CHAPTER 14
Electromagnetic Induction and Alternating Currents

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

(a) 50, 10 (b) $\frac{1000}{\sqrt{2}}, 10$
(c) $\frac{50}{\sqrt{2}}, 0$ (d) 50, 0 *(2018)*

2. For an RLC circuit driven with voltage of amplitude v_m and frequency $\omega_0 = \frac{1}{\sqrt{LC}}$ the current exhibits resonance. The quality factor, Q is given by

(a) $\frac{\omega_0 L}{R}$ (b) $\frac{\omega_0 R}{L}$ (c) $\frac{R}{(\omega_0 C)}$ (d) $\frac{CR}{\omega_0}$ *(2018)*

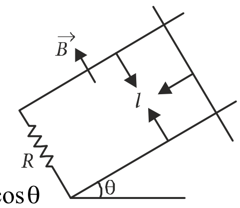
3. An ideal capacitor of capacitance 0.2 μF is charged to a potential difference of 10 V. The charging battery is then disconnected. The capacitor is then connected to an ideal inductor of self inductance 0.5 mH. The current at a time when the potential difference across the capacitor is 5 V, is

(a) 0.34 A (b) 0.17 A (c) 0.25 A (d) 0.15 A
(Online 2018)

4. At the centre of a fixed large circular coil of radius R, a much smaller circular coil of radius r is placed. The two coils are concentric and are in the same plane. The larger coil carries a current I. The smaller coil is set to rotate with a constant angular velocity ω about an axis along their common diameter. Calculate the emf induced in the smaller coil after a time t of its start of rotation.

(a) $\frac{\mu_0 I}{4R}\omega\pi r^2 \sin\omega t$ (b) $\frac{\mu_0 I}{4R}\omega r^2 \sin\omega t$
(c) $\frac{\mu_0 I}{2R}\omega r^2 \sin\omega t$ (d) $\frac{\mu_0 I}{2R}\omega\pi r^2 \sin\omega t$
(Online 2018)

5. A copper rod of mass m slides under gravity on two smooth parallel rails, with separation l and set at an angle of θ with the horizontal. At the bottom, rails are joined by a resistance R. There is a uniform magnetic field B normal to the plane of the rails, as shown in the figure. The terminal speed of the copper rod is



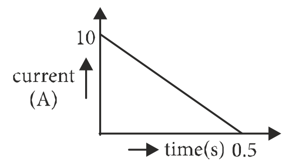
(a) $\frac{mgR\sin\theta}{B^2 l^2}$
(b) $\frac{mgR\cot\theta}{B^2 l^2}$
(c) $\frac{mgR\tan\theta}{B^2 l^2}$ (d) $\frac{mgR\cos\theta}{B^2 l^2}$
(Online 2018)

6. A power transmission line feeds input power at 2300 V to a step down transformer with its primary windings having 4000 turns, giving the output power at 230 V. If the current in the primary of the transformer is 5 A, and its efficiency is 90%, the output current would be
(a) 50 A (b) 25 A (c) 45 A (d) 20 A
(Online 2018)

7. A coil of cross-sectional area A having n turns is placed in a uniform magnetic field B. When it is rotated with an angular velocity ω, the maximum e.m.f. induced in the coil will be

(a) $\frac{3}{2}nBA\omega$ (b) $nBA\omega$
(c) $3nBA\omega$ (d) $\frac{1}{2}nBA\omega$ *(Online 2018)*

8. In a coil of resistance 100 Ω, a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is
(a) 200 Wb
(b) 225 Wb
(c) 250 Wb
(d) 275 Wb



(2017)

9. A small circular loop of wire of radius a is located at the centre of a much larger circular wire loop of radius b. The two loops are in the same plane. The outer loop of radius b carries an alternating current $I = I_0\cos(\omega t)$. The emf induced in the smaller inner loop is nearly

(a) $\frac{\pi\mu_0 I_0}{2}\cdot\frac{a^2}{b}\omega\cos(\omega t)$ (b) $\frac{\pi\mu_0 I_0 b^2}{a}\omega\cos(\omega t)$
(c) $\frac{\pi\mu_0 I_0}{2}\cdot\frac{a^2}{b}\omega\sin(\omega t)$ (d) $\pi\mu_0 I_0\frac{a^2}{b}\omega\sin(\omega t)$
(Online 2017)

10. A sinusoidal voltage of peak value 283 V and angular frequency 320/s is applied to a series LCR circuit. Given that $R = 5\ \Omega$, $L = 25$ mH and $C = 1000\ \mu$F. The total impedance, and phase difference between the voltage across the source and the current will respectively be

(a) $10\ \Omega$ and $\tan^{-1}\left(\frac{5}{3}\right)$ (b) $10\ \Omega$ and $\tan^{-1}\left(\frac{8}{3}\right)$

(c) $7\ \Omega$ and $\tan^{-1}\left(\frac{5}{3}\right)$ (d) $7\ \Omega$ and $45°$

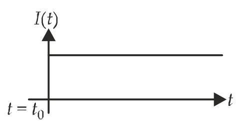
(Online 2017)

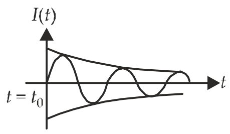
11. An arc lamp requires a direct current of 10 A at 80 V to function. If it is connected to a 220 V (rms), 50 Hz AC supply, the series inductor needed for it to work is close to

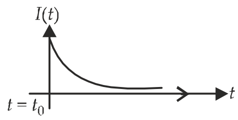
(a) 80 H (b) 0.08 H

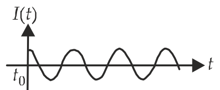
(c) 0.044 H (d) 0.065 H *(2016)*

12. A series LR circuit is connected to a voltage source with $V(t) = V_0 \sin\omega t$. After very large time, current $I(t)$ behaves as $\left(t_0 >> \frac{L}{R}\right)$

(a) 

(b) 

(c) 

(d) 

(Online 2016)

13. A conducting metal circular-wire-loop of radius r is placed perpendicular to a magnetic field which varies with time as $B = B_0 e^{-\frac{t}{\tau}}$, where B_0 and τ are constants, at time $t = 0$. If the resistance of the loop is R then the heat generated in the loop after a long time ($t \to \infty$) is

(a) $\frac{\pi^2 r^4 B_0^4}{2\tau R}$ (b) $\frac{\pi^2 r^4 B_0^2}{2\tau R}$ (c) $\frac{\pi^2 r^4 B_0^2 R}{\tau}$ (d) $\frac{\pi^2 r^4 B_0^2}{\tau R}$

(Online 2016)

14. A fighter plane of length 20 m, wing span (distance from tip of one wing to the tip of the other wing) of 15 m and height 5 m is flying towards east over Delhi. Its speed is 240 m s^{-1}. The earth's magnetic field over Delhi is 5×10^{-5} T with the declination angle ~ 0° and dip of θ such that $\sin\theta = \frac{2}{3}$. If the voltage developed is V_B between the lower and upper side of the plane and V_W between the tips of the wings then V_B and V_W are close to

(a) V_B = 40 mV; V_W = 135 mV with left side of pilot at higher voltage

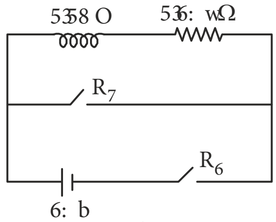
(b) V_B = 45 mV; V_W = 120 mV with right side of pilot at higher voltage

(c) V_B = 40 mV; V_W = 135 mV with right side of pilot at higher voltage

(d) V_B = 45 mV; V_W = 120 mV with left side of pilot at higher voltage.

(Online 2016)

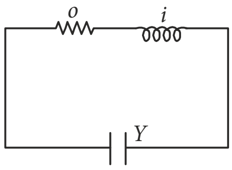
15. An inductor (L = 0.03 H) and a resistor (R = 0.15 kΩ) are connected in series to a battery of 15 V EMF in a circuit shown below. The key K_1 has been kept closed for a long time. Then at $t = 0$, K_1 is opened and key K_2 is closed simultaneously. At t = 1 ms, the current in the circuit will be ($e^5 \cong 150$)



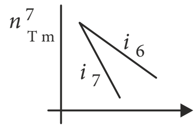
(a) 6.7 mA (b) 0.67 mA

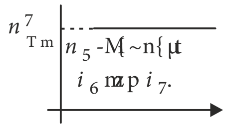
(c) 100 mA (d) 67 mA *(2015)*

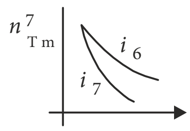
16. An LCR circuit is equivalent to a damped pendulum. In an LCR circuit the capacitor is charged to Q_0 and then connected to the L and R as shown here.

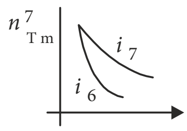


If a student plots graphs of the square of maximum charge (Q^2_{Max}) on capacitor with time (t) for two different values L_1 and L_2 ($L_1 > L_2$) of L then which of the following represents this graph correctly ? (plots are schematic and not drawn to scale)

(a) 

(b) 

(c) 

(d) 

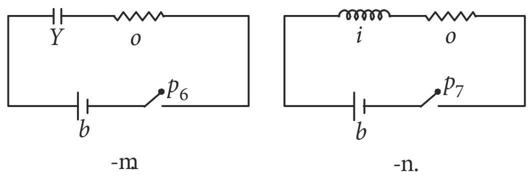
(2015)

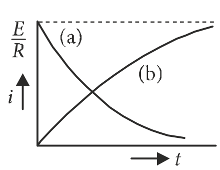
17. When current in a coil changes from 5 A to 2 A in 0.1 s, an average voltage of 50 V is produced. The self-inductance of the coil is

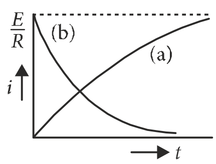
(a) 0.67 H (b) 1.67 H

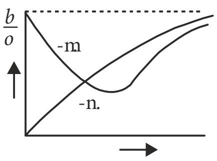
(c) 3 H (d) 6 H *(Online 2015)*

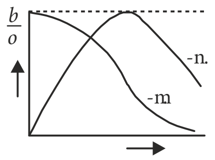
18. In the circuits (a) and (b) switches S_1 and S_2 are closed at $t = 0$ and are kept closed for a long time. The variation of currents in the two circuits for $t \geq 0$ are roughly shown by (figures are schematic and not drawn to scale)



(a) 

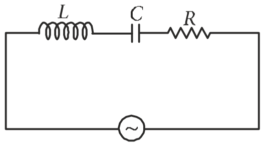
(b) 

(c) 

(d) 

(Online 2015)

19. For the LCR circuit, shown here, the current is observed to lead the applied voltage. An additional capacitor C', when joined with the capacitor C present in the circuit, makes the power factor of the circuit unity. The capacitor C', must have been connected in



$V = V_0 \sin\omega t$

(a) series with C and has a magnitude $\frac{6-\omega^7 i\, Y}{\omega^7 i}$

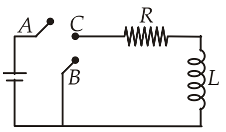
(b) series with C and has a magnitude $\frac{Y}{\text{-}\omega^7 i\, Y - 6.}$

(c) parallel with C and has a magnitude $\frac{Y}{\text{-}\omega^7 i\, Y - 6.}$

(d) parallel with C and has a magnitude $\frac{6-\omega^7 i\, Y}{\omega^7 i}$.

(Online 2015)

20. In the circuit shown here, the point 'C' is kept connected to point 'A' till the current flowing through the circuit becomes constant.

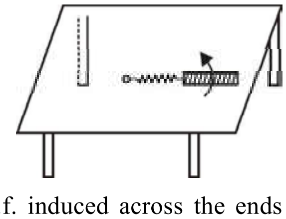


Afterward, suddenly, point 'C' is disconnected from point 'A' and connected to point 'B' at time $t = 0$. Ratio of the voltage across resistance and the inductor at $t = L/R$ will be equal to

(a) $\frac{1-e}{e}$ (b) $\frac{e}{1-e}$

(c) 1 (d) –1 *(2014)*

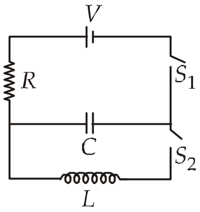
21. A metallic rod of length 'l' is tied to a string of length $2l$ and made to rotate with angular speed ω on a horizontal table with one end of the string fixed. If there is a vertical magnetic field 'B' in the region, the e.m.f. induced across the ends of the rod is



(a) $\frac{5B\omega l^2}{2}$ (b) $\frac{2B\omega l^2}{2}$ (c) $\frac{3B\omega l^2}{2}$ (d) $\frac{4B\omega l^2}{2}$

(2013)

22. In an LCR circuit as shown below both switches are open initially. Now switch S_1 is closed, S_2 kept open. (q is charge on the capacitor and $\tau = RC$ is capacitive time constant). Which of the following statement is correct?



(a) At $t = \frac{\tau}{2}$, $q = CV(1 - e^{-1})$

(b) Work done by the battery is half of the energy dissipated in the resistor

(c) At $t = \tau$, $q = CV/2$

(d) At $t = 2\tau$, $q = CV(1 - e^{-2})$ *(2013)*

23. A circular loop of radius 0.3 cm lies parallel to a much bigger circular loop of radius 20 cm. The centre of the small loop is on the axis of the bigger loop. The distance between their centres is 15 cm. If a current of 2.0 A flows through the smaller loop, then the flux linked with bigger loop is

(a) 6.6×10^{-9} weber (b) 9.1×10^{-11} weber

(c) 6×10^{-11} weber (d) 3.3×10^{-11} weber *(2013)*

24. A boat is moving due east in a region where the earth's magnetic field is 5.0×10^{-5} N A^{-1}m^{-1} due north and horizontal. The boat carries a vertical aerial 2 m long. If the speed of the boat is 1.50 m s^{-1}, the magnitude of the induced emf in the wire of aerial is

(a) 1 mV (b) 0.75 mV (c) 0.50 mV (d) 0.15 mV

(2011)

25. 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) $2\pi\sqrt{LC}$ (d) $\sqrt{LC}$

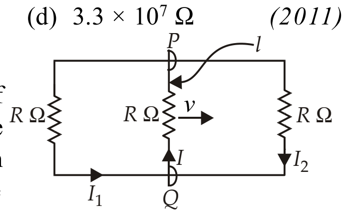
(2011)

26. A resistor R and 2 μF capacitor in series is connected through a switch to 200 V direct supply. Across the capacitor is a neon bulb that lights up at 120 V. Calculate the value of R to make the bulb light up 5 s after the switch has been closed. ($\log_{10}2.5 = 0.4$)

(a) $1.3 \times 10^4\ \Omega$ (b) $1.7 \times 10^5\ \Omega$

(c) $2.7 \times 10^6\ \Omega$ (d) $3.3 \times 10^7\ \Omega$ *(2011)*

27. A rectangular loop has a sliding connector PQ of length l and resistance $R\ \Omega$ and it is moving with a speed v as shown. The set-up is placed in a uniform magnetic field going into the plane of the paper. The three currents I_1, I_2 and I are



(a) $I_1 = I_2 = \frac{Blv}{6R}, I = \frac{Blv}{3R}$ (b) $I_1 = -I_2 = \frac{Blv}{R}, I = \frac{2Blv}{R}$

(c) $I_1 = I_2 = \frac{Blv}{3R}, I = \frac{2Blv}{3R}$ (d) $I_1 = I_2 = I = \frac{Blv}{R}$

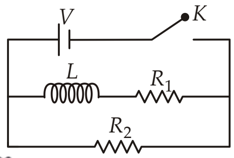
(2010)

28. 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) $\frac{1}{2}$ (d) $\frac{1}{4}$

(2010)

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



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

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

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

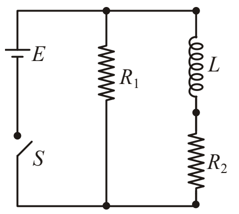
(d) $\frac{V}{R_2}$ at $t = 0$ and $\frac{VR_1R_2}{\sqrt{R_1^2+R_2^2}}$ at $t = \infty$ *(2010)*

30. In a series LCR circuit $R = 200\ \Omega$ and the voltage and the frequency of the main supply is 220 V and 50 Hz respectively. On taking out the capacitance from the circuit the current lags behind the voltage by 30°. On taking out the inductor from the circuit the current leads the voltage by 30°. The power dissipated in the LCR circuit is

(a) 242 W (b) 305 W (c) 210 W (d) zero W

(2010)

31. An inductor of inductance $L = 400$ mH and resistors of resistances $R_1 = 2\ \Omega$ and $R_2 = 2\ \Omega$ 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) $6e^{-5t}$ V (b) $\frac{12}{t}e^{-3t}$ V

(c) $6(1-e^{-t/0.2})$ V (d) $12e^{-5t}$ V *(2009)*

32. Two coaxial solenoids are made by winding thin insulated wire over a pipe of cross-sectional area $A = 10\ \text{cm}^2$ and length = 20 cm. If one of the solenoids has 300 turns and the other 400 turns, their mutual inductance is ($\mu_0 = 4\pi \times 10^{-7}$ T mA^{-1})

(a) $2.4\pi \times 10^{-4}$ H (b) $2.4\pi \times 10^{-5}$ H

(c) $4.8\pi \times 10^{-4}$ H (d) $4.8\pi \times 10^{-5}$ H *(2008)*

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

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

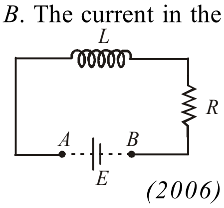
(c) e (d) e^{-1} *(2007)*

34. In an a.c. circuit the voltage applied is $E = E_0 \sin \omega t$. The resulting current in the circuit is $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$. The power consumption in the circuit is given by

(a) $P = \sqrt{2}E_0I_0$ (b) $P = \frac{E_0I_0}{\sqrt{2}}$

(c) P = zero (d) $P = \frac{E_0I_0}{2}$ *(2007)*

35. An inductor ($L = 100$ mH), a resistor ($R = 100\ \Omega$) and a battery ($E = 100$ V) are initially connected in series as shown in the figure. After a long time the battery is disconnected after short circuiting the points A and B. The current in the circuit 1 ms after the short circuit is



(a) 1 A
(b) (1/e) A
(c) e A
(d) 0.1 A

(2006)

36. The flux linked with a coil at any instant t is given by $\phi = 10t^2 - 50t + 250$. The induced emf at $t = 3$ s is

(a) 190 V (b) –190 V (c) –10 V (d) 10 V

(2006)

37. In an AC generator, a coil with N turns, all of the same area A and total resistance R, rotates with frequency ω in a magnetic field B. The maximum value of emf generated in the coil is

(a) $NAB\omega$ (b) $NABR\omega$ (c) NAB (d) $NABR$

(2006)

38. In a series resonant LCR circuit, the voltage across R is 100 volts and $R = 1$ kΩ with $C = 2\ \mu$F. The resonant frequency ω is 200 rad/s. At resonance the voltage across L is

(a) 4×10^{-3} V (b) 2.5×10^{-2} V

(c) 40 V (d) 250 V *(2006)*

39. The phase difference between the alternating current and emf is $\pi/2$. Which of the following cannot be the constituent of the circuit?

(a) LC (b) L alone (c) C alone (d) R, L

(2005)

40. A circuit has a resistance of 12 ohm and an impedance of 15 ohm. The power factor of the circuit will be

(a) 1.25 (b) 0.125 (c) 0.8 (d) 0.4

(2005)

41. 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) 1 μF (b) 2 μF (c) 4 μF (d) 8 μF

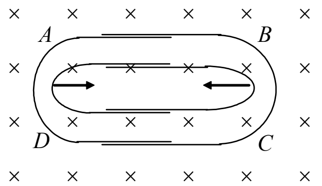
(2005)

42. A coil of inductance 300 mH and resistance 2 Ω is connected to a source of voltage 2 V. The current reaches half of its steady state value in

(a) 0.15 s (b) 0.3 s (c) 0.05 s (d) 0.1 s

(2005)

43. One conducting U tube can slide inside another as shown in figure, maintaining electrical contacts between the tubes. The magnetic field B is perpendicular to the plane of the figure. If each tube moves towards the other at a constant speed v, then the emf induced in the circuit in terms of B, l and v where l is the width of each tube, will be



(a) zero (b) $2Blv$ (c) Blv (d) $-Blv$ *(2005)*

44. A metal conductor of length 1 m rotates vertically about one of its ends at angular velocity 5 radian per second. If the horizontal component of earth's magnetic field is 0.2×10^{-4} T, then the e.m.f. developed between the two ends of the conductor is
(a) 5 μV (b) 50 μV (c) 5 mV (d) 50 mV *(2004)*

45. In a LCR circuit capacitance is changed from C to $2C$. For the resonant frequency to remain unchanged, the inductance should be changed from L to
(a) $4L$ (b) $2L$ (c) $L/2$ (d) $L/4$ *(2004)*

46. In a uniform magnetic field of induction B a wire in the form of a semicircle of radius r rotates about the diameter of the circle with angular frequency ω. The axis of rotation is perpendicular to the field. If the total resistance of the circuit is R the mean power generated per period of rotation is
(a) $\frac{B\pi r^2\omega}{2R}$ (b) $\frac{(B\pi r^2\omega)^2}{8R}$
(c) $\frac{(B\pi r\omega)^2}{2R}$ (d) $\frac{(B\pi r\omega^2)^2}{8R}$ *(2004)*

47. A coil having n turns and resistance R Ω is connected with a galvanometer of resistance $4R$ Ω. This combination is moved in time t seconds from a magnetic field W_1 weber to W_2 weber. The induced current in the circuit is
(a) $-\frac{W_2 - W_1}{5Rnt}$ (b) $-\frac{n(W_2 - W_1)}{5Rt}$
(c) $-\frac{(W_2 - W_1)}{Rnt}$ (d) $-\frac{n(W_2 - W_1)}{Rt}$ *(2004)*

48. Alternating current cannot be measured by D.C. ammeter because
(a) A.C. cannot pass through D.C. ammeter
(b) A.C. changes direction
(c) average value of current for complete cycle is zero
(d) D.C. ammeter will get damaged. *(2004)*

49. In an LCR series a.c. circuit, the voltage across each of the components, L, C and R is 50 V. The voltage across the LC combination will be
(a) 50 V (b) $50\sqrt{2}$ V
(c) 100 V (d) 0 V (zero) *(2004)*

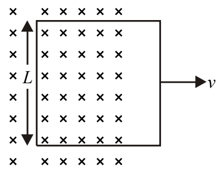
50. The core of any transformer is laminated so as to
(a) reduce the energy loss due to eddy currents
(b) make it light weight
(c) make it robust & strong
(d) increase the secondary voltage. *(2003)*

51. In an oscillating LC circuit the maximum charge on the capacitor is Q. The charge on the capacitor when the energy is stored equally between the electric and magnetic field is
(a) $Q/2$ (b) $Q/\sqrt{3}$ (c) $Q/\sqrt{2}$ (d) Q *(2003)*

52. When the current changes from +2 A to –2 A in 0.05 second, an e.m.f. of 8 V is induced in a coil. The coefficient of self-induction of the coil is
(a) 0.2 H (b) 0.4 H (c) 0.8 H (d) 0.1 H *(2003)*

53. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon
(a) the rates at which currents are changing in the two coils
(b) relative position and orientation of the two coils
(c) the materials of the wires of the coils
(d) the currents in the two coils. *(2003)*

54. A conducting square loop of side L and resistance R moves in its plane with a uniform velocity v perpendicular to one of its sides. A magnetic induction B constant in time and space, pointing perpendicular and into the plane at the loop exists everywhere with half the loop outside the field, as shown in figure. The induced emf is

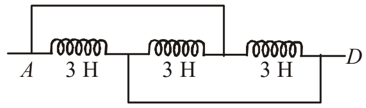


(a) zero
(b) RvB
(c) vBL/R
(d) vBL *(2002)*

55. In a transformer, number of turns in the primary coil are 140 and that in the secondary coil are 280. If current in primary coil is 4 A, then that in the secondary coil is
(a) 4 A (b) 2 A (c) 6 A (d) 10 A *(2002)*

56. The power factor of an AC 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) $R/(R^2 - \omega^2 L^2)^{1/2}$ *(2002)*

57. The inductance between A and D is



(a) 3.66 H
(b) 9 H
(c) 0.66 H
(d) 1 H *(2002)*

ANSWER KEY

1. (b)	**2.** (a)	**3.** (b)	**4.** (d)	**5.** (a)	**6.** (c)	**7.** (b)	**8.** (c)	**9.** (c)	**10.** (d)	**11.** (d)	**12.** (d)
13. (b)	**14.** (d)	**15.** (b)	**16.** (c)	**17.** (b)	**18.** (a)	**19.** (d)	**20.** (d)	**21.** (a)	**22.** (d)	**23.** (b)	**24.** (d)
25. (b)	**26.** (c)	**27.** (c)	**28.** (d)	**29.** (c)	**30.** (a)	**31.** (d)	**32.** (a)	**33.** (a)	**34.** (c)	**35.** (b)	**36.** (c)
37. (a)	**38.** (d)	**39.** (d)	**40.** (c)	**41.** (a)	**42.** (d)	**43.** (a)	**44.** (b)	**45.** (c)	**46.** (b)	**47.** (b)	**48.** (c)
49. (d)	**50.** (a)	**51.** (c)	**52.** (d)	**53.** (c)	**54.** (d)	**55.** (b)	**56.** (b)	**57.** (d)			

Explanations

1. **(b) :** Average power, $P_{av} = e_{\text{rms}}\, i_{\text{rms}} \cos\phi = \frac{e_0}{\sqrt{2}}\frac{i_0}{\sqrt{2}}\cos\phi$
Here, $e_0 = 100$, $i_0 = 20$, $\phi = \pi/4$

$\therefore\ P_{av} = \frac{100}{\sqrt{2}} \times \frac{20}{\sqrt{2}} \cos 45° = \frac{1000}{\sqrt{2}}$ units

Wattless current, $i_w = i_{\text{rms}} \sin\phi = \frac{i_0}{\sqrt{2}} \sin 45° = 10$ units

2. **(a)**

3. **(b) :** Using energy conservation
$U_e + 0 = U'_E + U'_B$

$$\frac{1}{2}\times 0.2\times 10^{-6}\times 10^2 + 0 = \frac{1}{2}\times 0.2\times 10^{-6}\times 5^2 + \frac{1}{2}\times 0.5\times 10^{-3} I^2$$

$I = \sqrt{3}\times 10^{-1}\,\text{A} = 0.17\,\text{A}$

4. **(d) :** Emf induced in smaller coil is given by

$$\varepsilon = -\frac{d\phi}{dt} = -B\times A\frac{d}{dt}(\cos\theta)$$
$$= \frac{\mu_0 I}{2R}(\pi r^2)(\sin\theta)\times\frac{d\theta}{dt} = \frac{\mu_0 I}{2R}\omega\pi r^2 \sin\omega t$$

($\because$ B is assumed to be constant in small region.)

5. **(a) :** Copper rod will acquire terminal velocity when magnetic force = gravitation force
or $IlB = mg\sin\theta$ ...(i)

Also, $I = \frac{\text{induced emf}}{R} = \frac{Blv}{R}$ ...(ii)

From equations (i) and (ii), we get

$$\frac{B^2 l^2 v}{R} = mg\sin\theta;\quad \therefore\ v = \frac{mgR\sin\theta}{B^2 l^2}$$

6. **(c) :** Efficiency $\eta = 0.9 = \frac{P_s}{P_p}$
$V_s I_s = 0.9 \times V_p I_p$

$$I_s = \frac{0.9\times 2300\times 5}{230} = 45\,\text{A}$$

7. **(b) :** emf induced in the coil is given by
$\varepsilon = BA\omega n \sin\omega t$
$\varepsilon_{\max} = BA\omega n$

8. **(c) :** We know, induced emf (ε) is $|\varepsilon| = \frac{d\phi}{dt}$; $iR = \frac{d\phi}{dt}$

Now, $d\phi = R\, idt$ or $\int d\phi = R\int idt$

$\therefore$ Change in magnetic flux = R × area under the current-time graph

$$\Delta\phi = R\times\frac{1}{2}\times 10\times 0.5 = 100\times\frac{1}{2}\times 10\times 0.5 = 250\text{ Wb}$$

9. **(c) :** The induced emf, $\varepsilon = -M$ ...(i)

where mutual inductance M is given by, $M = \frac{\mu_0\pi a^2}{2b}$

The current is given by, $I = I_0\cos(\omega t)$

Putting these values in eqn. (i)

$$\varepsilon = \frac{-\mu_0\pi a^2}{2b}\frac{d}{dt}(I_0\cos(\omega t)) = \frac{\mu_0\pi a^2}{2b}\ I_0\omega\sin(\omega t)$$
$$= \frac{\pi\mu_0 I_0}{2}\frac{a^2}{b}\ \omega\sin(\omega t)$$

10. **(d) :** Here, $\varepsilon_0 = 283$ V, $\omega = 320\ \text{s}^{-1}$, $R = 5\ \Omega$, $L = 25$ mH $= 25\times 10^{-3}$ H, $C = 1000\ \mu$F $= 10^{-3}$ F
$X_L = \omega L = 320\times 25\times 10^{-3} = 8\ \Omega$

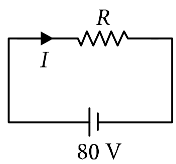
$$X_C = \frac{1}{\omega C} = \frac{1}{320\times 10^{-3}} = \frac{1000}{320} = 3.125\ \Omega$$

Impedance, $Z = \sqrt{R^2 + (X_L - X_C)^2}$
$$= \sqrt{5^2 + (8-3.125)^2} \approx \sqrt{49} = 7\Omega$$

Required phase difference, $\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$

$$\phi = \tan^{-1}\left(\frac{4.875}{5}\right) \approx 45°$$

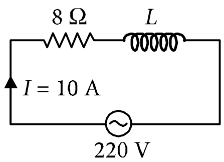
11. **(d) :** For a dc source
$I = 10$ A, $V = 80$ V



Resistance of the arc lamp,

$$o = \frac{s}{f} = \frac{=5}{65} = = \Omega$$

For an ac source,



$\varepsilon_{\text{rms}} = 220$ V
$\upsilon = 50$ Hz
$\omega = 2\pi\times 50 = 100\ \pi$ rad s^{-1}
Arc lamp will glow if $I = 10$ A,

$$\therefore\ f = \frac{\varepsilon_{\sim y\,-}}{\sqrt{o^7 + \omega^7 i^7}}\quad \{\sim\ o^7 + \omega^7 i^7 = \left(\frac{\varepsilon_{\sim y\,-}}{f}\right)^7$$

$$\{\sim =^7 + -655\ \pi.^7 i^7 = \left(\frac{775}{65}\right)^7\quad \{\sim i^7 = \frac{77^7 - =^7}{-655\ \pi.^7}$$

$$\therefore\ i = \frac{\sqrt{85\times 69}}{655\ \pi} = 53\!5;:\ \text{O}$$

12. **(d) :** Current in LR circuit is $I = \frac{V_0}{\sqrt{R^2+\omega^2 L^2}}\sin\left(\omega t - \frac{\pi}{2}\right)$, *i.e.*, it is sinusoidal in nature.

13. **(b) :** Here, $B = B_0 e^{-\frac{t}{\tau}}$

Area of the circular loop, $A = \pi r^2$
Flux linked with the loop at any time, t,

$$\phi = BA = \pi r^2 B_0 e^{-\frac{t}{\tau}}$$

Emf induced in the loop, $\varepsilon = -\frac{d\phi}{dt} = \pi r^2 B_0\frac{1}{\tau}e^{-\frac{t}{\tau}}$

Net heat generated in the loop

$$= \int_0^\infty \frac{\varepsilon^2}{R} dt = \frac{\pi^2 r^4 B_0^2}{\tau^2 R}\int_0^\infty e^{-\frac{2t}{\tau}} dt = \frac{\pi^2 r^4 B_0^2}{\tau^2 R} \times \frac{1}{\left(-\frac{2}{\tau}\right)} \times \left[e^{-\frac{2t}{\tau}}\right]_0^\infty$$

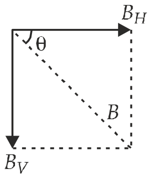
$$= \frac{-\pi^2 r^4 B_0^2}{2\tau^2 R} \times \tau(0-1) = \frac{\pi^2 r^4 B_0^2}{2\tau R}$$

14. (d) : Length of the plane, $l = 20$ m
Wing span, $l' = 15$ m
Height of plane, $h = 5$ m
Velocity of plane = 240 m s^{-1} towards east

$\sin\theta = \frac{2}{3}$, $B = 5 \times 10^{-5}$ T, V_B = ?, V_W = ?

V_B = Voltage developed between the lower and upper side of the plane

$= vh\, B \cos\theta$

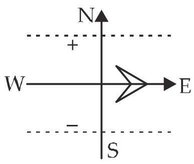


$$= 240 \times 5 \times 5 \times 10^{-5} \times \frac{\sqrt{5}}{3}$$

$= 44.72 \times 10^{-3}$ V ≈ 45 mV

$B_V = B \sin\theta$

$$= 5 \times 10^{-5} \times \frac{2}{3} = \frac{1}{3} \times 10^{-4} \text{ T}$$



V_W = Voltage developed between tips of the wings

$$= B_V l' V = \frac{1}{3} \times 10^{-4} \times 15 \times 240 = 1200 \times 10^{-4}$$

$= 120$ mV

15. (b) : When key K_1 is kept closed, a steady current $f_5\left(=\frac{\varepsilon}{o}\right)$ flows through the circuit.
When K_1 is opened and K_2 is closed, current at any time t in the circuit is

$$f = f_5^{\;-4\tau} = \frac{\varepsilon}{o}^{\;-\frac{o}{i}} \qquad \left(\because \tau = \frac{i}{o}\right)$$

Here, ε = 15 V, R = 0.15 kΩ = 150 Ω
L = 0.03 H, t = 1 ms = 10^{-3} s

$$\therefore \quad f = \frac{6:}{6:5}^{\,-\left(\frac{65^{-8}\times 6:5}{5358}\right)} = \frac{-:}{65} = \frac{6}{65^{:}} = \frac{6}{65 \times 6:5}$$

$= 6.67 \times 10^{-4}$ A = 0.67 mA

16. (c) : At any time t, the equation of the given circuit is

$$i\frac{7}{7} + o\,\text{—} + \frac{6}{Y} = 5 \qquad \text{...(i)}$$

which is equivalent to that of a damped pendulum.
The solution to eqn. (i) is $q = Q_0\, e^{-Rt/2L} \cos(\omega' t + \phi)$

where $\omega' = \sqrt{\frac{6}{iY} - \left(\frac{o}{7i}\right)^7}$

The square of maximum charge on capacitor at any time t is

$$n_{\text{y m}}^7 = n_5^{7\;-o\;4i}\; o\{-^7\text{-}\omega' + \phi.$$

∴ It decays exponentially with time.
For L_2 ($L_2 < L_1$), the curve is more steep.

17. (b) : I_1 = 5 A, I_2 = 2 A
$\Delta I = 2 - 5 = -3$ A
$\Delta t = 0.1$ s, ε = 50 V

As, $\varepsilon = -L\frac{\Delta I}{\Delta t}$

$50 = -L\left(\frac{-3}{0.1}\right)$; $50 = 30L$

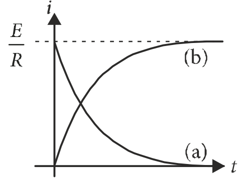
$L = \frac{5}{3} = 1.67$ H

18. (a) : For RC circuit,

$i = \frac{b}{o}\; e^{-t/RC}$

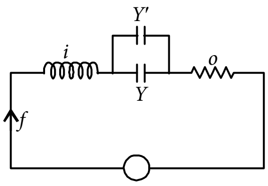
For RL circuit

$i = \frac{b}{o}\;(1 - e^{-t(L/R)})$



19. (d) : Since power factor has to be made 1.
∴ Effective capacitance should be increased thus connecting in parallel.

$\because$ o{ −φ =6 ∴ φ =5



$$f\omega i = \frac{f}{\omega\text{-}Y + Y'.}$$

$$\{\sim\;\; Y + Y' = \frac{6}{\omega^7 i} \quad \therefore\;\; Y' = \frac{6}{\omega^7 i} - Y$$

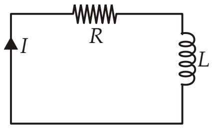
$$\therefore\;\; Y' = \frac{6 - \omega^7 i\, Y}{\omega^7 i} \quad \text{uz | m-nxqx}$$

20. (d) : Initially current in the circuit = I_0
After time t current falls to new value.

$I = I_0\, e^{(-t/\tau)}$

∴ Voltage drop across the resistance,

$V_R = IR = V_0 e^{-t/\tau}$ ...(i)



Voltage across the inductor,

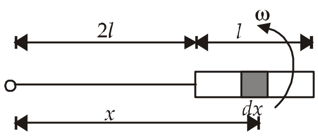
$$V_L = L\frac{dI}{dt} = L\left[-\frac{I_0}{\tau}e^{(-t/\tau)}\right]$$

$\Rightarrow \;\; V_L = -I_0 R e^{-t/\tau} = -\,V_0 e^{-t/\tau}$ ...(ii)

From eqn (i) and (ii)

$$\frac{V_R}{V_L} = -1$$

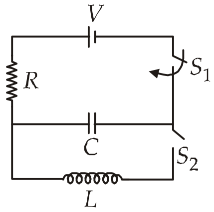
21. (a) :



Consider a element of length dx at a distance x from the fixed end of the string.
e.m.f. induced in the element is $d\varepsilon = B(\omega x)dx$
Hence, the e.m.f. induced across the ends of the rod is

$$\varepsilon = \int_{2l}^{3l} B\omega x dx = B\omega\left[\frac{x^2}{2}\right]_{2l}^{3l} = \frac{B\omega}{2}[(3l)^2 - (2l)^2] = \frac{5B\omega l^2}{2}$$

22. (d) :



As switch S_1 is closed and switch S_2 is kept open. Now, capacitor is charging through a resistor R.

Charge on a capacitor at any time t is

$$q = q_0(1 - e^{-t/\tau})$$

$$q = CV(1 - e^{-t/\tau}) \qquad [\text{As } q_0 = CV]$$

At $t = \frac{\tau}{2}$

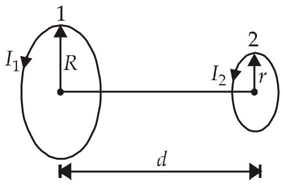
$$q = CV(1 - e^{-\tau/2\tau}) = CV(1 - e^{-1/2})$$

At $t = \tau$

$$q = CV(1 - e^{-\tau/\tau}) = CV(1 - e^{-1})$$

At $t = 2\tau, q = CV(1 - e^{-2\tau/\tau}) = CV(1 - e^{-2})$

23. (b) :



As field due to current loop 1 at an axial point

$$\therefore \quad B_1 = \frac{\mu_0 I_1 R^2}{2(d^2 + R^2)^{3/2}}$$

Flux linked with smaller loop 2 due to B_1 is

$$\phi_2 = B_1 A_2 = \frac{\mu_0 I_1 R^2}{2(d^2 + R^2)^{3/2}} \pi r^2$$

The coefficient of mutual inductance between the loops is

$$M = \frac{\phi_2}{I_1} = \frac{\mu_0 R^2 \pi r^2}{2(d^2 + R^2)^{3/2}}$$

Flux linked with bigger loop 1 is

$$\phi_1 = MI_2 = \frac{\mu_0 R^2 \pi r^2 I_2}{2(d^2 + R^2)^{3/2}}$$

Substituting the given values, we get

$$\phi_1 = \frac{4\pi \times 10^{-7} \times (20 \times 10^{-2})^2 \times \pi \times (0.3 \times 10^{-2})^2 \times 2}{2[(15 \times 10^{-2})^2 + (20 \times 10^{-2})^2]^{3/2}}$$

$\phi_1 = 9.1 \times 10^{-11}$ weber

24. (d) : Here, $B_H = 5.0 \times 10^{-5}$ N A^{-1} m^{-1}

$l = 2$ m and $v = 1.5$ m s^{-1}

Induced emf, $\varepsilon = B_H vl = 5 \times 10^{-5} \times 1.50 \times 2$

$= 15 \times 10^{-5}$ V $= 0.15$ mV

25. (b) : Charge on the capacitor at any instant t is

$$q = q_0 \cos\omega t \qquad \text{...(i)}$$

Equal sharing of energy means

Energy of a capacitor $= \frac{1}{2}$ Total energy

$$\frac{1}{2}\frac{q^2}{C} = \frac{1}{2}\left(\frac{1}{2}\frac{q_0^2}{C}\right) \Rightarrow q = \frac{q_0}{\sqrt{2}}$$

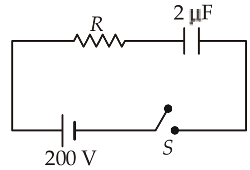
From equation (i)

$$\frac{q_0}{\sqrt{2}} = q_0 \cos\omega t$$

$$\cos\omega t = \frac{1}{\sqrt{2}} \Rightarrow \omega t = \cos^{-1}\left(\frac{1}{\sqrt{2}}\right) = \frac{\pi}{4}$$

$$t = \frac{\pi}{4\omega} = \frac{\pi}{4}\sqrt{LC} \qquad \left(\because \omega = \frac{1}{\sqrt{LC}}\right)$$

26. (c) :



In case charging of capacitor through the resistance is

$V = V_0(1 - e^{-t/RC})$

Here, $V = 120$ V, $V_0 = 200$ V, $R = ?$, $C = 2$ μF and $t = 5$ s.

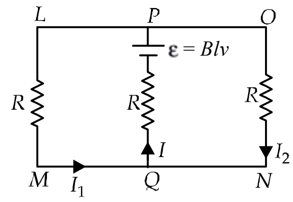
$$\therefore \quad 120 = 200(1 - e^{-5/R \times 2 \times 10^{-6}}) \text{ or } e^{-5/R \times 2 \times 10^{-6}} = \frac{80}{200}$$

Taking the natural logarithm on both sides, we get

$$\frac{-5}{R \times 2 \times 10^{-6}} = \ln(0.4) = -0.916 \Rightarrow R = 2.7 \times 10^6\ \Omega$$

27. (c) : Emf induced across PQ is $\varepsilon = Blv$.

The equivalent circuit diagram is as shown in the figure.



Applying Kirchhoff's first law at junction Q, we get

$$I = I_1 + I_2 \qquad \text{...(i)}$$

Applying Kirchhoff's second law for the closed loop $PLMQP$, we get

$$-I_1R - IR + \varepsilon = 0$$

$$I_1R + IR = Blv \qquad \text{...(ii)}$$

Again, applying Kirchhoff's second law for the closed loop $PONQP$, we get

$$-I_2R - IR + \varepsilon = 0$$

$$I_2R + IR = Blv \qquad \text{...(iii)}$$

Adding equations (ii) and (iii), we get

$$2IR + I_1R + I_2R = 2Blv$$

$$2IR + R(I_1 + I_2) = 2Blv$$

$$2IR + IR = 2Blv \qquad \text{(Using (i))}$$

$$3IR = 2Blv$$

$$I = \frac{2Blv}{3R} \qquad \text{...(iv)}$$

Substituting this value of I in equation (ii), we get $I_1 = \frac{Blv}{3R}$

Substituting the value of I in equation (iii), we get $I_2 = \frac{Blv}{3R}$

Hence, $I_1 = I_2 = \frac{Blv}{3R}$, $I = \frac{2Blv}{3R}$

28. (d) : During discharging of capacitor through a resistor,

$$q = q_0 e^{-t/RC} \qquad \text{...(i)}$$

The energy stored in the capacitor at any instant of time t is

$$U = \frac{1}{2}\frac{q^2}{C} = \frac{1}{2}\frac{(q_0 e^{-t/RC})^2}{C} \qquad \text{(Using(i))}$$

$$= \frac{1}{2}\frac{q_0^2}{C} e^{-2t/RC} = U_0 e^{-2t/RC} \qquad \text{...(ii)}$$

where $U_0 = \frac{1}{2}\frac{q_0^2}{C}$, the maximum energy stored in the capacitor.
According to given problem

$$\frac{U_0}{2} = U_0 e^{-2t_1/RC} \quad \text{(Using (ii))} \qquad \text{...(iii)}$$

and $\frac{q_0}{4} = q_0 e^{-t_2/RC}$ (Using (i)) ...(iv)

From equation (iii), we get $\frac{1}{2} = e^{-2t_1/RC}$

Taking natural logarithms of both sides, we get

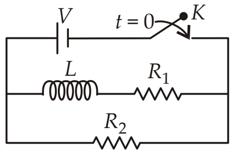
$$\ln 1 - \ln 2 = -\frac{2t_1}{RC} \quad \text{or} \quad t_1 = \frac{RC\ln 2}{2} \qquad (\because\ \ln 1 = 0)$$

From equation (iv), we get $\frac{1}{4} = e^{-t_2/RC}$

Taking natural logarithms of both sides of the above equation, we get $\ln 1 - \ln 4 = -\frac{t_2}{RC}$

$t_2 = RC \ln 4 = 2RC \ln 2$ $(\because \ln 4 = 2\ln 2)$

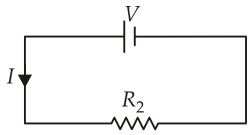
$$\therefore\ \frac{t_1}{t_2} = \frac{RC\ln 2}{2} \times \frac{1}{2RC\ln 2} = \frac{1}{4}$$

29. (c) : 

At time $t = 0$, the inductor acts as an open circuit. The corresponding equivalent circuit diagram is as shown in the figure (i).

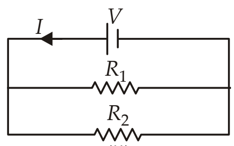
The current through battery is

$$I = \frac{V}{R_2}$$



(i)

At time $t = \infty$, the inductor acts as a short circuit. The corresponding equivalent circuit diagram is as shown in the figure (ii).



(ii)

$\therefore$ The current through the battery is

$$I = \frac{V}{R_{eq}} = \frac{V}{\frac{R_1 R_2}{R_1 + R_2}} \qquad (\because\ R_1 \text{ and } R_2 \text{ are in parallel})$$

$$= \frac{V(R_1 + R_2)}{R_1 R_2}$$

30. (a) : Here, $R = 200\ \Omega$, $V_{\text{rms}} = 220$ V, $\upsilon = 50$ Hz

When only the capacitance is removed, the phase difference between the current and voltage is $\tan\phi = \frac{X_L}{R}$

$$\tan 30^\circ = \frac{X_L}{R} \quad \text{or} \quad X_L = \frac{1}{\sqrt{3}}R$$

When only the inductance is removed, the phase difference between current and voltage is $\tan\phi' = \frac{X_C}{R}$

$$\tan 30^\circ = \frac{X_C}{R} \quad \text{or} \quad X_C = \frac{1}{\sqrt{3}}R$$

As $X_L = X_C$, therefore the given series LCR is in resonance.

$\therefore$ Impedance of the circuit is $Z = R = 200\ \Omega$

The power dissipated in the circuit is

$$P = V_{\text{rms}} I_{\text{rms}} \cos\phi$$

$$= \frac{V_{\text{rms}}^2}{Z}\cos\phi \qquad \left(\because\ I_{\text{rms}} = \frac{V_{\text{rms}}}{Z}\right)$$

At resonance power factor $\cos\phi = 1$

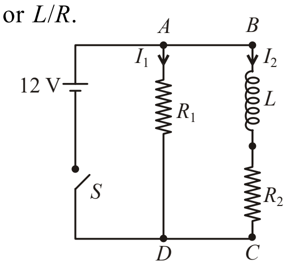
$$\therefore\ P = \frac{V_{\text{rms}}^2}{Z} = \frac{(220\text{ V})^2}{(200\ \Omega)} = 242\text{ W}$$

31. (d) : For the given R, L circuit the potential difference across $AD = V_{BC}$ as they are parallel.

$I_1 = E/R_1$

$I_2 = I_0(1 - e^{-t/\tau})$ where τ = mean life or L/R.

$\tau = t_0$ (given)



$$E\ (\text{across } BC) = L\frac{dI_2}{dt} + R_2 I_2$$

$I_2 = I_0(1 - e^{-t/t})$

$$\text{But } I_0 = \frac{E}{R_2} = \frac{12}{2} = 6\text{ A}$$

$$\tau = t_0 = \frac{L}{R} = \frac{400 \times 10^{-3}\text{ H}}{2\ \Omega} = 0.2\text{ s}$$

$\therefore\ I_2 = 6(1 - e^{-t/0.2})$

Potential drop across $L = E - R_2 I_2$

$= 12 - 2 \times 6(1 - e^{-t/0.2}) = 12e^{-t/0.2} = 12e^{-5t}$ V.

32. (a) : $M = \mu_0 n_1 n_2 \pi r_1^2 l$

From $\phi_2 = \pi r_1^2 (\mu_0 n i) n_2 l$

$A = \pi r_1^2 = 10\text{ cm}^2$, $l = 20$ cm, $N_1 = 300$, $N_2 = 400$

$$M = \frac{\mu_0 N_1 N_2 A}{l} = \frac{4\pi \times 10^{-7} \times 300 \times 400 \times 10 \times 10^{-4}}{0.20} = 2.4\pi \times 10^{-4}\text{ H}$$

33. (a) : During the growth of current in LR circuit current is given by $I = I_0\left(1 - e^{-\frac{R}{L}t}\right)$ or $I = \frac{E}{R}\left(1 - e^{-\frac{R}{L}t}\right) = \frac{5}{5}\left(1 - e^{-\frac{5}{10}\times 2}\right)$

$I = (1 - e^{-1})$

34. (c) : Given : $E = E_0 \sin\omega t$

$$I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$$

Since the phase difference (ϕ) between voltage and current is $\frac{\pi}{2}$.

$\therefore$ Power factor $\cos\phi = \cos\frac{\pi}{2} = 0$

Power consumption $= E_{\text{rms}} I_{\text{rms}} \cos\phi = 0$

35. (b) : Maximum current $I_0 = \frac{E}{R} = \frac{100}{100} = 1$ A

The current decays for 1 millisecond $= 1 \times 10^{-3}$ sec

During decay, $I = I_0\, e^{-tR/L}$

$$I = (1)e^{\frac{(-1\times10^{-3})\times 100}{100\times 10^{-3}}} \quad \text{or} \quad I = e^{-1} = \frac{1}{e}\text{ A}$$

36. (c) : $\phi = 10t^2 - 50t + 250 \quad \therefore \quad \frac{d\phi}{dt} = 20t - 50$

Induced emf, $e = \frac{-d\phi}{dt}$

or $e = -(20t - 50) = -[(20 \times 3) - 50] = -10$ volt

or $e = -10$ volt

37. (a) : In an a.c. generator, maximum emf = $NAB\omega$.

38. (d) : Current $I = \frac{E}{Z}$ where $E = \sqrt{V_R^2 + (V_L - V_C)^2}$

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

At resonance, $X_L = X_C \therefore Z = R$

Again at resonance, $V_L = V_C \therefore E = V_R$

$\therefore \quad I = \frac{V_R}{R} = \frac{100}{1 \times 10^3} = 0.1$ A

$\therefore \quad V_L = I L\omega = \frac{I}{C\omega} = \frac{0.1}{(2 \times 10^{-6}) \times (200)}$

$\therefore \quad V_L = 250$ volt

39. (d) : R and L cause phase difference to lie between 0 and $\pi/2$ but never 0 and $\pi/2$ at extremities.

40. (c) : Power factor $\cos\phi = \frac{R}{Z} = \frac{12}{15} = 0.8$

41. (a) : For maximum power, $L\omega = \frac{1}{C\omega}$

$\therefore \quad C = \frac{1}{L\omega^2} = \frac{1}{10 \times (2\pi \times 50)^2} = \frac{1}{10 \times 10^4 \times (\pi)^2} = 10^{-6}$ F

or $\quad C = 1\ \mu$F

42. (d) : During growth of charge in an inductance, $I = I_0\,(1 - e^{-Rt/L})$

or $\quad \frac{I_0}{2} = I_0(1 - e^{-Rt/L})$

or $\quad e^{-Rt/L} = \frac{1}{2} = 2^{-1}$ or $\frac{Rt}{L} = \ln 2 \Rightarrow t = \frac{L}{R}\ln 2$

$t = \frac{300 \times 10^{-3}}{2} \times (0.693)$ or $t = 0.1$ sec

43. (a) : The emf induced in the circuit is zero because the two emf induced are equal and opposite when one U tube slides inside another tube.

44. (b) : Induced e.m.f. $= \frac{1}{2}B\omega l^2 = \frac{1}{2} \times (0.2 \times 10^{-4})(5)(1)^2$

$\therefore \quad$ Induced e.m.f. $= \frac{10^{-4}}{2} = \frac{100 \times 10^{-6}}{2} = 50\ \mu$V

45. (c) : At resonance, $\omega = \frac{1}{\sqrt{LC}}$ when ω is constant,

$\therefore \quad \frac{1}{L_1C_1} = \frac{1}{L_2C_2} \Rightarrow \frac{1}{LC} = \frac{1}{L_2(2C)} = \frac{1}{2L_2C} \quad \therefore \quad L_2 = L/2$

46. (b) : Magnetic flux linked $= BA\cos\omega t = \frac{B\pi r^2 \cos\omega t}{2}$

$\therefore \quad$ Induced emf $e = \frac{-d\phi}{dt} = \frac{-1}{2}B\pi r^2\omega\sin\omega t$

$\therefore \quad$ Power $= \frac{e^2}{R} = \frac{B^2\pi^2r^4\omega^2\sin^2\omega t}{4R} = \frac{(B\pi r^2\omega)^2}{4R}\sin^2\omega t$

$\because \quad \langle\sin^2\omega t\rangle = 1/2$

$\therefore \quad$ Mean power generated $= \frac{(B\pi r^2\omega)^2}{4R} \times \frac{1}{2} = \frac{(B\pi r^2\omega)^2}{8R}$

47. (b) : Induced current $I = \frac{-n}{R'}\frac{d\phi}{dt} = \frac{-n}{R'}\frac{dW}{dt}$

where $\phi = W$ = flux × per unit turn of the coil

$\therefore \quad I = -\frac{1}{(R + 4R)}\frac{n(W_2 - W_1)}{t} = -\frac{n(W_2 - W_1)}{5Rt}$

48. (c) : Average value of A.C. for complete cycle is zero. Hence A.C. can not be measured by D.C. ammeter.

49. (d) : In an LCR series a.c. circuit, the voltages across components L and C are in opposite phase. The voltage across LC combination will be zero.

50. (a) : The energy loss due to eddy currents is reduced by using laminated core in a transformer.

51. (c) : Let Q denote maximum charge on capacitor. Let q denote charge when energy is equally shared

$\therefore \quad \frac{1}{2}\left(\frac{1}{2}\frac{Q^2}{C}\right) = \frac{1}{2}\frac{q^2}{C} \Rightarrow Q^2 = 2q^2 \quad \therefore \quad q = Q/\sqrt{2}$

52. (d) : $L = \frac{-e}{di/dt} = \frac{-8 \times 0.05}{-4} = 0.1$ H

53. (c) : Mutual inductance between two coils depends on the materials of the wires of the coils.

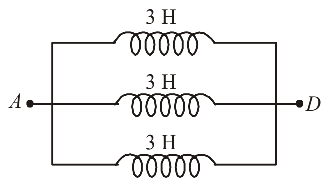
54. (d) : Induced emf = vBL

55. (b) : $I_2N_2 = I_1N_1$ for a transformer

$\therefore \quad I_2 = \frac{I_1N_1}{N_2} = \frac{4 \times 140}{280} = 2$ A

56. (b) : Power factor $= \frac{R}{\sqrt{R^2 + L^2\omega^2}}$

57. (d) : Three inductors are in parallel



$\therefore \quad \frac{1}{L_{(eq)}} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3} = \frac{3}{3} = \frac{1}{1}$

$\therefore \quad L_{(eq)} = 1$ H