ELECTROMAGNETIC INDUCTION & ALTERNATING CURRENT

1. A rectangular loop of length 2.5 m and width 2 m is placed at 60° to a magnetic field of 4 T. The loop is removed from the field in 10 sec. The average emf induced in the loop during this time is :

(1) – 2V (2) + 2V

(3) + 1V (4) – 1V

2. Two coils have mutual inductance 0.002 H. The current changes in the first coil according to the relation $i = i_0 \sin \omega t$, where $i_0 = 5A$ and $\omega = 50\pi$ rad/s. The maximum value of emf in the second coil is $\frac{\pi}{\alpha}$ V. The value of α is _____.

3. Primary side of a transformer is connected to 230 V, 50 Hz supply. Turns ratio of primary to secondary winding is 10 : 1. Load resistance connected to secondary side is 46 Ω. The power consumed in it is :

(1) 12.5 W (2) 10.0 W

(3) 11.5 W (4) 12.0 W

4. A series LCR circuit with $L = \frac{100}{\pi}$ mH, $C = \frac{10^{-3}}{\pi}$ F and R = 10 Ω, is connected across an ac source of 220 V, 50 Hz supply. The power factor of the circuit would be _________.

5. A capacitor of capacitance 100 ∝F is charged to a potential of 12 V and connected to a 6.4 mH inductor to produce oscillations. The maximum current in the circuit would be :

(1) 3.2 A (2) 1.5 A

(3) 2.0 A (4) 1.2 A

6. A square loop of side 10 cm and resistance 0.7Ω is placed vertically in east-west plane. A uniform magnetic field of 0.20 T is set up across the plane in north east direction. The magnetic field is decreased to zero in 1 s at a steady rate. Then, magnitude of induced emf is $\sqrt{x} \times 10^{-3}$ V. The value of x is _________.

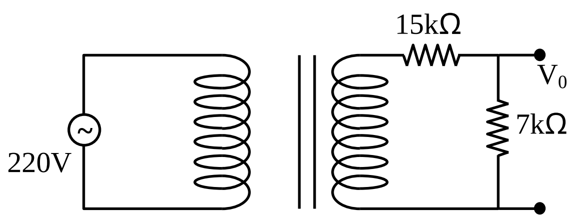
7. In an a.c. circuit, voltage and current are given by :
V = 100 sin (100 t) V and
$I = 100 \sin (100 t + \frac{\pi}{3})$ mA respectively.
The average power dissipated in one cycle is :

(1) 5 W (2) 10 W

(3) 2.5 W (4) 25 W

8. A horizontal straight wire 5 m long extending from east to west falling freely at right angle to horizontal component of earth's magnetic field 0.60×10^{-4} Wbm^{-2}. The instantaneous value of emf induced in the wire when its velocity is 10 ms^{-1} is __________ $\times 10^{-3}$ V.

9. Primary coil of a transformer is connected to 220 V ac. Primary and secondary turns of the transforms are 100 and 10 respectively. Secondary coil of transformer is connected to two series resistance shown in shown in figure. The output voltage (V_0) is :



(1) 7 V (2) 15 V

(3) 44 V (4) 22 V

10. A series L,R circuit connected with an ac source E = (25 sin 1000 t) V has a power factor of $\frac{1}{\sqrt{2}}$.
If the source of emf is changed to
E = (20 sin 2000 t)V, the new power factor of the circuit will be :

(1) $\frac{1}{\sqrt{2}}$ (2) $\frac{1}{\sqrt{3}}$

(3) $\frac{1}{\sqrt{5}}$ (4) $\frac{1}{\sqrt{7}}$

11. An alternating voltage V(t) = 220 sin 100πt volt is applied to a purely resistive load of 50 Ω. The time taken for the current to rise from half of the peak value to the peak value is:

(1) 5 ms (2) 3.3 ms

(3) 7.2 ms (4) 2.2 ms

12. A power transmission line feeds input power at 2.3 kV to a step down transformer with its primary winding having 3000 turns. The output power is delivered at 230 V by the transformer. The current in the primary of the transformer is 5A and its efficiency is 90%. The winding of transformer is made of copper. The output current of transformer is_____A.

13. A coil is placed perpendicular to a magnetic field of 5000 T. When the field is changed to 3000 T in 2s, an induced emf of 22 V is produced in the coil. If the diameter of the coil is 0.02 m, then the number of turns in the coil is :

(1) 7 (2) 70

(3) 35 (4) 140

14. A small square loop of wire of side □ is placed inside a large square loop of wire of side L (L = $□^2$). The loops are coplanar and their centers coinside. The value of the mutual inductance of the system is $\sqrt{x} \times 10^{-7}$ H, where x = _____.

15. An AC voltage $V = 20 \sin 200\pi t$ is applied to a series LCR circuit which drives a current $I = 10 \sin\left(200\pi t + \frac{\pi}{3}\right)$. The average power dissipated is:

(1) 21.6 W (2) 200 W

(3) 173.2 W (4) 50 W

16. A parallel plate capacitor has a capacitance C = 200 pF. It is connected to 230 V ac supply with an angular frequency 300 rad/s. The rms value of conduction current in the circuit and displacement current in the capacitor respectively are :

(1) 1.38 ∝A and 1.38 ∝A

(2) 14.3 ∝A and 143 ∝A

(3) 13.8 ∝A and 138 ∝A

(4) 13.8 ∝A and 13.8 ∝A

17. The magnetic flux φ (in weber) linked with a closed circuit of resistance 8 Ω varies with time (in seconds) as $\varphi = 5t^2 - 36t + 1$. The induced current in the circuit at t = 2s is _______ A.

18. In series LCR circuit, the capacitance is changed from C to 4C. To keep the resonance frequency unchanged, the new inductance should be :

(1) reduced by $\frac{1}{4}L$

(2) increased by 2L

(3) reduced by $\frac{3}{4}L$

(4) increased to 4L

19. A rectangular loop of sides 12 cm and 5 cm, with its sides parallel to the x-axis and y-axis respectively moves with a velocity of 5 cm/s in the positive x axis direction, in a space containing a variable magnetic field in the positive z direction. The field has a gradient of 10^{-3} T/cm along the negative x direction and it is decreasing with time at the rate of 10^{-3} T/s. If the resistance of the loop is 6 mΩ, the power dissipated by the loop as heat is _______ × 10^{9} W.

20. A transformer has an efficiency of 80% and works at 10 V and 4 kW. If the secondary voltage is 240 V, then the current in the secondary coil is :

(1) 1.59 A (2) 13.33 A

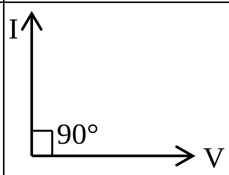
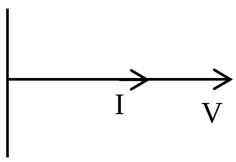
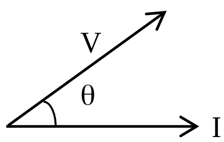
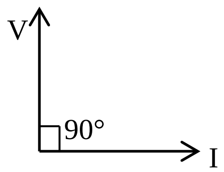
(3) 1.33 A (4) 15.1 A

21. A coil of 200 turns and area 0.20 m^2 is rotated at half a revolution per second and is placed in uniform magnetic field of 0.01 T perpendicular to axis of rotation of the coil. The maximum voltage generated in the coil is $\frac{2\pi}{\beta}$ volt. The value of β is______.

22. In an ac circuit, the instantaneous current is zero, when the instantaneous voltage is maximum. In this case, the source may be connected to :
A. pure inductor.
B. pure capacitor.
C. pure resistor.
D. combination of an inductor and capacitor.
Choose the correct answer from the options given below :
(1) A, B and C only (2) B, C and D only
(3) A and B only (4) A, B and D only

23. A alternating current at any instant is given by $i = \left[6 + \sqrt{56}\sin\left(100\pi t + \frac{\pi}{3}\right)\right]$ A. The rms value of the current is___________ A.

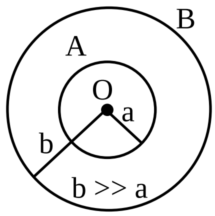
24. Match List I with List II.

	List–I		List–II
A.	Purely capacitive circuit	I.	
B.	Purely inductive circuit	II.	
C.	LCR series at resonance	III.	
D.	LCR series circuit	IV.	

Choose the correct answer from the options given below :
(1) A-I, B-IV, C-III, D-II
(2) A-IV, B-I, C-III, D-II
(3) A-IV, B-I, C-II, D-III
(4) A-I, B-IV, C-II, D-III

25. A rod of length 60 cm rotates with a uniform angular velocity 20 rad s^{-1} about its perpendicular bisector, in a uniform magnetic field 0.5 T. The direction of magnetic field is parallel to the axis of rotation. The potential difference between the two ends of the rod is ____V.

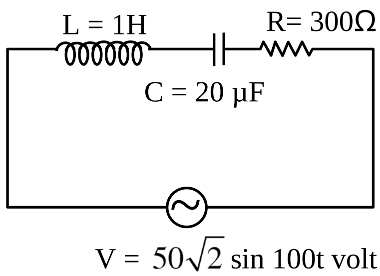
26. Two conducting circular loops A and B are placed in the same plane with their centres coinciding as shown in figure. The mutual inductance between them is:



(1) $\frac{\propto_0 \pi a^2}{2b}$ (2) $\frac{\propto_0}{2\pi}\cdot\frac{b^2}{a}$

(3) $\frac{\propto_0 \pi b^2}{2a}$ (4) $\frac{\propto_0}{2\pi}\cdot\frac{a^2}{b}$

27. An ac source is connected in given series LCR circuit. The rms potential difference across the capacitor of 20 μF is .... V.



28. A series LCR circuit is subjected to an AC signal of 200 V, 50 Hz. If the voltage across the inductor (L = 10 mH) is 31.4 V, then the current in this circuit is ________ :
(1) 68 A (2) 63 A
(3) 10 A (4) 10 mA

29. The current in an inductor is given by I = (3t + 8) where t is in second. The magnitude of induced emf produced in the inductor is 12 mV. The self-inductance of the inductor _______ mH.

30. Given below are two statements :

Statement I : In an LCR series circuit, current is maximum at resonance.

Statement II : Current in a purely resistive circuit can never be less than that in a series LCR circuit when connected to same voltage source.

In the light of the above statements, choose the ***correct*** from the options given below :

(1) Statement I is true but Statement II is false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

31. When a dc voltage of 100V is applied to an inductor, a dc current of 5A flows through it. When an ac voltage of 200V peak value is connected to inductor, its inductive reactance is found to be $20\sqrt{3}\,\Omega$. The power dissipated in the circuit is _________W.

32. In a coil, the current changes form –2 A to +2A in 0.2 s and induces an emf of 0.1 V. The self-inductance of the coil is :

(1) 5 mH (2) 1 mH

(3) 2.5 mH (4) 4 mH

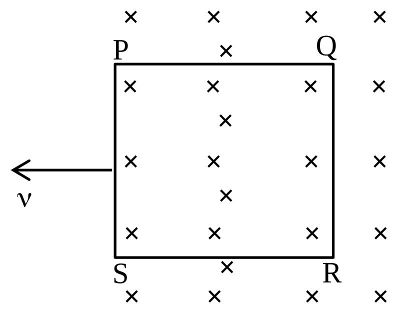
33. For a given series LCR circuit it is found that maximum current is drawn when value of variable capacitance is 2.5 nF. If resistance of 200Ω and 100 mH inductor is being used in the given circuit. The frequency of ac source is _____ × 10^3 Hz. (given $\pi^2 = 10$)

34. A LCR circuit is at resonance for a capacitor C, inductance L and resistance R. Now the value of resistance is halved keeping all other parameters same. The current amplitude at resonance will be now:

(1) Zero (2) double

(3) same (4) halved

35. A square loop PQRS having 10 turns, area 3.6×10^{-3} m^2 and resistance 100 Ω is slowly and uniformly being pulled out of a uniform magnetic field of magnitude B = 0.5 T as shown. Work done in pulling the loop out of the field in 1.0 s is _________ × 10^{-6} J.



36. A coil of negligible resistance is connected in series with 90Ω resistor across 120 V, 60 Hz supply. A voltmeter reads 36 V across resistance. Inductance of the coil is :

(1) 0.76 H (2) 2.86 H

(3) 0.286 H (4) 0.91 H

37. A bulb and a capacitor are connected in series across an ac supply. A dielectric is then placed between the plates of the capacitor. The glow of the bulb:

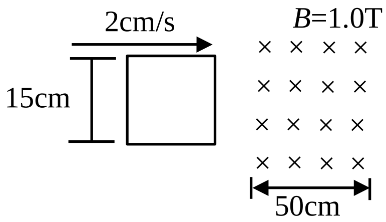
(1) increases (2) remains same

(3) becomes zero (4) decreases

38. An alternating emf E = 110 $\sqrt{2}$ sin 100t volt is applied to a capacitor of 2μF, the rms value of current in the circuit is ………. mA.

39. When a coil is connected across a 20 V dc supply, it draws a current of 5 A. When it is connected across 20 V, 50 Hz ac supply, it draws a current of 4 A. The self inductance of the coil is ______ mH. (Take $\pi = 3$)

40. A square loop of side 15 cm being moved towards right at a constant speed of 2 cm/s as shown in figure. The front edge enters the 50 cm wide magnetic field at t = 0. The value of induced emf in the loop at t = 10 s will be :



(1) 0.3 mV (2) 4.5 mV

(3) zero (4) 3 mV

41. A capacitor of reactance $4\sqrt{3}\Omega$ and a resistor of resistance 4Ω are connected in series with an ac source of peak value $8\sqrt{2}$V. The power dissipation in the circuit is ……………..W.

SOLUTIONS

1. Ans. (3)

Sol. Average emf $= \frac{\text{Change in flux}}{\text{Time}} = -\frac{\Delta\varphi}{\Delta t}$

$= -\frac{0-\left(4\times(2.5\times 2)\cos 60^\circ\right)}{10} = +1\text{V}$

2. Ans. (2)

Sol. $\varphi = Mi = Mi_0\sin\omega t$

$\text{EMF} = -M\frac{di}{dt} = -0.002\left(i_0\omega\cos\omega t\right)$

$\text{EMF}_{max} = i_0\omega\ (0.002) = (5)(50\pi)(0.002)$

$\text{EMF}_{max} = \frac{\pi}{2}\text{V}$

3. Ans. (3)

Sol. $\frac{V_1}{V_2} = \frac{N_1}{N_2};\ \frac{230}{V_2} = \frac{10}{1}$

$V_2 = 23\text{V}$

Power consumed $= \frac{V_2^2}{R}$

$= \frac{23\times 23}{46} = 11.5\ \text{W}$

4. Ans. (1)

Sol. $X_c = \frac{1}{\omega C} = \frac{\pi}{2\pi\times 50\times 10^{-3}} = 10\Omega$

$X_L = \omega L = 2\pi\times 50\times\frac{100}{\pi}\times 10^{-3}$

$= 10\Omega$

$\because X_C = X_L$, Hence, circuit is in resonance

$\therefore$ power factor $= \frac{R}{Z} = \frac{R}{R} = 1$

5. Ans. (2)

Sol. By energy conservation

$\frac{1}{2}CV^2 = \frac{1}{2}LI_{max}^2$

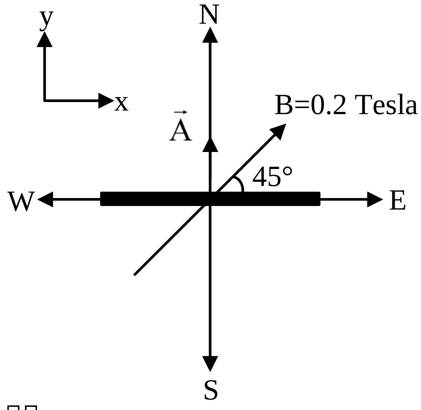
$I_{max} = \sqrt{\frac{C}{L}}\ V$

$= \sqrt{\frac{100\times 10^{-6}}{6.4\times 10^{-3}}}\times 12$

$= \frac{12}{8} = \frac{3}{2} = 1.5\ \text{A}$

6. Ans. (2)

Sol.



$\vec{A} = (0.1)^2\,\hat{j}$

$\vec{B} = \frac{0.2}{\sqrt{2}}\hat{i} + \frac{0.2}{\sqrt{2}}\hat{j}$

Magnitude of induced emf

$e = \frac{\Delta\varphi}{\Delta t} = \frac{\vec{B}\cdot\vec{A}\ \theta}{1} = \sqrt{2}\times 10^{-3}\text{V}$

7. Ans. (3)

Sol. $P_{avg} = V_{rms}\, I_{rms}\, \cos(\Delta\varphi)$

$= \frac{100}{\sqrt{2}}\times\frac{100\times 10^{-3}}{\sqrt{2}}\times\cos\left(\frac{\pi}{3}\right)$

$= \frac{10^4}{2}\times\frac{1}{2}\times 10^{-3} = \frac{10}{4} = 2.5\text{W}$

8. Ans. (3)

Sol. $B_H = 0.60\times 10^{-4}\ \text{Wb/m}^2$

Induced emf $e = B_H v \ell$

$= 0.60\times 10^{-4}\times 10\times 5 = 3\times 10^{-3}\ \text{V}$

9. Ans. (1)

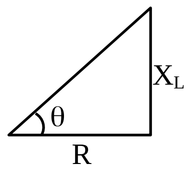
Sol. $\frac{\varepsilon_1}{\varepsilon_2} = \frac{N_1}{N_2} = \frac{100}{10} \Rightarrow \varepsilon_2 = 22\ \text{V}$

$I = \frac{22}{22\times 10^3} = 1\text{mA},\ V_0 = 7\text{V}$

10. Ans. (3)

Sol. E = 25 sin (1000 t)

$\cos\theta = \frac{1}{\sqrt{2}}$



LR circuit

Initially

$\frac{R}{\omega_1 L} = \frac{1}{\tan\theta} = \frac{1}{\tan 45^\circ} = 1$

$X_L = \omega_1 L$

$\omega_2 = 2\omega_1$, given

$\tan\theta' = \frac{\omega_2 L}{R} = \frac{2\omega_1 L}{R}$

$\tan\theta' = 2$

$\cos\theta' = \frac{1}{\sqrt{5}}$

11. Ans. (2)

Sol. Rising half to peak

$t = T/6$

$$t = \frac{2\pi}{6\omega} = \frac{\pi}{3\omega} = \frac{\pi}{300\pi} = \frac{1}{300} = 3.33\text{ms}$$

12. Ans. (45)

Sol. $P_i = 2300 \times 5$ watt

$P_0 = 2300 \times 5 \times 0.9 = 230 \times I_2$

$I_2 = 45A$

13. Ans. (2)

Sol. $\varepsilon = N\left(\frac{\Delta}{\varphi t}\right)$; $\Delta\varphi = (\Delta B)A$

$B_i = 5000$ T, $B_f = 3000$ T

d = 0.02 m

r = 0.01 m

$\Delta\varphi = (\Delta B)A$

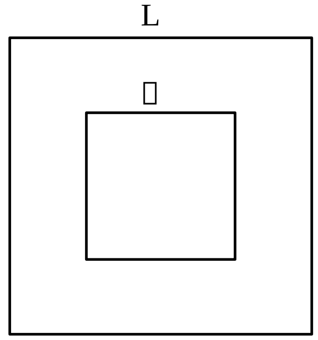
$= (2000)\pi(0.01)^2 = 0.2\pi$

$$\varepsilon = N\left(\frac{\Delta}{\varphi t}\right) \Rightarrow 22 = N\left(\frac{0.2\pi}{2}\right)$$

N = 70

14. Ans. (128)

Sol.



Flux linkage for inner loop.

$\varphi = B_{center} \cdot \ell^2$

$$= 4 \cdot \frac{\propto_0 i}{4\pi \frac{L}{2}}(\sin 45 + \sin 45)\ell^2$$

$$\varphi = 2\sqrt{2}\frac{\propto_0 i}{\pi L}\ell^2$$

$$M = \frac{\varphi}{i} = \frac{2\sqrt{2}\propto_0 \ell^2}{\pi L} = 2\sqrt{2}\frac{\propto_0}{\pi}$$

$$= 2\sqrt{2}\frac{4\pi}{\pi} \cdot 10^{-7}$$

$= 8\sqrt{2} \cdot 10^{-7}$ H

$= \sqrt{128} \cdot 10^{-7}$ H , x = 128

15. Ans. (4)

Sol. $< P > = IV \cos\varphi$

$$= \frac{20}{\sqrt{2}} \cdot \frac{10}{\sqrt{2}} \cdot \cos 60^\circ = 50 \text{ W}$$

16. Ans. (4)

Sol. $I = \frac{V}{X_C}$

$= 230 \times 300 \times 200 \times 10^{-12}$

$= 13.8 \propto A$

17. Ans. (2)

Sol. $\varepsilon = -\left(\frac{d\varphi}{dt}\right) = 10t - 36$

at $t = 2$, $\varepsilon = 16$ V

$$i = \frac{\varepsilon}{R} = \frac{16}{8} = 2 \text{ A}$$

18. Ans. (3)

Sol. $\omega' = \omega$

$$\frac{1}{\sqrt{L'C'}} = \frac{1}{\sqrt{LC}}$$

$\therefore$ L'C' = LC

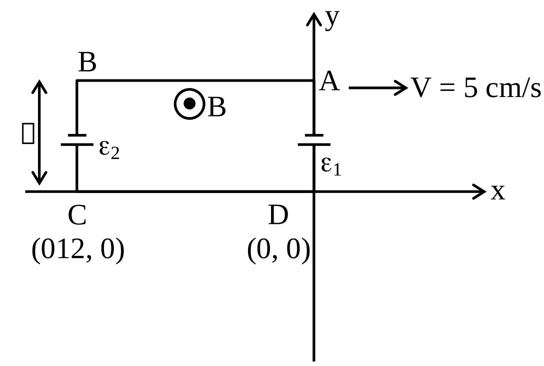
L'(4C) = LC

$L' = \frac{L}{4}$

$\because$ Inductance must be decreased by $\frac{3L}{4}$

19. Ans. (216)

Sol.



B_0 is the magnetic field at origin

$$\frac{dB}{dx} = -\frac{10^{-3}}{10^{-2}}$$

$$\int_{B_0}^{B} dB = -\int_0^x 10^{-1} dx$$

$B - B_0 = -10^{-1}x$

$$B = \left(B_0 - \frac{x}{10}\right)$$

Motional emf in AB = 0

Motional emf in CD = 0

Motional emf in AD = $\varepsilon_1 = B_0 v \ell$

Magnetic field on rod BC B

$$= \left(B_0 - \frac{(-12 \cdot 10^{-2})}{10}\right)$$

Motional emf in BC = ε_2

$= \left(B_0 + \frac{12 \cdot 10^{-2}}{10}\right) \ell \cdot v$

$\varepsilon_{eq} = \varepsilon_2 - \varepsilon_1 = 300 \times 10^{-7}$ V

For time variation

$(\varepsilon_{eq})' = A \frac{dB}{dt} = 60 \times 10^{-7}$ V

$(\varepsilon_{eq})_{net} = \varepsilon_{eq} + (\varepsilon_{eq})' = 360 \times 10^{-7}$ V

Power $= \frac{(\varepsilon_{eq})^2_{net}}{R} = 216 \times 10^{-9}$ W

20. Ans. (2)

Sol. Efficiency $= \frac{E_S I_S}{E_P I_P}$

$0.8 = \frac{240 I_S}{4000}$

$I_S = \frac{3200}{240} = 13.33$A

21. Ans. (5)

Sol. $\varphi = NAB\cos(\omega t)$

$\varepsilon = -\frac{d\varphi}{dt} = NAB\omega\sin(\omega t)$

$\varepsilon_{max} = NAB\omega$

$= 200 \times 0.2 \times 0.01 \times \pi$

$= \frac{4\pi}{10} = \frac{2\pi}{5}$ volt

22. Ans. (4)

Sol. This is possible when phase difference is $\frac{\pi}{2}$ between current and voltage so correct answer will be (4)

23. Ans. (8)

Sol. $I_{rms} = \sqrt{\frac{\int i^2 dt}{\int dt}}$

$I_{rms} = \sqrt{(6)^2 + \frac{(\sqrt{56})^2}{2}}$

$= \sqrt{36 + 28} = \sqrt{64} = 8$A

24. Ans. (4)

Sol. **A** – V lags by 90° from I hence option (I) is correct.

B – V lead by 90° from I hence option (IV) is correct

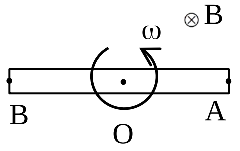
C – In LCR resonance $X_L = X_C$. Hence circuit is purely resistive so option (II) is correct

D – In LCR series V is at some angle from I hence (III) is correct

Hence option (4) is correct.

25. Ans. (0)

Sol.



$\because V_0 - V_A = \frac{B\omega \ell^2}{2}$

$V_0 - V_B = \frac{B\omega \ell^2}{2}$

$\therefore V_A = V_B$

$\therefore V_A - V_B = 0$

26. Ans. (1)

Sol. $\varphi = Mi = BA$

$\Rightarrow Mi = \frac{\mu_0 i}{2b}\pi a^2$

$\therefore M = \frac{\mu_0 \pi a^2}{2b}$

27. Ans. (50)

Sol. $X_L = \omega L = 100 \times 1 = 100\Omega$

$X_C = \frac{1}{\omega C} = \frac{1}{100 \cdot 20 \cdot 10^{-6}} = 500\Omega$

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

$\sqrt{(100 - 500)^2 + 300^2}$

$Z = 500\Omega$

$i_{rms} = \frac{V_{rms}}{Z} = \frac{50}{500} = 0.1$A

rms voltage across capacitor

$V_{rms} = X_C\, i_{rms}$

$= 500 \times 0.1 = 50$V

28. Ans. (3)

Sol. Voltage across inductor $V_L = IX_L$

$31.4 = I[L\omega]$

$31.4 = I[L(2\pi f)]$

$31.4 = I[10 \times 10^{-3}(2 \times 3.14) \times 50$

$\Rightarrow I = 10$ A

29. Ans. (4)

Sol. $I = 3t + 8$

$\varepsilon = 12$ mV

$|\varepsilon| = L\left|\frac{dI}{dt}\right|$

$12 = L \times 3$

$L = 4$ mH

30. Ans. (3)

Sol. Statement-I

$$I_m = \frac{V_m}{\sqrt{R^2 + (X_L - X_C)^2}}$$ at resonance $X_L = X_C$

Thus, $I_m = \frac{V_m}{R}$

∵ Impendence is minimum therefore I is maximum at resonance.

Statement-II

$I = \left(\frac{V}{R}\right)$ in purely resistive circuit.

31. Ans. (250)

Sol. For DC voltage

$$R = \frac{V}{I} = \frac{100}{5} = 20\ \Omega$$

for AC voltage

$X_L = 20\sqrt{3}\ \Omega$

$R = 20\ \Omega$

$$Z = \sqrt{X_L^2 + R^2} = \sqrt{3 \cdot 400 + 400} = 40\ \Omega$$

Power $= i_{rms}^2 R$

$$= \left(\frac{V_{rms}}{Z}\right)^2 \cdot R = \left(\frac{\frac{200}{\sqrt{2}}}{40}\right)^2 \cdot 20 = 250\text{W}$$

32. Ans. (1)

Sol. $(\text{Emf})_{\text{induced}} = -L\frac{di}{dt}$

In magnitude form,

$$|\text{Emf}_{\text{ind}}| = \left|(-)L\frac{di}{dt}\right|$$

$$\Rightarrow 0.1 = \frac{(L)[+2-(-2)]}{0.2}$$

$$\Rightarrow \boxed{L = \frac{0.1 \cdot 0.2}{4} = 5\text{mH}}$$

33. Ans. (10)

Sol. for maximum current, circuit must be in resonance.

$$f_0 = \frac{1}{2\pi\sqrt{L \cdot C}}$$

$$f_0 = \frac{1}{2\pi\sqrt{100 \cdot 10^{-3} \cdot 2.5 \cdot 10^{-9}}}$$

$$= \frac{1}{2\pi\sqrt{25 \cdot 10^{-11}}}$$

$$= \frac{1}{2\pi \cdot 5} \cdot 10^5 \cdot \sqrt{10}\ \text{Hz}$$

$$= \frac{100}{10} \cdot 10^3\ \text{Hz}\ ;\ f_0 = 10 \times 10^3\ \text{Hz}$$

34. Ans. (2)

Sol. In resonance Z = R

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

R → halved ⇒ I → 2I

I becomes doubled.

35. Ans. (3)

Sol. $\in = NB\ell v$

$$i = \frac{\in}{R} = \frac{NB\ell v}{R}$$

$$F = N(i\ell B) = \frac{N^2B^2\ell^2 v}{R}$$

$$W = F \cdot \ell = \frac{N^2B^2\ell^3}{R}\left(\frac{\ell}{t}\right)$$

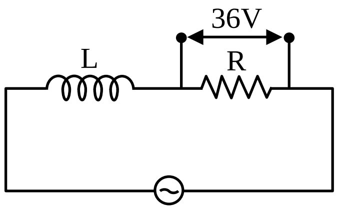
$A = \ell^2$

$$W = \frac{(10 \cdot 10)(0.5)^2 \cdot (3.6 \cdot 10^{-3})^2}{100 \cdot 1}$$

$W = 3.24 \times 10^{-6}$ J

36. Ans. (1)

Sol.



120V/60Hz

$36 = I_{rms} R$

$$36 = \frac{120}{\sqrt{X_L^2 + R^2}} \cdot R$$

$$R = 90\ \Omega \Rightarrow 36 = \frac{120 \cdot 90}{\sqrt{X_L^2 + 90^2}}$$

$\sqrt{X_L^2 + 90^2} = 300;\ X_L^2 = 81900$

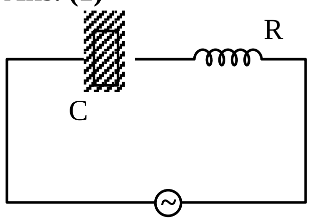
$X_L = 286.18$

$\omega L = 286.18$

$L = \frac{286.18}{376.8}$; L = 0.76 H

37. Ans. (1)

Sol.



$$Z = \sqrt{R^2 + X_C^2}\ \&\ X_C = \frac{1}{WC}$$

due to dielectric

C ↑ ⇒ X_C ↓ ⇒ Z ↓

So, current increases & thus bulb will glow more brighter.

38. Ans. (22)

Sol. $C = 2\mu f$; $E = 110\sqrt{2}\ \sin(100\ t)$

$X_C = \frac{1}{\omega c} = \frac{1}{100 \cdot 2 \cdot 10^6}$

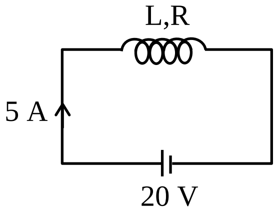
$= \frac{10000}{2} = 5000\Omega$

$i_o = \frac{110\sqrt{2}}{5000}$; $i_{rms} = \frac{110\sqrt{2}}{5000\sqrt{2}}$

$= \frac{110}{5} mA = 22\ mA$

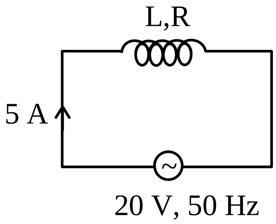
39. Ans. (10)

Sol. Case-I:



$i = \frac{20}{R} \Rightarrow R = 4\Omega$

Case-II:



$i = \frac{20}{Z}$

$4 = \frac{20}{\sqrt{R^2 + X_L^2}} \Rightarrow \sqrt{R^2 + X_L^2} = 5$

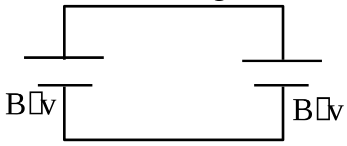
$R^2 + X_L^2 = 25 \Rightarrow X_L = 3\ \Omega$

$L = \frac{3}{2\pi f} = \frac{1}{2 \cdot 50} = \frac{1000}{100} mH$

$L = 10\ mH$

40. Ans. (3)

Sol. At t = 10 sec complete loop is in magnetic field therefore no change in flux

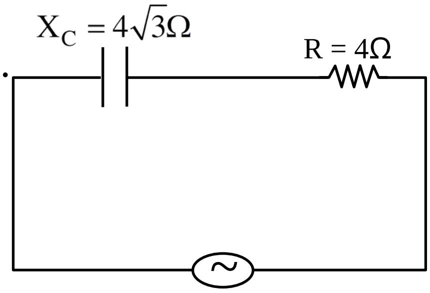


$e = \frac{d\varphi}{dt} = 0$

e = 0 for complete loop

41. Ans. (4)

Sol.



$Z = \sqrt{R^2 + X_L^2}$

$Z = \sqrt{4^2 + (4\sqrt{3})^2} = 8\Omega$

$V_{rms} = \frac{V}{\sqrt{2}} = \frac{8\sqrt{2}}{\sqrt{2}} = (8V)$

$I_{rms} = \frac{V_{rms}}{z} = \frac{8}{8} = 1A$

Power dissipated = $I_{rms}^2 \times R = 1 \times 4 = (4W)$