Unit-14

Electromagnetic Induction and Alternating Current

SUMMERY

1. Net flux through the surface $\phi = \oint \vec{B} \cdot d\vec{A} = BA\cos\theta$

   θ = angle between area vector $\vec{A}$ & magnetic field $\vec{B}$

   • if $\theta = 0$ then $\phi_{max} = BA$

   • if $\theta = 90$ then $\phi = 0$

2. Unit of magnatic flux is weber (wb) in SI unit and maxwell or Gauss x cm^2 in CGS unit where 1wb = 10^8 maxwell

   • other units = $\text{tesla} \times m^2 = \frac{Nm}{A} = \frac{Joule}{A} =$

   $$\frac{Volt \times Coulomb}{A} = \text{Volt x sec} = \text{ohm x coulomb} = \text{henery x A}$$

   • Its dimensional formula = $M^1L^2T^{-2}A^{-1}$

3. **Faraday's Law**

   • The induced emf $\varepsilon = -N\frac{d\phi}{dt} = -N\frac{d}{dt}(AB\cos\omega t)$

   • If A alone is changing $\varepsilon = -NB\cos\omega t \frac{dA}{dt}$

   • If B alone is changing $\varepsilon = -NA\cos\omega t \frac{dB}{dt}$

   • If θ alone is changing $\varepsilon = +NAB\omega \sin\omega t$

4. Motional emf $\varepsilon = -Bvl\sin\theta$ where, θ = angle between $\vec{v}$ & $\vec{B}$

5. If conducting rod moves on two parallel conducting rails placed in magnetic field perpendicular to plane of close loop.

   • induced emf $\varepsilon = -Bvl$

   • induced current $I = \varepsilon = -\frac{Bvl}{R}$

   • magnetic force $F = IlB = -\frac{B^2vl^2}{R}$

   • power dessipated $P = \frac{B^2v^2l^2}{R} = F_m \cdot v$

   where l = distance between two rails

   R = Resistance of the loop

6. **Self induction**

- self inductance $L = \frac{N\phi}{I}$

- induced emf $\varepsilon = -L \frac{dI}{dt}$

- unit of L is $\frac{wb}{A}$ = ohm x sec = Henery

- dimensional formula of L is $M^1L^2T^{-2}A^{-2}$

- magnetic potential energy of inductor $U = \frac{1}{2}LI^2$

- magnetic energy density $S_m = \frac{U}{Al} = \frac{B^2}{2\mu_0}$

7. **Mutual Induction**

- Mutual inductance $M = \frac{N_1\phi_1}{I_2} = \frac{N_2\phi_2}{I_1}$

- induced emf = $\varepsilon_2 = -M \frac{dI_1}{dt}$ OR $\varepsilon 1 = -M \frac{dI_2}{dt}$

8. **Relation between M, L_1 & L_2**

For two magnetically coupled coils $M = k\sqrt{L_1L_2}$ where k = coefficient of coupling or coupling factor $(0 \le k \le 1)$

$$k = \frac{\text{magnetic flux linked in secondary}}{\text{magnetic flux linked in primary}}$$

9. **Combination of inductances**

- series $L_s = L_1 + L_2$ if they are situated close to each other then $L_s = L_1 + L_2 \pm 2M$

- Parellel $L_p = \frac{L_1L_2}{L_1+L_2}$ OR $\frac{1}{L_p} = \frac{1}{L_1} + \frac{1}{L_2}$ if they are situated close to each other then

$$L_p = \frac{L_1L_2 - M^2}{L_1 + L_2 \pm 2M}$$

10. **Growth & decay of current in LR circuit**

- The value of current at time t after closing the circuit $I = I_0[1 - e^{\frac{-Rt}{L}}]$

where $I_0 = I_{max} = \frac{\varepsilon}{R}$

• The value of current at time t after opening from the steady state condition $I = I_0\ e^{\frac{-Rt}{L}}$

• Time constant $\tau = \frac{L}{R}$

11. **A.C. generator**

• emf $V = NAB\omega \sin \omega t = V_m \sin \omega t$

• current $I = \frac{V_m}{R} \sin \omega t = I_m \sin \omega t$

• A.C. current & voltage are positive for half the cycle & negative for the rest half. So aweerage value of ac quantity is zero over a complete cycle.

• at $t = \frac{T}{4}$ from the begining I or V reach their maximum value.

12. **Series LCR circuit**

• current $I = I_m \cos(\omega t - \delta)$

where $I_m = \frac{V_m}{|z|}$

δ = phase difference between V & I

• Voltage $V = \sqrt{V_R^{\ 2} + (V_L - V_C)^2}$

• Impedence $|z| = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + (\omega L - \frac{1}{\omega c})^2}$

• Phase difference $\tan\delta = \frac{X_L - X_C}{R} = \frac{V_L - V_C}{V_R}$

13. **At resonance**

• $X_L = X_C$ then $|z| = R$ then $\omega_0 = \frac{1}{\sqrt{LC}}$ then $f_0 = \frac{1}{2\pi\sqrt{LC}}$

• Half power band width $\Delta\omega = \frac{R}{L}$

• Q-factor $Q = \frac{\omega_0}{\Delta\omega} = \frac{1}{R}\sqrt{\frac{L}{C}}$

14. **Power**

- $P = V_{rms} I_{rms} \cos \delta$

  where $\cos \delta$ = power factor

15. **Parellel LC circuit in series with R**

- $|z| = \sqrt{R^2 + \dfrac{1}{(\omega c - \frac{1}{\omega L})^2}}$

- $\tan \delta = \dfrac{1}{R(\omega c - \frac{1}{\omega L})}$

16. **Transformer**

- $\dfrac{\varepsilon_s}{\varepsilon_p} = \dfrac{I_p}{I_s} = \dfrac{N_s}{N_p} = r$ = transformation ratio

MCQ

For the answer of the following questions choose the correct alternative from among the given ones.

1. A coil having area $2m^2$ is placed in a magnetic field which changes from 1 wb /m^2 to 4 wb/m^2 in an interval of 2 second. The emf induced in the coil of single turn is....

   (a) 4 v (b) 3 v (c) 1.5 v (d) 2 v

2. Two different loops are concentric & lie in the same plane. The current in outer loop is clockwise & increasing with time. The induced current in the inner loop then, is.........

   (a) clockwise (b) zero

   (c) counter clockwise (d) direction depends on the ratio of loop radii

3. A ring of radius r is rotating about its diameter with angular velocity ω in a perpendicular magnetic field $\vec{B}$ It has 20turns.The emf induced is

   (a) $20B\pi r^2 \text{Sin } wt$ (b) $20B\pi r^2 \cos wt$

   (c) $10\sqrt{2}B\pi r^2$ (d) $20B\pi r^2 w \sin wt$

4. A magnetic field 2×10^{-2} T acts at right angles to a coil of area 200 cm^2 with 25 turns. The average emf induced in the coil is 0.1 v when it removes from the field in time t. The value of t is

   (a) 0.1 sec (b) 1 sec (c) 0.01 sec (d) 20 sec

5. The magnetic flux linked with a coil, in webers, is given by the equation $\phi = 4t^2 - 3t + 7$. Then the magnitude of induced emf at 2 sec will be ...

   (a) 15 v (b) 19 v (c) 17 v (d) 21 v

6. A solenoid of 1.5 m long with inner diamter of 4 cm has three layers of windings of 1000 turns each & carries a current of 2 A. The magnetic flux through a cross section of the solenoid is nearly.....

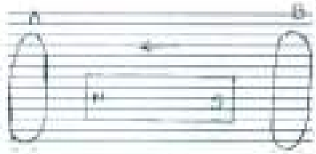
   (a) 2.5×10^{-7} wb (b) 6.31×10^{-6} wb

   (c) 2.1×10^{-6} wb (d) 4.1×10^{-7} wb

7. A coil has an area of 0.05 m^2 & it has 800 turns. It is placed perpendicularly in a magnetic field of strength , 4×10^{-5} Wb/m^2. It is rotated through 90° in 0.1 sec. The average emf induced in the coil is...

   (a) 0.056 v (b) 0.046 v (c) 0.026 v (d) 0.016 v

8. A bar magnet is moving along the common axis of two coils A & B towards A. current is induced in



(a) Only A (b) Only B

(c) both A & B in same direction (d) both A & B in opposite direction

9. A coil having n turns & resistance $R\Omega$ is connected with a galvanometer of resistance $4R\Omega$. This combination is moved from a magnetic field W_1 Wb to W_2 Wb in t second. The induced current in the circut is....

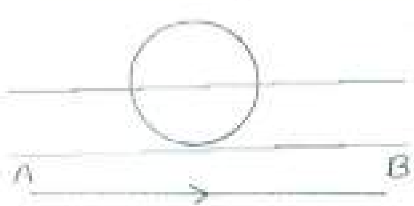
(a) $-\frac{(W_2 - W_1)}{5Rnt}$ (b) $-n\frac{(W_2 - W_1)}{5Rt}$

(c) $-\frac{(W_2 - W_1)}{Rnt}$ (d) $-n\frac{(W_2 - W_1)}{Rt}$

10. When a train travels with a speed 360 km h^{-1} along the track separated by 1 meter. The vertical component of earth's magnetic field is 0.1×10^{-4} T. What is the value of induced emf between the rails ?

(a) 10^{-2} V (b) 10^{-4} V (c) 10^{-3} V (d) 1V

11. An electron moves along the line AB, which lies in the same plane as a circular loop of conducting wires as shown in figure. What will be the direction of current induced if any, in the loop ?



(a) No current will be induced

(b) The current will be clockwise

(c) The current will be anticlockwise

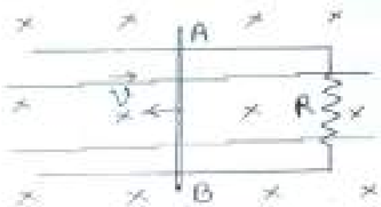
(d) The current will change direction as the electron passes by

12. A circular loop of radius R carrying current I lies in X-Y plane with its centre at origin. The total magnetic flux through x-y plane is.....

(a) Directly proportional to I (b) Directly proportional to R

(c) Directly proportional to R^2 (d) zero

13. Consider the situation shown in the figure. The wire AB is sliding on the fixed rails with a constant velocity $\vec{v}$. If the wire AB replaced by semi circular wire the magnitude of the induced current will.



(a) Increases
(b) decreased
(c) Remain same
(d) depending on whether the semicircle bulge is towards the resistance or away from it.

14. Two similar circular loops carry equal currents in the same direction. On moving the coils further apart, the electric current will

(a) Remain unchanged
(b) Increasing in both
(c) Increasing in one decreasing in other
(d) Decreasing in both

15. When the number of turns in a coil is make four time without any change in length of the coil, its self inductance becomes......

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

16. A metal road moves at a constant velocity in a direction perpendicular to its length & a constant uniform magnetic field too. Select the correct statement (s) from the following.

(a) The entire rod is at the same electrical potential
(b) There is an electric field in the rod
(c) The electric polential is highest at the centre of the rod.
(d) The electric polential is lowest at the centre of the rod.

17. Two co-axial solenoids are made by a pipe of cross sectional area 10 cm^2 and length 20 cm If one of the solenoid has 300 turns and the other 400 turns, their mutual inductance is........

(a) $4.8\pi\times10^{-4}$ H
(b) $4.8\pi\times10^{-5}$ H
(c) $2.4\pi\times10^{-4}$ H
(d) $4.8\pi\times10^{4}$ H

18. The self inductance of a straight conductor is...

(a) zero
(b) very large
(c) very small
(d) ∞

19. Two coils of self inductances 2 mH & 8 mH are placed so close togather that the effective flux in one coil is completely half with the other. The mutual inductance between these coils is.......

(a) 4 mH
(b) 6 mH
(c) 2 mH
(d) 16 mH

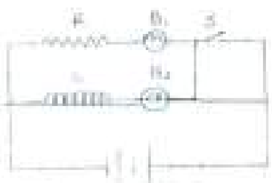
20. In circular coil, when no. of turns is doubled & resistance becomes half of the initial then inductance becomes....

(a) 4 times
(b) 2 times
(c) 8 times
(d) No change

21. In the figure the magnetic energy stored in the coil is

(a) zero (b) infinite (c) 25 J (d) 16 J

22. When the switch S turned off.



(a) Both B_1 and B_2 die out promptly
(b) Both B_1 and B_2 die out with some delay
(c) B_1 dies out promptly but B_2 with some delay
(d) B_2 dies out promptly but B_1 with some delay

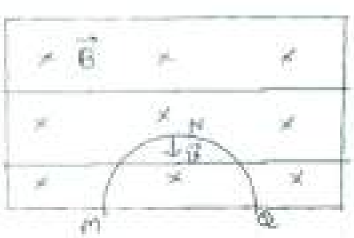
23. A transformer of efficiency 90% draws an input power of 4 kW. An electrical applience connected across the secondary draws a current of 6 A. The impedence of device is.........

(a) 60 Ω (b) 50 Ω (c) 80 Ω (d) 100 Ω

24. The armature of dc motor has 20 Ω resistance. It draws current of 1.5 A when run by 220 V dc suppy. The value of back induced in it will be

(a) 150 V (b) 190 V (c) 170 V (d) 180 V

25. A thin semicircular conducting ring of radius R is falling in a magnetic field B. Which is in limited area as shown in figure. At the position MNQ, the speed of ring is v and the potential difference developed across the ring is



(a) zero
(b) $Bv\pi \frac{R^2}{2}$ and M is at higher potential
(c) πRBv and Q is at higher potential
(d) $2RBv$ and Q is at higher potential

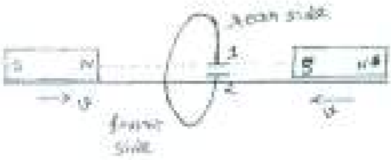
26. Two identical circular loops of metal wire are lying on a table near to each other without touching. Loop A carries a current which increasing with time. In response the loop B.......

(a) Is repelled by loop A
(b) Is attracted by loop A
(c) rotates about its centre of mass
(d) remains stationary

27. A wire of length 2m is moving at a speed $2ms^{-1}$ keep its length perpendicular to uniform magnetic field of 0.5 T. The resistance of circuit joined with this wire is 6Ω. The rate at which wolrk is being done to keep the wire moving at constant speed is ....

(a) $\frac{1}{3}\omega$ (b) $\frac{2}{3}\omega$ (c) $\frac{1}{6}\omega$ (d) 2ω

28. Two identical magnets moving towards a coil, connecting a condenser at rear side shown in fig., with equal speed from opposite sides Then



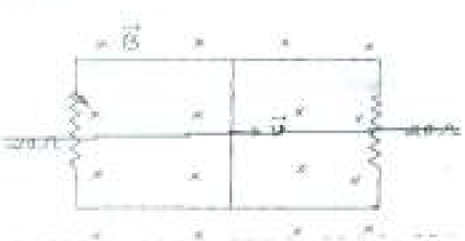
(a) Both plate will be positive

(b) There is no charging of condenser

(c) Plate 1 will be positive and 2 negative

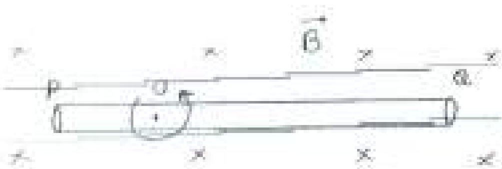
(d) Plate 2 will be positive and 1 negative

29. A rectangular loop with a sliding rod of length 2m & resistance 2Ω. It moves in a uniform magnetic field of 3T perpendicular to plane of loop. The external force required to keep the rod moving with constant velocity of $2ms^{-1}$ is



(a) 2N (b) 4N (c) 6N (d) 8N

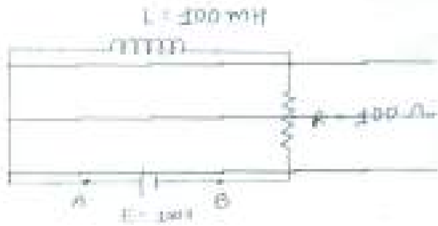
30. A conducting rod PQ of length $4l$ is rotated about a point O in a uniform magnetic field $\overrightarrow{B}$. $PO = \ell$ Then



(a) $V_O - V_P = -\frac{B\omega\ell^2}{2}$ (b) $V_Q - V_O = \frac{5}{2}B\omega\ell^2$

(c) $V_Q - V_O = \frac{9}{2}B\omega\ell^2$ (d) $V_A - V_Q = 4\ B\omega\ell^2$

31. As shown in figure after a long time the battery is disconnected and short circuiting the points A & B. The current in circuit after 2ms after the short circuit is.

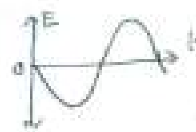


(a) $\frac{1}{e^2}$ A (b) $\frac{1}{e}$ A (c) 0.2A (d) e^2 A

32. The variation of induced emf with time in a coil if a short bar magnet is moved along its axis with constant velocity is.

(a)

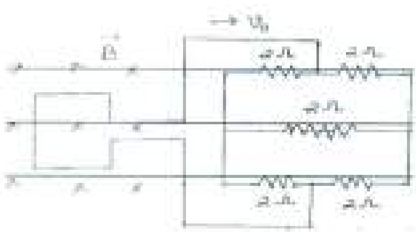
(b)



(c)

(d)

33. A square loop of side 10 cm and resistance 2Ω is moved with velocity v_0 as shown in fig. The uniform magnetic field is 3T with what speed should the loop be moved so that a steady current of 1.5 mA flows in the loop.



(a) 1 cms^{-1} (b) 2 cms^{-1} (c) 3 cms^{-1} (d) 4 cms^{-1}

34. An inductor-resistor-battery circuit is switched on at t = 0. If the emf of battry is ε find the charge passes through the battery in one time constant τ.

(a) $\frac{i_{max}\tau}{e}$ (b) $(\tau-1)e\ i_{max}$ (c) $\frac{i_{max}}{e}$ (d) $\tau\ i_{max}$

35. A square loop of side 5 cm being moved right at a constant speed $2\,cms^{-1}$. The front edge of it enters in magnetic field at t = 0. Fined the induced emf in the loop at t = 1s, 5s, 11s.

(a) 0.3 mv, 0.3 mv, 0.3mv (b) 0, 0.3mv, 0

(c) 0.3 mv, 0,0.3 mv (d) 0, 0, 0

36. The time constant of a LR circuit is 20 ms The circuit is connected at t = 0 and the steady state current is found to be 4A. Find the current at 80 ms.

(a) 0.98 A (b) 1 A (c) 0.44 A (d) 0.88 A

37. A metal rod of length 2 m rotates vertically about one of its end with frequency 2 Hz. The horizontal component of earth's magnetic field is 3.14×10^{-5} T then emf developed between two ends of road is.....

(a) 78.87×10^{-4} V (b) 7.887×10^{-4} V (c) 78.87×10^{-5} V (d) 0V

38. In the following circuit the bulb will become suddenly bright if

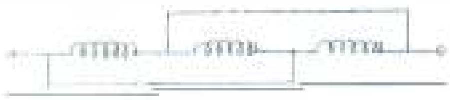
(a) contact is made (b) contanct is broken

(c) contact is made or broken (d) Won't become bright at all

39. The self inductance of a coil is 5H, a current of 1A changes to 2A within 5 sec. through the coil. The value of induced emf will be.......

(a) 10 V (b) 0.1 V (c) 1 V (d) 100 V

40. Pure inductance of 3H each are connected as shown below. The equivalent inductance of the circuit is



(a) 1 H (b) 2 H (c) 3 H (d) 9 H

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

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

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

What is increased in step down transformer ?

(a) Half (b) Two times (c) Four times (d) unchanged

43. The core of a transformer is laminated so that.......

(a) Ratio of I/p & O/p voltage increases

(b) Rusting of core may be stopped

(c) Energy loss due to eddy current may be reduced

(d) Change in flux is increased

44. In transformer, core is made of soft iron to reduce.....

(a) Hysterlsis losses (b) Eddy current losses

(c) Force opposing current (d) the weight

45. An ideal transformer has 1:25 turn ratio. The peak value of the ac is 28 V. The rms ms secondary voltage is nearest to......

(a) 50 V (b) 70 V (c) 100 V (d) 40 V

46. A primary winding of transformer has 500 turns whereas its secondary has 5000 turns. Primary is connected to ac supply of 20V, 50Hz The secondary output of....

(a) 200V, 25 Hz (b) 200 V, 50Hz (c) 2 V, 100 Hz (d) 2V, 50 Hz

47. A step down transformer is connected to main supply 200 V to operate a 6V, 30 w bulb. The current in primary is.....

(a) 3A (b) 1.5 A (c) 0.3 A (d) 0.15 A

48. An emf of 15 V is applied in a circuit containing 5H inductance & 10 Ω resistance. The ratio of the currents at time $t = \infty$ and at t = 1sec.

(a) $\frac{e^{\frac{1}{2}}}{e^{\frac{1}{2}}-1}$ (b) $1-e^{-1}$ (c) $\frac{e^2}{e^2-1}$ (d) e^{-1}

49. Two coils have a mutual inductance 0.005H The current changes in a coil according to equation $I = I_0 \sin \omega t$ Where $I_0 = 10$ A & $\omega = 100\ \pi$ rad s^{-1} The maximum value of emf in second coil is.....

(a) 2π (b) 5π (c) π (d) 4π

50. A coil of inductance 8.4 mH and resistance 6Ω is connected to a 12 V battery. The current in the coil is 1 A in the time..........

(a) 500 sec (b) 20 sec (c) 35 ms (d) 1 ms

51. Alternating current can not be measured by dc ammeter because,

(a) ac can not pass through dc ammeter

(b) Average value of complete cycle is zero

(c) ac is virtual

(d) ac changes its direction

52. The resistance of a coil for dc is in ohms. In ac, the resistance

(a) will remain same (b) will increase

(c) will decrease (d) will be zero

53. An alternating current of rms valuve 10 A is passed through a 12 Ω resistance. The maximum potential difference across the resistor is,

(a) 20 V (b) 90 V (c) 169. 68 V (d) None of these

54. 220 V,50 Hz, ac is applied to a resistor. The instantaneous value of voltage is

(a) $220\sqrt{2}\sin 100\pi t$ (b) $220\sin 100\pi t$

(c) $220\sqrt{2}\sin 50\pi t$ (d) $220\sin 50\pi t$

55. The rms value of an ac of 50 Hz is 10 amp. The time taken by the alternating current in reaching from zero to maximum value and the peak value of current will be,

(a) 2×10^{-2} sec and 14.14 amp (b) 1×10^{-2} sec and 7.07 amp

(c) 5×10^{-3} sec and 7.07 amp (d) 5×10^{-3} sec and 14.14 amp

56. If a current I given by $I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$ flows in an ac circuit across which an ac potential of $E = E_0 \sin \omega t$ has been applied, then the power consumption p in the circuit will be,

(a) $P = \frac{E_0 I_0}{\sqrt{2}}$ (b) $P = \sqrt{2} E_0 I_0$

(c) $P = \frac{E_0 I_0}{2}$ (d) $P = 0$

57. In general in an alternating current circuit.

(a) The average value of current is 20w.

(b) The average value of square of current is zero.

(c) Average power dissipation is zero.

(d) The phase difference between voltage and current is zero.

58. An alternating current is given by the eqn $I = I_1 \cos wt + I_2 \sin wt$. The rms current is given by,

(a) $\frac{1}{\sqrt{2}}(I_1 + I_2)$ (b) $\frac{1}{\sqrt{2}}(I_1 + I_2)^2$

(c) $\frac{1}{\sqrt{2}}(I_1^2 + I_2^2)^{\frac{1}{2}}$ (d) $\frac{1}{2}(I_1^2 + I_2^2)^{\frac{1}{2}}$

59. In an ac circuit, the current is given by $I = 5\sin\left[100\ t - \frac{\pi}{2}\right]$ and the ac potential is $V = 200 \sin 100t$. Then the power consumption is,

(a) 20 watts (b) 40 watts

(c) 1000 watts (d) 0 watts

60. In ac circuit with voltage V and current I, the power dissipaled is.

(a) VI (b) $\frac{1}{2}$VI

(c) $\frac{1}{\sqrt{2}}$VI (d) Depends on the phase between V and I

61. In the transmission of a.c. power through transmission lines, when the voltage is shapped up n times, the power loss in transmission,

(a) increase n times (b) Decrease n times

(c) Increase n^2 times (d) Decrease n^2 times

62. An alternating voltage is represented as $E = 20 \sin 300t$. The average value of voltage over one cycle will be.

(a) zero (b) 10 volt

(c) $20\sqrt{2}$ volt (d) $\frac{20}{\sqrt{2}}$ volt

63. An ac source is rated at 220V, 50 Hz. The time taken for voltage to change from its peak value to zero is,

(a) 50 sec (b) 0.02 sec

(c) 5 sec (d) 5×10^{-3} sec

64. A lamp consumes only 50% of peak power in an ac circuit. What is the phase difference between the applied voltage and the circuit current.

(a) $\frac{\pi}{6}$ (b) $\frac{\pi}{3}$

(c) $\frac{\pi}{4}$ (d) $\frac{\pi}{2}$

65. The instantaneous voltage through a device of impedance 20Ω is $\varepsilon = 80 \sin 100\pi t$. The effective value of the current is,

(a) 3A (b) 2.828 A

(c) 1.732 A (d) 4A

66. A choke coil has.

(a) High inductance and low resistance (b) Low inductance and high resistance

(c) High inductance and high resistance (d) Low inductance and low resistance

67. A resistor and a capicitor are connected in series with an ac source. If the potential drop across the capacitor is 5 V and that across resistor is 12 V, the applied voltage is,

(a) 13 V (b) 17 V

(c) 5 V (d) 12 V

68. In an ac circuit the emf (e) and the current (i) at any instant core given respectively by $e = E_0 \sin \omega t$, $i = I_0 \sin(\omega t - \phi)$ The average power in the circuit over one cycle of ac is.

(a) $\frac{E_0 I_0}{2} \cos\phi$ (b) $E_0 I_0$

(c) $\frac{E_0 I_0}{2}$ (d) $\frac{E_0 I_0}{2} \sin\phi$

69. The instanteneous value of current in an A.C. circuit is $I = 2\sin\left(100\pi t + \frac{\pi}{3}\right)A$. The current will be maximum for the first time at,

(a) $t = \frac{1}{100}S$ (b) $t = \frac{1}{200}S$

(c) $t = \frac{1}{400}S$ (d) $t = \frac{1}{600}S$

70. An alternating current of frequency 'f' is flowing in a circuit containing a resistance R and a choke L in series. The impedance of this circuit is,

(a) $R + 2\pi fL$ (b) $\sqrt{R^2 + 4\pi^2 f^2 L^2}$

(c) $\sqrt{R^2 + L^2}$ (d) $\sqrt{R^2 + 2\pi fL}$

71. The resistance of an R-L circuit is 10Ω. An emf E_0 applied across the circuit at $\omega = 20$ rad/s. If the current in the ckt is $\frac{I_0}{\sqrt{2}}$ what is the value of L.

(a) 1 H (b) 2 H (c) 3 H (d) 0.5 H

72. A resistor 30Ω, inductor of reactance $10\ \Omega$ and the capacitor of reactance $10\ \Omega$ are connected in series to an ac voltage source $e = 300\sqrt{2}\ \sin(\omega t)$ The current in the circuit is

(a) $10\sqrt{2}A$ (b) 10 A (c) $30\sqrt{11}A$ (d) $\frac{30}{\sqrt{11}}A$

73. Same current is flowing in two alternating circuits. The first circuits 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) Increase in the first circuit and dicrease in other
(b) Increase in both the circuit
(c) Decrease in both the circuit
(d) Decrease in the first and increase in other

74. The value of alternating emf E in the given ckt will be.

(a) 100 V (b) 20 V (c) 220 V (d) 140 V

75. A 20 volts ac is applied to a circuit consisting of a resistance and a coil with negligible resistance. If the voltage across the resistance is 12 V, the voltage across the coil is,

(a) 16 volts (b) 10 volts (c) 8 volts (d) 6 volts

76. An alternating voltage $E = 200\sqrt{2}\ \sin\ (100t)$ is connected to 1 microfarad capacitor through an ac ammeter. The reading of the ammeter shall be.

(a) 10 m A (b) 20 m A (c) 40 m A (d) 80 m A

77. In a region of uniform magnetic induction $B = 10^{2}$ tesla, a circular coil of radius 30 cm and resistance π^2 ohm is rotated about an axis which is perpendicular to the direction of B and which forms a diameter of the coil. If the coil rotates at 200 rpm the amplitude of the alternating current induced in the coil is,

(a) $4\pi^2$ mA (b) 30 mA (c) 6 mA (d) 200 mA

78. An LCR series circuit with $R = 100\Omega$ is connected to a 200 V, 50 Hz a.c source when only the capacitance is removed the current lies the voltage by 60^0 when only the inductance is removed, the current leads the voltage by 60^0. The current in the circuit is,

(a) 2A (b) 1A (c) $\frac{\sqrt{3}}{2}$ A (d) $\frac{2}{\sqrt{3}}$ A

79. The impedance of a circuit consists of $3\ \Omega$ resistance and $4\ \Omega$ reactance. The power factor of the circuit is.

(a) 0.4 (b) 0.6 (c) 0.8 (d) 1.0

80. The power factor of a good choke coil is

(a) Nearly zero (b) Exactly zero (c) Nearly one (d) Exactly one

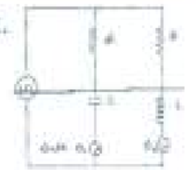
81. A coil of inductance L has an inductive reactance of X_L in an AC circuit in which the effective current is I. The coil is made from a super-conducting material and has no resistance. The rate at which power is dissipated in the coil is.

(a) 0 (b) IX_L (c) I^2X_L (d) Ix^2_L

82. When 100 volt dc is applied across a coil, a current of 1A flows through it. When 100 volt ac at 50 cyle s^{-1} is applied to the same coil, only 0.5 A current flows. The impedance of the coil is,

(a) $100\ \Omega$ (b) 200Ω (c) 300Ω (d) 400Ω

83. Two identical incandesant light bulbs are connected as shown in figure. when the circuit is an AC voltage source of frequency f, which of the following observations will be correct.



(a) both bulbs will glow alternatively

(b) Both bulbs will glow with same brightness provided $f = \frac{1}{2\pi}\sqrt{1/LC}$

(c) Bulb b_1 will light up initially and goes off, bulb b2 will be ON constantly.

(d) Bulb b_1 will blink and bulb b_2 will be ON constantly.

84. An LC circuit contains a 20 mH inductor and a 50 μF capacitor with an initial charge of 10 mc. The resistance of the circuit is negligible. At the instant the circuit is closed be t = 0. At what time is the energy stored compeletly magnetic.

(a) t = 0 (b) t = 1.54 ms (c) t = 3.14 ms (d) t = 6.28 ms

85. In the circuit shown below, the ac source has voltage v = 20 cos ωt volts with ω = 2000 rad/sec. The amplitude of the current will be nearest to

(a) 2A (b) 3.3 A (c) $21\sqrt{5}$ A (d) $\sqrt{5}$ A

86. The quality factor of LCR circuit having resistance (R) and inductance (L) at resonance frequency (ω) is given by

(a) $\frac{\omega L}{R}$ (b) $\frac{R}{\omega L}$ (c) $\left(\frac{\omega L}{R}\right)^{\frac{1}{2}}$ (d) $\left(\frac{\omega}{L}\right)^{2}$

87. For high frequency, a capacitor offers

(a) More reactance (b) Less reactance (c) Zero reactance (d) Infinite reactance

88. The coil of a choke in a circuit

(a) increase the current (b) Decrease the current

(c) Does not change the current (d) Has high resistance to be circuit

89. The power factor of an ac circuit having resistance (R) and inductance (L) connected in series and an angular velocity w is,

(a) $R/\omega L$ (b) $R/\left(R^2 + \omega^2 L^2\right)^{\frac{1}{2}}$

(c) $\omega L/R$ (d) $R/\left(R^2 - \omega^2 L^2\right)^{\frac{1}{2}}$

90. An inductor of inductance L and resistor of resistance R are joined in series and connected by a source of frequency ω power dissipated in the circuit is,

(a) $\frac{(R^2+\omega^2 L^2)}{V}$ (b) $\frac{V^2 R}{(R^2+\omega^2 L^2)}$ (c) $\frac{V}{(R^2+\omega^2 L^2)}$ (d) $\frac{\sqrt{R^2+\omega^2 L^2}}{V^2}$

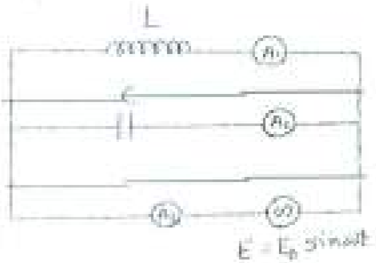
91. In a LCR circuit capacitance is changed from C to 2C. For the resonant fequency to remain unchanged, the inductance should be change from L to

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

92. In an LCR series ac 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)

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



(a) A_1 (b) A_2

(c) A_3 (d) None of these

94. In a circuit L, C and R are connected in series with an alternating voltage source of frequency f. The current leads the voltage by 45^0. The value of c is,

(a) $\frac{1}{2\pi f(2\pi f L+R)}$ (b) $\frac{1}{\pi f(2\pi f L+R)}$ (c) $\frac{1}{2\pi f(2\pi f L-R)}$ (d) $\frac{1}{\pi f(2\pi f L-R)}$

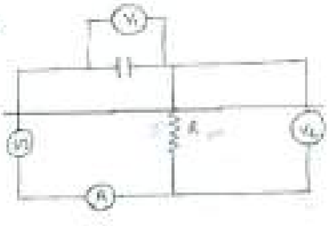
95. In a series resonant LCR circuit, the voltage across R is 100 V and R= 1kΩ with C =2 μF. The resonant frequency ω is 200 rad/s.At resonance the voltage across L is.

(a) 40V (b) 250 V (c) 4×10^{-3} V (d) 2.5×10^{-2} V

96. A coil of inductive reactance 31 Ω has a resistance of 8 Ω. It is placed in series with a condenser of copacitive reactance 25 Ω. The combination is connected to an a.c. source of 110 volt. The power factor of the circuit is.

(a) 0.80 (b) 0.33 (c) 0.56 (d) 0.64

97. The diagram shows a capacitor C and resistor R connected in series to an ac source. V_1 and V_2 are voltmeters and A is an ammeter, consider the following statements.



(1) Readings in A and V_2 are always in phase.

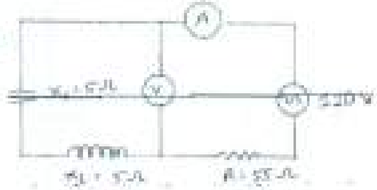
(2) Reading in V_1 is ahead in phase with reading in V_2.

(3) Reading in A and V_1 are always in phase.

Which of these statements are / is correct

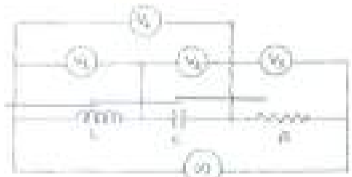
(a) 1) only (b) 2) only (c) 1) and 2) only (d) 2) and 3) only

98. The reading of ammeter in the circuit shown will be



(a) 24 A (b) 2.4 A (c) Zero (d) 1.7 A

99. In the adjoining circuit the voltmeter whose reading will be zero at resonance is



(a) V_1 (b) V_2 (c) V_3 (d) V_4

100. In the adjoining figure the impedance of the circuit will be

(a) 120Ω (b) 50Ω (c) 60Ω (d) 90Ω

101. Is it possible

(a) Yes (b) No

(c) can not be predicted (d) Insufficient data to reply

KEY NOTE

1	B	26	A	51	B	76	B
2	C	27	B	52	B	77	C
3	D	28	C	53	C	78	A
4	A	29	C	54	A	79	B
5	A	30	D	55	D	80	A
6	B	31	A	56	D	81	A
7	D	32	B	57	A	82	B
8	D	33	B	58	C	83	A
9	B	34	A	59	D	84	B
10	C	35	C	60	D	85	A
11	D	36	D	61	D	86	A
12	D	37	B	62	A	87	B
13	C	38	B	63	D	88	B
14	B	39	C	64	B	89	B
15	D	40	A	65	B	90	B
16	B	41	D	66	A	91	C
17	C	42	B	67	A	92	D
18	A	43	A	68	A	93	C
19	C	44	C	69	D	94	A
20	A	45	A	70	B	95	B
21	C	46	A	71	D	96	A
22	C	47	B	72	B	97	B
23	D	48	C	73	D	98	C
24	B	49	B	74	A	99	D
25	D	50	D	75	A	100	B
						101	A

Hints & Solution

13. $\varepsilon \propto l$, distance bet n rails.

14. Oppose any change

19. $L = k\sqrt{L_1 L_2}$, $k = \frac{1}{2}$

20. $L \propto N^2$

21. $\frac{1}{2} LI^2 \quad I = \frac{10}{2}\ 5A$

22. Current in B_1 promptly becomes zero while in B_2 becomes slowly zero.

25. Rate of decrease of area of semicircle ring $\frac{dA}{dt} = 2\,Rv$

$$\varepsilon = \frac{d\theta}{dt} = B\frac{dA}{dt} = 2\,RvB$$

to oppose the change, Q at higher potential

27. $\rho = F.v. = \frac{B^2 \ell^2 v^2}{R} = \frac{1}{6} w$

28. Current will flow anticlock wise as seen from left side of the figure.

29. Consider rod as a bettary $I = 1A$ $F = I\ell b$

30. $\varepsilon_O - \varepsilon_P = \frac{1}{2} BW\ell^2$, $\varepsilon_O - \varepsilon_Q = \frac{1}{2} BW(3\ell)^2$

$$\varepsilon_P - \varepsilon_Q = 4\,BW\ell^2$$

31. $I = I_O e^{\frac{-Rt}{L}}$ where $I_O = \frac{E}{R} \Rightarrow I = E^{-\alpha} = \frac{1}{e^2}$

33. $I = \frac{Bv\ell}{R}$, $R = 4\Omega$

34. $I = I_O(1 - e^{-t/T})(I_O = I_{max})$

$$Q = \int_0^T (I_O - I_O e^{-t/T})\,dt = I_O T/e$$

36. $I = I_O(1 - e^{-t/T}) \Rightarrow 4(1 - e^{-\frac{1}{4}}) = 4\,(1 - \frac{1}{(2.718)}\frac{1}{4}) = 0.88\text{ A}$

38. When the contact is broken current decrease in circuit, inductor release current to oppose it.

48. $I = I_O(1 - e^{-R/L \, t})$

$I_\alpha = I_O(1 - e^{-\infty}) = 1.5 \quad I_1 = 1.5\,(1 - e^{-2}) \Rightarrow \frac{I_\alpha}{I_1} = \frac{1}{1 - e^{-2}}$

49. $\varepsilon = M\frac{dI}{dt} \Rightarrow 0.005\,\frac{d}{dt}\,(10 \sin 100\,\pi t) = \varepsilon_{max} = 5\pi$

50. $I_O = \frac{12}{6} = 2A$. Current becomes half in time $t = 0.693\,\frac{L}{R} = 1$ ms

64. $p = p_m \cos\theta$

67. With help of phasor $v = \sqrt{v_R^2 + v_C^2}$

71. $I = \frac{\varepsilon_O}{\sqrt{R^2 + \omega^2 L^2}} = \frac{\varepsilon_O}{R\sqrt{1 + \left(\frac{\omega L}{R}\right)^2}} = \frac{I_O}{\sqrt{1 + \left(\frac{\omega L}{R}\right)^2}}$

72. $I_{rms} = \frac{v_{rms}}{|Z|} = \frac{300}{30} = 10A$

77. $I_O = \frac{NAB\omega}{R}$

78. for inductor $\tan\theta = \frac{\omega L}{R}$

for capacitor $\tan\theta = \frac{1}{\omega CR}$

$|\theta|$ is same 50, $\omega L = \frac{1}{\omega C}$ means resoance

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

83. L.C. oscillator

84. $t = \frac{T}{4} = \frac{2\pi\sqrt{LC}}{4}$

95. $v_L = v_C = I_{X_C} = \frac{v}{R\omega C}$

97. In RC series circuit v_C leads v_R by $\frac{\pi}{2}$

98. $X_L = X_C = 5\ \Omega \Rightarrow V = 0 \Rightarrow I = 0$

100. $I_L = \frac{90}{30} = 3A,\ I_C = \frac{90}{20} = 4.5\ A$

$I = I_C - I_L = 1.5\ A$

$Z = \frac{v}{I} = \frac{90}{1.5} = 60\ \Omega$

101. in AC circuit AB has R, BC has C & BD has pure L