18 V. The current i through the battery just after the switch closed is



(a) 0.2 A
(b) 4 A
(c) 0.8 A
(d) 2 mA

30. Match List I and List II

	List-I		List-II
(a)	$\omega L > \frac{1}{\omega C}$	(i)	Current is in phase with emf
(b)	$\omega L = \frac{1}{\omega C}$	(ii)	Current lags behind the applied emf
(c)	$\omega L < \frac{1}{\omega C}$	(iii)	Maximum current occurs
(d)	Resonant frequency	(iv)	Current leads the emf

(a) (a)(ii), (b)(i), (c)(iv), (d)(iii)
(b) (a)(ii), (b)(i), (c)(iii), (d)(iv)
(c) (a)(iii), (b)(i), (c)(iv), (d)(ii)
(d) (iv), (b)(iii), (c)(ii), (d)(i)

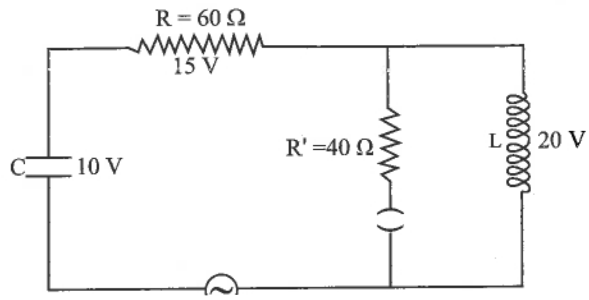
31. For a series LCR circuit with R = 100 Ω, L = 0.5 mH and C = 0.1 pF connected across 220 V–50 Hz AC supply, the phase angle between current and supplied voltage and the nature of the circuit is

(a) 0°, resistive circuit
(b) ≈ 90°, predominantly inductive circuit
(c) 0°, resonance circuit
(d) ≈ 90°, predominantly capacitive circuit

32. A solenoid of inductance L and resistance R is connected to a battery. The time taken for the magnetic energy to reach 25% of its maximum value is:

(a) $\frac{L}{R} ln(1)$
(b) $\frac{L}{R} ln(2)$
(c) $\frac{L}{R} ln(3)$
(d) $\frac{L}{R} ln(4)$

33. The angular frequency of alternating current in a L-C-R circuit is 100 rad/s. The components connected are shown in the figure. Find the value of inductance of the coil and capacity of condenser.



(a) 0.8 H and 150 μF
(b) 0.8 H and 250 μF
(c) 1.33 H and 150 μF
(d) 1.33 H and 250 μF

34. An AC circuit has R= 100 Ω, C = 2 μF and L = 80 mH, connected in series. The quality factor of the circuit is:

(a) 20 (b) 2 (c) 0.5 (d) 400

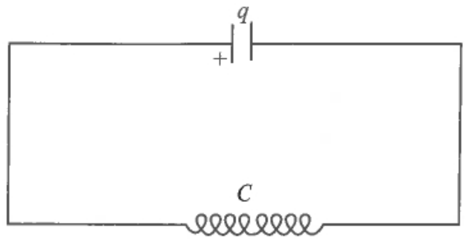
35. A series L-R circuit is connected to a battery of emf V. If the circuit is switched on at t = 0, then the time at which the energy stored in the inductor reaches $\left(\frac{1}{n}\right)$ times of its maximum value, is :

(a) $\frac{L}{R}ln\left(\frac{\sqrt{n}}{\sqrt{n+1}}\right)$ (b) $\frac{L}{R}ln\left(\frac{\sqrt{n}}{\sqrt{n-1}}\right)$ (c) $\frac{L}{R}ln\left(\frac{\sqrt{n+1}}{\sqrt{n-1}}\right)$ (d) $\frac{L}{R}ln\left(\frac{\sqrt{n-1}}{\sqrt{n}}\right)$

36. In an a.c. circuit, the instantaneous e.m.f. and current are given by e = 100 sin 30 t, i = 20 sin $\left(30t-\frac{\pi}{4}\right)$. In one cycle of a.c. the average power consumed by the circuit and the wattles current are, respectively.

(a) $\frac{50}{\sqrt{2}}$,0 (b) 50, 0 (c) 50, 10 (d) $\frac{1000}{\sqrt{2}}$,10

37. In an LC circuit shown in Fig., C = 1F, L = 4H. At time t = 0, charge in the capacitor is 4 C and it is decreasing at the rate of $\sqrt{5}$ Cs^{-1}. Choose the correct statement



(a) maximum charge in the capacitor can be 6 C
(b) maximum charge in the capacitor can be 8 C
(c) charge in the capacitor will be maximum after 3 $\sin^{-1}(2/3)$s
(d) none of these

38. A 10 μF capacitor is connected across a 200 V, 50 Hz A.C. supply. The peak current through the circuit is:

(a) 0.6 A (b) 0.889 A (c) $0.06\sqrt{2}$ A (d) 0.6 πA

39. In L-C-R circuit, the capacitance is changed from C to 4 C. For the same resonant frequency, the inductance should be changed from L to

(a) 2L (b) L/2 (c) L/4 (d) 4L

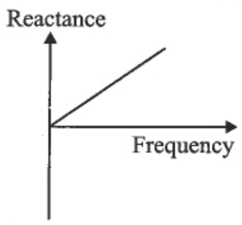
40. The resonant frequency of a circuit is f. If the capacitance is made 4 times the initial value, then the resonant frequency will become

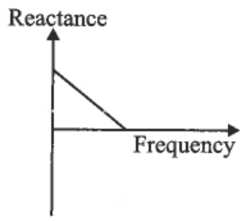
(a) f/2 (b) 2f (c) f (d) 4f

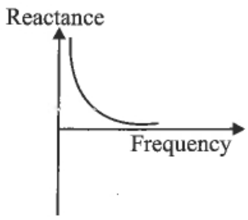
41. The instantaneous current in an AC circuit is $i = \sqrt{2}\sin(50t + \pi/4)$. The rms value of current is

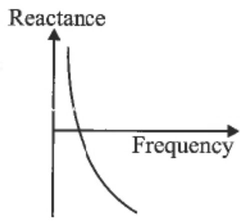
(a) $\sqrt{2}$ A (b) 50 A (c) 90 A (d) 1 A

42. Which of the shown graph may represent the reactance of a series L-C combination?

(a) 

(b) 

(c) 

(d) 

43. Two identical electric heater each marked 1000 W, 220 V are connected in series. This combination is connected to an AC supply of 220 V. What will be their combined rate of heating? (Assume that resistance of each heater remains constant.)

(a) 2000 W (b) 1000 W (c) 500 W (d) 250 W

44. An L-C-R series circuit with a resistance of 100 Ω is connected to an AC source of 200 V (rms) and angular frequency 300 rad/s. When only the capacitor is removed, the current lags behind the voltage by 60°. When only the inductor is removed the current leads the voltage by 60°.The average power dissipated in original L-C-R circuit is

(a) 50 W (b) 100 W (c) 200 W (d) 400 W

45. A virtual current of 4 A and 50 Hz flows in an AC circuit containing a coil. The power consumed in the coil is 240 W. If the virtual voltage across the coil is 100 V. Its inductance will be

(a) $\frac{1}{5\pi}H$ (b) $\frac{1}{3\pi}H$ (c) 15 H (d) $\frac{1}{\pi}H$

46. An ideal choke takes a current of 8 A when connected to an AC source of 100 V and 50 Hz. A pure resistor under the same conditions takes a current of 10 A. If two are connected in series to an AC supply of 100 V and 40 Hz, then the current in the series combination of above resistor and inductor is

(a) 10 A (b) 5 A (c) $10\sqrt{2}$ A (d) $5\sqrt{2}$ A

47. In an L-R circuit, the inductive ractance is equal to the resistance R of the circuit. An emf $E = E_0\cos(\omega t)$ is applied to the circuit. The power consumed in the circuit is

(a) $\frac{E_0^2}{\sqrt{2}R}$ (b) $\frac{E_0^2}{4R}$ (c) $\frac{E_0^2}{2R}$ (d) $\frac{E_0^2}{8R}$

48. If the rms current in a 50 Hz AC circuit is 5 A, the value of the current 1/300 s after its value becomes zero is

(a) $5\sqrt{2}$ (b) $5\sqrt{3/2}$ (c) 5/6 A (d) $5/\sqrt{2}$ A

49. An inductor of reactance 1 Ω and a resistor of 2 Ω are connected in series to the terminals of a 6 V (*rms*) AC source. The power dissipated in the circuit is

(a) 8 W (b) 12 W (c) 14.4 W (d) 18 W

50. The output of a step-down transformer is measured to be 24 V when connected to a 12 W light bulb. The value of the peak current is

(a) $1/\sqrt{2}$ A (b) $\sqrt{2}$ A (c) $2\sqrt{2}$ A (d) 2 A

51. When a voltage measuring device is connected to AC mains, the meter shows the steady input voltage of 220 V. This means

(a) input voltage cannot be AC voltage, but a DC voltage
(b) maximum input voltage is 220 V
(c) the meter reads not V but $< V^2 >$ and is calibrated to read $\sqrt{< V^2 >}$
(d) the pointer of the meter is stuck by some mechanical defect

52. To reduce the resonant frequency in an L-C-R series circuit with a generator

(a) the generator frequency should be reduced
(b) another capacitor should be added in parallel
(c) the iron core of the inductor should be removed the first
(d) dielectric in the capacitor should be removed

53. If coil is open, then L and R become

(a) ∞, 0 (b) 0, ∞ (c) ∞, ∞ (d) 0, 0

54. In an LR circuit f = 50 Hz, L = 2 H, E = 5 V, R = 1Ω, energy stored in inductor is

(a) 50 J (b) 25 J (c) 100 J (d) none of these

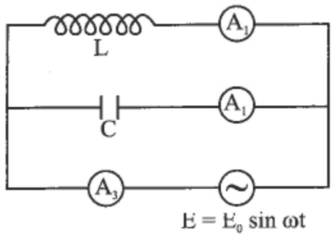
55. In LCR-circuit if resistance increases, quality factor

(a) increases finitely (b) decreases finitely (c) remains constant (d) none of these

56. A capacitor in an ideal LCR-circuit is fully charged by a DC source. Then it is disconnected from DC source, the current in the circuit

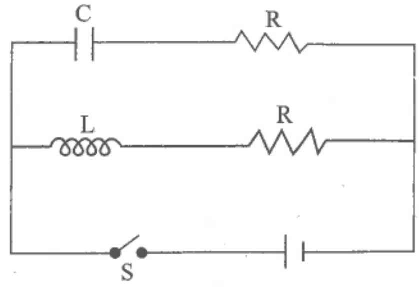
(a) becomes zero instantaneously (b) grows monotonically
(c) decays monotonically (d) oscillates infinitely.

57. An inductor L and a capacitor C are connected in the circuit as shown in the figure. The frequency of the power supply is equal to the resonant frequency of the circuit. Which ammeter will read zero ampere?



(a) A_1 (b) A_2
(c) A_3 (d) none of these.

58. In the circuit shown in the figure, the switch S is closed at time $t = 0$ $\left(Given : R = \sqrt{\frac{L}{C}} \right)$



The current through the capacitor and inductor will be equal at time t is

(a) RC (b) $RCln2$ (c) $1/ RCln2$ (d) LR

59. A choke is preferred to a resistance for limiting current in an a.c circuit because

(a) choke is cheap
(b) there is no wastage of power
(c) choke is compact in size
(d) choke is good absorber of heat.

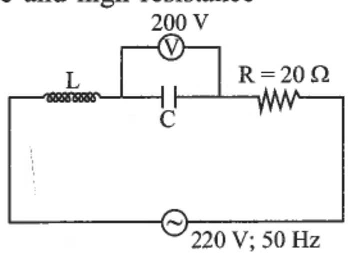
60. If the speed of rotation of a dynamo is doubled, then the induced e.m.f. will

(a) become half (b) become double (c) become four times (d) remain unchanged.

61. A choke coil has

(a) low inductance and high resistance
(b) high inductance and low resistance
(c) low inductance and low resistance
(d) high inductance and high resistance

62. In the circuit shown rms current is 11 A. The potential difference across the inductor is



(a) 220 V (b) 0 V
(c) 300 V (d) 200 V

63. Alternating current cannot be measured by d.c. ammeter, because

(a) a.c cannot pass through a.c ammeter
(b) a.c changes direction.
(c) average value of current of complete cycle is zero.
(d) a.c. ammeter will get damaged.`

64. The self inductance of the motor of an electric fan is 10 H. In order to impart maximum power at 50 Hz, it should be connected to a capacitance of

(a) 4 μF (b) 8 μF (c) 1 μF (d) 2 μF

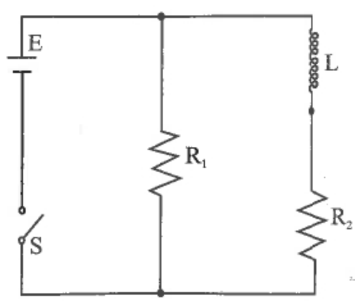
65. The power factor of an a.c circuit having resistance R and inductance L(connected in series) and an angular velocity ω is

(a) $R/\omega L$ (b) $R/(R^2 + \omega^2 L^2)^{1/2}$ (c) $\omega L/R$ (d) $R/(R^2 - \omega^2 L^2)^{1/2}$

66. An ideal coil of 10 H is connected in series with a resistance of 5 Ω and a battery of 5 V. 2 seconds after the connection is made, the current flowing in amperes in the circuit is

(a) $(1 - e^{-1})$ (b) $(1 - e)$
(c) e (d) e^{-1}

67. An inductor of inductance L = 400 mH and resistors of resistances R_1 = 2 Ω and R_2 = 2 Ω are connected to a battery of emf 12 V as shown in the figure.
The internal resistance of the battery is negligible. The switch S is closed at $t = 0$.
The potential drop across L as a function of time is



(a) $12e^{-5t}\ V$ (b) $\frac{12}{t}e^{3t}\ V$
(c) $6\left(1-e^{-t/0.2}\right)V$ (d) $6e^{-5t}\ V$

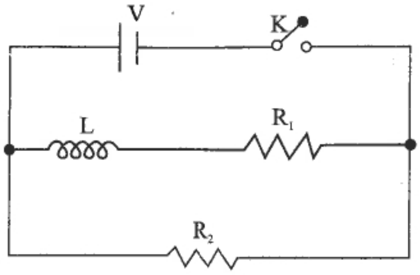
68. A fully charged capacitor C with initial charge q_0 is connected to a coil of self inductance L at $t = 0$. The time at which the energy is stored equally between the electric and the magnetic fields is

(a) $\pi\sqrt{LC}$ (b) $\frac{\pi}{4}\sqrt{LC}$ (c) $\frac{\pi}{2}\sqrt{LC}$ (d) $\frac{\pi}{6}\sqrt{LC}$

69. Let C be the capacitance of a capacitor discharging through a resistor R. Suppose t_1 is the time taken for the energy stored in the capacitor to reduce to half its initial value and t_2 is the time taken for the charge to reduce to one-fourth its initial value. Then the ratio t_1/t_2 will be

(a) 2 (b) 1 (c) ½ (d) ¼

70. In the circuit shown below, the key K is closed at $t = 0$. The current through the battery is



(a) $\frac{VR_1R_2}{\sqrt{R_1^2+R_2^2}}$ at $t=0$ and $\frac{V}{R_2}$ at $t=\infty$

(b) $\frac{V}{R_2}$ at $t=0$ and $\frac{V(R_1+R_2)}{R_1R_2}$ at $t=\infty$

(c) $\frac{V}{R_2}$ at $t=0$ and $\frac{VR_1R_2}{\sqrt{R_1^2+R_2^2}}$ at $t=\infty$

(d) $\frac{V(R_1+R_2)}{R_1R_2}$ at $t=0$ and $\frac{V}{R_2}$ at $t=\infty$

71. A 50 W – 100 V electric bulb is to be used on a 200 V–50 Hz a.c supply. What should be the inductance of the lamp so that it may glow with its normal brightness? (take $\pi = 3$)

(a) 5 H (b) 1.115 H (c) 1.5 H (d) 2 H

72. An ac voltage source of variable angular frequency ω and fixed amplitude V_0 is connected in series with a capacitor C and an electric bulb of resistance R (inductance zero). When ω is increased

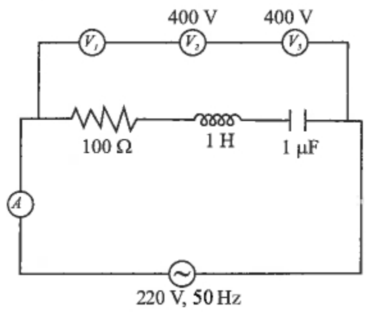
(a) the bulb glows dimmer (b) the bulb glows brighter

(c) total impedance of the circuit is unchanged (d) total impedance of the circuit increases

73. A 4μF capacitor and a resistance of 2.5 MΩ are in series with 12 V battery. Find the time after which potential difference across the capacitor is 3 times the potential difference across the resistor. [Given *ln*(2)=0.693]

(a) 13.86 s (b) 6.93 s (c) 7 s (d) 14 s

74. In the given circuit the readings of the voltmeter V_1 and the ammeter A are :



(a) 220 V, 2.2 A

(b) 110 V; 1.1 A

(c) 220 V, 1.1 A

(d) 110 V; 2.2 A

75. An inductor L, a capacitor of 20 μF and a resistor of 100 Ω are connected in series with an AC source of frequency 50 Hz. I the current is in phase with the voltage, then the inductance of the inductor is

(a) 2.00 H (b) 0.51 H

(c) 1.5 H (d) 0.99 H

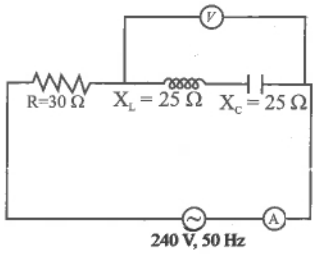
76. In a series L-C-R circuit, resistance R = 10 Ω and the impedance Z=10 Ω. The phase difference between the current and the voltage is

(a) 0° (b) 30° (c) 45° (d) 60°

77. In a circuit, the frequency is $f = \frac{1000}{2\pi}$ Hz and the inductance is 2 henry, then the reactance will be

(a) 200 Ω (b) 200 μΩ (c) 2000 Ω (d) 2000 μΩ

78. In the circuit shown in figure neglecting source resistance, the voltmeter and ammeter readings will be respectively



(a) 0V, 8A (b) 150 V, 8A

(c) 150 V, 3A (d) 0 V, 3A

79. The power dissipated in an AC circuit is zero if the circuit is

(a) purely resistive

(b) purely inductive only

(c) either purely inductive or purely capacitive

(d) purely capacitive only

80. Same current is flowing in two alternating circuits. The first circuit contains only inductance and the other contains only a capacitor. If the frequency of the emf of AC is increased, the effect on the value of the current will be

(a) increases in the first circuit and decreases in the other

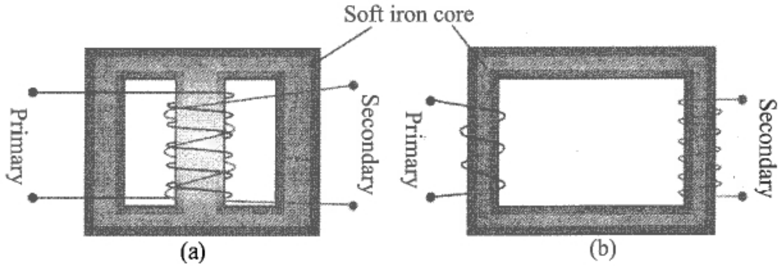
(b) increases in both the circuits

(c) decreases in both the circuits

(d) decreases in the first circuit and increases in the other

INPUT TEXT BASED MCQs

1. *A transformer consists of two sets of coils, insulated from each other. They are wound on a soft-iron core, either one on top of the other as in Fig (a) or on separate limbs of the core as in Fig (b). One of the coils called the primary coil has Np turns. The other coil is called the secondary coil; it has Ns turns. Often the primary coil is the input coil and the secondary coil is the output coil of the transformer.*



When an alternating voltage is applied to the primary, the resulting current produces an alternating magnetic flux which links the secondary and induces an emf in it. The value of this emf depends on the number of turns in the secondary. For an ideal transformer, the resistance of the primary and secondary winding are negligible.

It can be shown that $\frac{E_s}{E_p} = \frac{I_p}{I_s} = \frac{n_s}{n_p} = k$

Where the symbols have their standard meanings.

For a step up transformer, $n_s > n_p$; $E_s > E_p$; $k > 1$; $I_s < I_p$

For a step down transformer, $n_s < n_p$; $E_s < E_p$; $k < 1$

The above relations are on the assumptions that efficiency of transformer is 100%

Infact, efficiency $\eta = \frac{\text{output power}}{\text{Input power}} = \frac{E_s I_s}{E_p I_p}$

Where subscripts p and s refer to the primary and secondary of the transformer.

(i) Which of the following quantity remains constant in an ideal transformer?

(a) Current (b) Voltage (c) Power (d) All of these

(ii) Transformer is used to

(a) convert ac to dc voltage (b) convert dc to ac voltage

(c) obtain desired dc power (d) obtain desired ac voltage and current

(iii) The number of turns in primary coil of a transformer is 20 and the number of turns in a secondary is 10. If the voltage across the primary is 220 ac V, what is the voltage across the secondary?

(a) 100 ac V (b) 120 ac V (c) 110 ac V (d) 220 ac V

(iv) In a transformer the number of primary turns is four times that of the secondary turns. Its primary is connected to an a.c. source of voltage V. Then

(a) current through its secondary is about four times that of the current through its primary

(b) voltage across its secondary is about four times that of the voltage across its primary.

(c) voltage across its secondary is about two times that of the voltage across its primary.

(d) voltage across its secondary is about $\frac{1}{2\sqrt{2}}$ times that of the voltage across its primary.

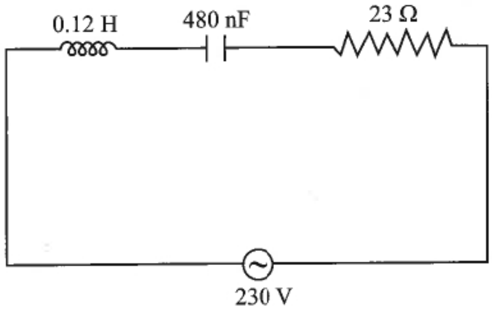
(v) A transformer is used to light 100 W-110 V lamp from 220 V mains. If the main current is 0.5 A, the efficiency of the transformer is

(a) 95% (b) 99% (c) 90% (d) 96%

2. *When the frequency of ac supply is such that the inductive reactance and capacitive reactance become equal, the impedance of the series LCR circuit is equal to the ohmic resistance in the circuit. Such a series LCR circuit is known as resonant series LCR circuit and the frequency of the ac supply is known as resonant frequency.*

Resonance phenomenon is exhibited by a circuit only if both I and C are present in the circuit. We cannot have resonance in a RL or RC circuit.

A series LCR circuit with L = 0.12 H, C = 480 nF, R = 23 Ω is connected to a 230 V variable frequency supply.



(i) Find the value of source frequency for which current amplitude is maximum.

(a) 222.32 Hz (b) 550.52 Hz (c) 663.48 Hz (d) 770 Hz

(ii) The value of maximum current is

(a) 14.14 A (b) 22.52 A (c) 50.25 A (d) 47.41 A

(iii) The value of maximum power is

(a) 2200 W (b) 2299.3 W (c) 5500 W (d) 4700 W

(iv) What is the Q-factor of the given circuit?

(a) 25 (b) 4221 (c) 35.42 (d) 21.74

(v) Which of the following physical quantity is maximum at resonance?

(a) Impedence (b) Current (c) Both (a) and (b) (d) Neither (a) nor (b)

ANSWERS

1. (b)	**2.** (a)	**3.** (d)	**4.** (a)	**5.** (d)	**6.** (a)	**7.** (d)	**8.** (a)	**9.** (d)	**10.** (c)
11. (d)	**12.** (d)	**13.** (b)	**14.** (d)	**15.** (c)	**16.** (b)	**17.** (c)	**18.** (b)	**19.** (b)	**20.** (b)
21. (d)	**22.** (b)	**23.** (b)	**24.** (d)	**25.** (a)	**26.** (c)	**27.** (d)	**28.** (b)	**29.** (b)	**30.** (a)
31. (d)	**32.** (b)	**33.** (b)	**34.** (b)	**35.** (b)	**36.** (d)	**37.** (a)	**38.** (b)	**39.** (c)	**40.** (a)
41. (d)	**42.** (d)	**43.** (c)	**44.** (d)	**45.** (a)	**46.** (d)	**47.** (b)	**48.** (b)	**49.** (c)	**50.** (a)
51. (c)	**52.** (b)	**53.** (b)	**54.** (d)	**55.** (b)	**56.** (d)	**57.** (c)	**58.** (b)	**59.** (b)	**60.** (c)
61. (b)	**62.** (d)	**63.** (c)	**64.** (c)	**65.** (b)	**66.** (a)	**67.** (a)	**68.** (b)	**69.** (d)	**70.** (b)
71. (b)	**72.** (b)	**73.** (a)	**74.** (a)	**75.** (b)	**76.** (a)	**77.** (c)	**78.** (a)	**79.** (c)	**80.** (d)

Input Text Based MCQs

1. (i) (c), (ii) (d), (iii) (c), (iv) (a), (v) (c) **2.** (i) (c), (ii) (a), (iii) (b), (iv) (d), (v) (b)