18 - ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS

(Answers at the end of all questions)

1) 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) 8 μF (b) 4 μF (c) 2 μF (d) 1 μF [AIEEE 2005]

2) The phase difference between the alternating current and emf is $\pi / 2$. Which of the following cannot be the constituent of the circuit ?
(a) R, L (b) C alone (c) L alone (d) L, C [AIEEE 2005]

3) A circuit has a resistance of 12 ohm and an impedance of 15 ohm. The power factor of the circuit will be
(a) 0.4 (b) 0.8 (c) 0.125 (d) 1.25 [AIEEE 2005]

4) 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) 0.1 s (b) 0.05 s (c) 0.3 s (d) 0.15 s [AIEEE 2005]

5) 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) [AIEEE 2004]

6) A coil having n turns and resistance having 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 combined 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) $-\frac{n(W_2 - W_1)}{Rt}$ [AIEEE 2004]

7) In a uniform magnetic field of induction B, a wire in the form of 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) $\frac{(B\pi r\omega^2)^2}{8R}$ [AIEEE 2004]

8) In an 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) 4 L (b) 2 L (c) L / 2 (d) L / 4 [AIEEE 2004]

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

10) The magnetic flux linked with a coil is given by the equation $\phi = 3t^2 + 4t + 9$ Wb. The magnitude of induced emf at t = 2 sec. is
(a) 16 V (b) 9 V (c) 4 V (d) 1 V [AIEEE 2003]

11) 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 in the coil is
(a) 0.1 H (b) 0.2 H (c) 0.4 H (d) 0.8 H [AIEEE 2003]

12) Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon

(a) currents in the coils (b) materials of the wires of the coils
(c) relative position and orientation of the coils
(d) rates at which the currents are changing in the coils [AIEEE 2003]

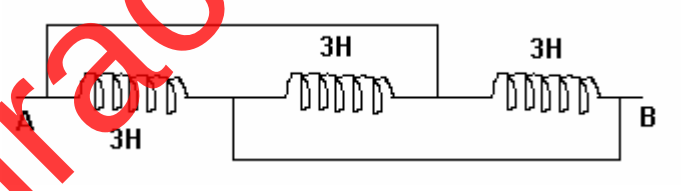
13) In an oscillating LC - circuit, maximum charge on the capacitor is Q. The charge on this capacitor, when the energy is stored equally between the electric and magnetic fields, is

(a) Q (b) Q / 2 (c) Q / $\sqrt{3}$ (d) Q / $\sqrt{2}$ [AIEEE 2003]

14) When number of turns in a coil is tripled, without any change in the length of the coil, its self-inductance becomes

(a) one-third (b) three times (c) six times (d) nine times [AIEEE 2002]

15) The equivalent inductance between A and B is



(a) 0 (b) 1 H (c) 3 H (d) 9 H

[AIEEE 2002]

16) The power-factor of an A.C. LR-circuit is

(a) zero (b) $\frac{R}{\sqrt{\omega L}}$ (c) $\sqrt{R^2 + \omega^2 L^2}$ (d) $\frac{R}{\sqrt{R^2 + \omega^2 L^2}}$ [AIEEE 2002]

17) The core of any transformer is laminated so as to

(a) make it light weight (b) make it robust and strong
(c) increase the secondary voltage (d) reduce the energy loss due to eddy current
[AIEEE 2002]

18) In a transformer, number of turns in a primary coil are 140 and that in a 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 [AIEEE 2002]

19) A capacitor of capacitance 4 μF and a resistor of 2.5 MΩ are connected in series to a battery of emf 12 volt having negligible internal resistance. Then time in which potential drop across the capacitor will be three times the potential drop across the resistor will is

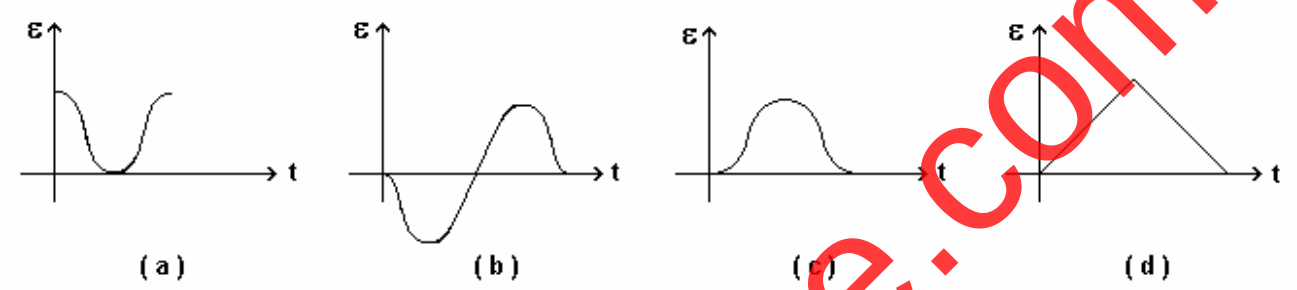
(a) 13.86 s (b) 6.93 s (c) 27.72 s (d) 3.46 s [IIT 2005]

20) A long hollow cylindrical wire is placed parallel to the direction of uniform magnetic field which is directed along + z-axis. Then induced current on the surface of cylinder is

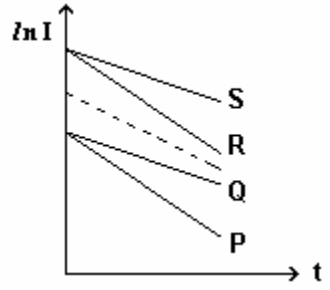
(a) in the direction of the magnetic field (b) zero
(c) clockwise as seen from + z-axis (d) anticlockwise as seen from + z-axis
[IIT 2005]

21) The variation of induced emf (ε) with time (t) in a coil if a short bar magnet is moved along its axis with a constant velocity is best represented as

[IIT 2004]



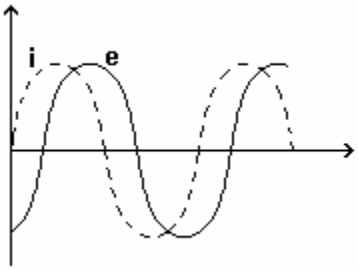
22) In an RC circuit while charging, the graph of $ln\ I$ versus time is as shown by the dotted line in the adjoining diagram where I is the current. When the value of the resistance is doubled, which of the solid curve best represents the variation of $ln\ I$ versus time ?



(a) P (b) Q (c) R (d) S

[IIT 2004]

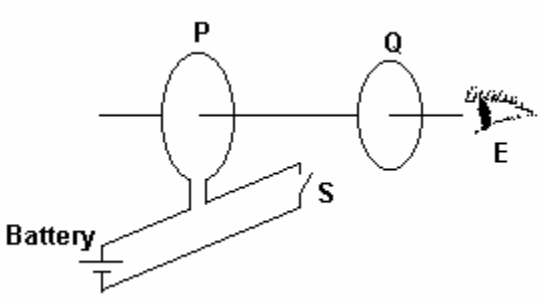
23) When an AC source of emf $e = E_0 \sin (100t)$ is connected across a circuit, the phase difference between the emf e and the current I in the circuit is observed to be $\pi / 4$, as shown in the diagram. If the circuit consists possibly only of R-C or R-L or L-C in series, find the relationship between the two elements:



(a) R = 1 kΩ, C = 10 μF (b) R = 1 kΩ, C = 1 μF
(b) R = 1 kΩ, L = 10 H (d) R = 1 kΩ, L = 1 H

[IIT 2003]

24) As shown in the figure, P and Q are two coaxial conducting loops separated by some distance. When the switch S is closed, a clockwise current I_p flows in P (as seen by E) and an induced current I_Q flows in Q. The switch remains closed for a long time. When S is opened, a current $I_{Q'}$ flows in Q. Then the direction of I_Q and $I_{Q'}$ (as seen by E) are



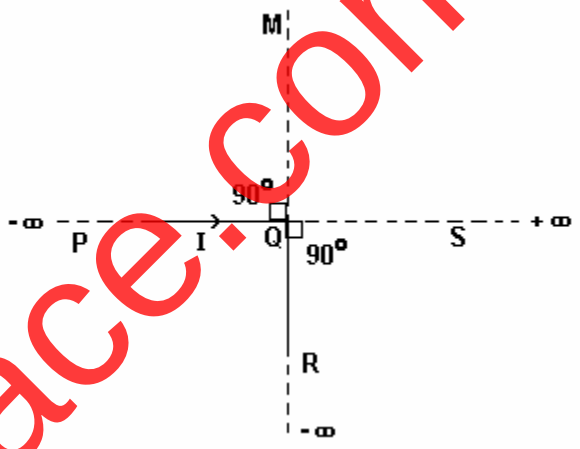
(a) respectively clockwise and anti-clockwise
(b) both clockwise (c) both anti-clockwise
(d) respectively anti-clockwise and clockwise

[IIT 2002]

25) A short-circuited coil is placed in a time-varying magnetic field. Electrical power is dissipated due to the current induced in the coil. If the number of turns were to be quadrupled and the coil radius halved, the electrical power dissipated would be

(a) halved (b) the same (c) doubled (d) quadrupled [IIT 2001]

26) An infinitely long conductor PQR is bent to form a right angle as shown. A current I flows through PQR. The magnetic field due to this current at the point M is H_1. Now another infinitely long straight conductor QS is connected to Q so that the current is $I/2$ in QR as well as in QS, the current in PQ remaining unchanged. The magnetic field at M is now H_2. The ratio H_1/H_2 is given by



(a) 1 / 2 (b) 1
(c) 2 / 3 (d) 2 [IIT 2000]

27) A coil of wire having finite inductance and resistance has a conducting ring placed coaxially within it. The coil is connected to a battery at time $t = 0$, so that the time dependent current $I_1(t)$ starts flowing through the coil. If $I_2(t)$ is the current induced in the ring, and $B(t)$ is the magnetic field at the axis of the coil due to $I_1(t)$, then as a function of time ($t > 0$), the product $I_2(t) \cdot B(t)$

(a) increases with time (b) decreases with time
(c) does not vary with time (d) passes though a maximum. [IIT 2000]

28) Two identical circular loops of metal wire are lying on a table without touching each other. Loop A carries a current which increases with time. In response, the loop B
(a) remains stationary
(b) is attracted by the loop A
(c) is repelled by the loop A
(d) rotates about its CM, with CM fixed [IIT 1999]

29) A coil of inductance 8.4 mH and resistance 6 Ω is connected to a 12 V battery. The current in the coil is 1.0 A at approximately the time
(a) 500 s (b) 20 s (c) 35 ms (d) 1 ms [IIT 1999]

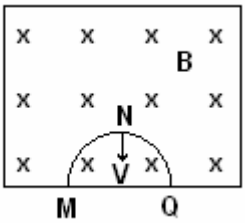
30) A small square loop of wire of side l is placed inside a large square loop of wire of side L ($L >> l$). The loops are coplanar and their centres coincide. The mutual inductance of the system is proportional to
(a) l/L (b) l^2/L (c) L/l (d) L^2/l [IIT 1998]

31) L, C and R represent the physical quantities inductance, capacitance and resistance respectively. The combinations which have the dimensions of frequency are
(a) $\frac{1}{RC}$ (b) $\frac{R}{L}$ (c) $\frac{1}{\sqrt{LC}}$ (d) $\frac{C}{L}$ [BIT 1992, IIT 1984]

32) A metal rod moves at a constant velocity in a direction perpendicular to its length. A constant uniform magnetic field exists in space in a direction perpendicular to the rod as well as its velocity. Select the correct statement (s) from the following:
(a) the entire rod is at the same electric potential
(b) there is an electric field in the rod
(c) the electric potential is highest at the centre of the rod and decreases towards its ends
(d) the electric potential is lowest at the centre of the rod and increases towards its ends

[IIT 1998]

33) A thin semicircular conducting ring of radius R is falling with its plane vertical in horizontal magnetic induction $\vec{B}$ as shown in the figure. At the position MNQ the speed of the ring is V and the potential difference developed across the ring is



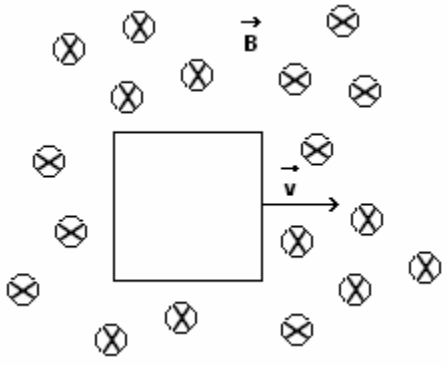
(a) zero (b) $BV\pi R^2/2$ and M is at higher potential
(c) πBRV and Q is at higher potential
(d) 2RBV and Q is at higher potential

[IIT 1996]

34) Two different coils have self-inductances L_1 = 8 mH, L_{21} = 2 mH. The current in one coil is increased at a constant rate. The current in the second coil is also increased at the same constant rate. At a certain point of time, the power given to the two coils is the same. At that time, the current, the induced voltage and the energy stored in the first coil are i_1, v_1 and w_1 respectively. Corresponding values for the second coil at the same instant are i_2, v_2 and w_2 respectively. Then

(a) $\frac{i_1}{i_2} = \frac{1}{4}$ (b) $\frac{i_1}{i_2} = 4$ (c) $\frac{w_1}{w_2} = 4$ (d) $\frac{v_2}{v_1} = \frac{1}{4}$ [IIT 1994]

35) 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 of the loop exists everywhere.



(as shown in the figure)
The current induced in the loop is
(a) BLv / R clockwise
(b) BLv / R anticlockwise
(c) 2BLv / R anticlockwise
(d) zero [IIT 1989]

36) A coil having an inductance of $1/\pi$ henry is connected in series with a resistance of 300 Ω. If 20 volts from a 200 cycles source are impressed across the combination, the value of the tangent of the phase angle between the voltage and the current is

(a) $\tan^{-1}(5/4)$ (b) $\tan^{-1}(4/5)$
(c) $\tan^{-1}(3/4)$ (d) $\tan^{-1}(4/3)$ [Roorkee 1980]

37) A circular coil of n turns and radius r is placed in a uniform magnetic field B. Initially, the plane of the coil is perpendicular to the field. The coil is rotated through 90°. Its resistance is R. The quantity of charge passing through the coil is
(a) zero (b) $\pi n^2 r B / R$ (c) $2 \pi n r^2 B / R$ (d) $\pi n r^2 B / R$

38) A coil of insulated wire is connected in series with a bulb, a battery and a switch. When the circuit is completed, the bulb lights up immediately. The circuit is switched off and a rod of soft iron is placed inside the coil. On completing the circuit again, it is observed that
(a) the bulb is not so bright
(b) there is a slight delay before the bulb lights up to its normal brightness
(c) the bulb is initially bright but gradually becomes dim
(d) the bulb is brighter than before

39) An L-C-R series circuit is connected to an external e.m.f. $e = 200 \sin (100\pi t)$. The values of the capacitance and resistance in the circuit are 1 μF and 100 Ω respectively. The amplitude of current in the circuit will be maximum when the inductance is
(a) 100 H (b) $100 / \pi^2$ H (c) 100π H (d) 10000 H

40) In series L-C-R circuit, $e = e_0 \sin \omega t$, where $e_0 = 200$ V, R = 100 Ω, L = 0.1 H and C = 1 μF. The frequency of applied a.c. varies from 0 to ∞. For very low values of frequency f, the amplitude of current is
(a) 2 A (b) $(1 / \sqrt{2})$ A (c) $2 \sqrt{2}$ A (d) zero

41) The potential difference V and the current I flowing through an instrument in an a.c. circuit are given by $V = 5 \cos \omega t$ volts and $I = 2 \sin \omega t$ amperes. The power dissipated in the instrument is
(a) zero W (b) 10 W (c) 5 W (d) 2.5 W

42) In an a.c. circuit $V = 100 \sin (100 t)$ volts and $I = 100 \sin (100 t + \pi / 3)$ mA. The power dissipated in the circuit is
(a) 10^4 W (b) 10 W (c) 2.5 W (d) 5.0 W

43) A capacitor, an inductor and an electric bulb are connected in series to an a.c. supply of variable frequency. As the frequency of the supply is increased gradually, then the electric bulb is found to
(a) increase in brightness
(b) decrease in brightness
(c) increase, reach maximum and then decrease in brightness
(d) shown no change in brightness

44) A coil of resistance 200 Ω and self-inductance 1.0 H has been connected to an a.c. source of frequency $100 / \pi$ Hz. The phase difference voltage and current is
(a) 30° (b) 60° (c) 45° (d) 75°

45) An alternating voltage $E = 200 \sqrt{2} \sin (100 t)$ is connected to a 1 μF capacitor through an a.c. ammeter. The reading of the ammeter shall be
(a) 10 mA (b) 20 mA (c) 40 mA d) 80 mA

46) A broadcasting centre broadcasts at 300 m band. A condenser of capacitance 2.4 μF is available. The value of the inductance required for the resonant circuit is
(a) 10^{-4} H (b) 10^{-8} H (c) 10^{-6} H (d) 10^{-2} H

47) It is desired to construct a circuit whose resonant frequency is 1 MHz using a coil of 3 mH. The value of capacitor needed is about
(a) 8.5 pico-farad (b) 0.8 pic0-farad (c) 85 pico-farad (d) 850 pico-farad
(pico = 10^{-12})

48) In series L-C-R circuit, the voltages across R, L and C are 40 V, 50 V and 20 V respectively. The voltage of the applied source is
(a) 110 V (b) 10 V (c) 50 V (d) 70 V

Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
d	d	b	a	d	b	b	c	b	a	a	c	d	b	b	d	d	b	a	b

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
b	b	a	d	b	c	d	c	d	b	c	b	d	a,c,d	d	d	d	b	b	d

41	42	43	44	45	46	47	48
a	c	c	c	b	b	a	c