Electromagnetic Induction

Question1

The self inductance of an air-cored solenoid of length 40 cm , diameter 7 cm having 200 turns is nearly

AP EAPCET 2025 - 26th May Morning Shift

Options:

A.

484μH

B.

242μH

C.

121μH

D.

968μH

Answer: A

Solution:

Self inductance

$L = \dfrac{\mu_0 N^2 A}{l}$

$= \dfrac{4\pi \times 10^{-7} \times (200)^2 \times \left(\frac{7}{2} \times 10^{-2}\right)^2 \times 2\pi}{0.4}$

$= 484 \times 10^{-6}\text{H} = 484\mu$H

Question2

When current in a coil changes from 2 A to 5 A in time of 0.3 s , if the emf induced in the coil is 40 mv , then the self inductance of the coil is

AP EAPCET 2025 - 26th May Evening Shift

Options:

A.

4 H

B.

4 mH

C.

40 mH

D.

4μH

Answer: B

Solution:

Let's restate the given data:

$$\text{Initial current, } I_1 = 2\,\text{A}$$
$$\text{Final current, } I_2 = 5\,\text{A}$$
$$\text{Change in current, } \Delta I = 5 - 2 = 3\,\text{A}$$
$$\text{Time, } \Delta t = 0.3\,\text{s}$$
$$\text{Induced emf, } e = 40\,\text{mV} = 40 \times 10^{-3}\,\text{V}$$

Formula:

$$e = L\frac{\Delta I}{\Delta t}$$

Rearranging for L:

$$L = \frac{e\,\Delta t}{\Delta I}$$

Substituting values:

$L = \frac{40 \times 10^{-3} \times 0.3}{3}$

$L = \frac{12 \times 10^{-3}}{3} = 4 \times 10^{-3}\,\text{H}$

$L = 4\,\text{mH}$

✅ **Final Answer:**

Option B — 4 mH

Question3

A coil of resistance 200Ω is placed in a magnetic field. If the magnetic flux ϕ (in weber) linked with the coil varies with time ' t ' (in second) as per the equation $\phi = 50t^2 + 4$, then the current induced in the coil at a time $t = 2$ s is

AP EAPCET 2025 - 24th May Morning Shift

Options:

A.

2 A

B.

1 A

C.

0.5 A

D.

0.1 A

Answer: B

Solution:

We need to find the current in the coil at $t = 2$ seconds.

Step 1: Find the induced EMF.

The magnetic flux is given by $\phi = 50t^2 + 4$.

To find the EMF (E), we take the derivative of ϕ with respect to t:

$E = \frac{d\phi}{dt}$

Now, differentiate ϕ:

$\frac{d}{dt}(50t^2 + 4) = 100t$ (because the derivative of t^2 is $2t$, and 50 times $2t$ is $100t$; the derivative of a constant is 0).

Step 2: Calculate EMF at $t = 2$ seconds.

Plug in $t = 2$:

$E = 100 \times 2 = 200$ volts

Step 3: Find the current using Ohm's Law.

Ohm's Law: $I = \frac{E}{R}$

Here, $E = 200$ volts and $R = 200\,\Omega$.

$I = \frac{200}{200} = 1\,\text{A}$

So, the current induced in the coil at $t = 2$ seconds is 1 ampere.

Question4

When a current of 4 mA passes through an inductor, if the flux linked with it is $32 \times 10^{-6}\mathrm{Tm}^2$, then the energy stored in the inductor is

AP EAPCET 2025 - 23rd May Evening Shift

Options:

A.

64×10^{-9} J

B.

32×10^{-9} J

C.

128×10^{-9} J

D.

96×10^{-9} J

Answer: A

Solution:

We are given: current $I = 4\,\text{mA} = 4 \times 10^{-3}$ A and flux $\phi = 32 \times 10^{-6}\,\text{Tm}^2$.

Step 1: Find the inductance (L).

The relationship between flux, inductance, and current is $\phi = LI$.

So, $L = \frac{\phi}{I} = \frac{32 \times 10^{-6}}{4 \times 10^{-3}} = 8 \times 10^{-3}$ H.

Step 2: Find the energy stored in the inductor.

The formula for energy stored is $E = \frac{1}{2}LI^2$.

Plug in the values: $E = \frac{1}{2} \times 8 \times 10^{-3} \times (4 \times 10^{-3})^2$.

Calculate the value: $E = 64 \times 10^{-9}$ J.

Question5

If a wheel with 24 metallic spokes each 40 cm long is rotated with a speed of $180\text{rev}/\text{min}$ in a plane normal to the horizontal component of Earth's magnetic field, the emf induced between the axle and the rim of the wheel is E. If the number of spokes is made 12 and the wheel is rotated with a speed of $90\text{rev}/\text{min}$ in the same field, the induced emf is

AP EAPCET 2025 - 23rd May Morning Shift

Options:

A.

E

B.

$2E$

C.

$4E$

D.

$0.5E$

Answer: D

Solution:

The induced emf in a rotating spoke

$$e = \frac{1}{2}B\omega r^2$$

$$\therefore \quad e_1 = \frac{1}{2}B\left(2\pi \times \frac{180}{60}\right)(0.4)^2 = 0.48\pi B$$

$$\text{and } e_2 = \frac{1}{2}B\left(2\pi \times \frac{90}{60}\right) \times (0.4)^2$$

$$= 0.24\pi B$$

$$= 2 \times 0.24\pi \times \frac{B}{2} = \frac{e_1}{2} = \frac{E}{2} = 0.5B$$

Question6

A metallic disc of radius 0.3 m is rotating with a constant angular speed of 60rads^{-1} in a plane perpendicular to a uniform magnetic field of 5×10^{-2} T. The emf induced between a point on the rim and centre of the disc is

AP EAPCET 2025 - 22nd May Evening Shift

Options:

A.

0.06 V

B.

0.612 V

C.

1.35 V

D.

0.135 V

Answer: D

Solution:

Induced emf, $e = \dfrac{1}{2}B\omega R^2$

$= \dfrac{1}{2} \times 5 \times 10^{-2} \times 60 \times (0.3)^2$

$= 0.135$ volt

Question7

A coil of 45 turns and radius 4 cm is placed in a uniform magnetic field such that its plane is perpendicular to the direction of the field. If the magnetic field increases from 0 to 0.70 T at a constant rate in a time interval of 220 s , then the induced emf in the coil is

AP EAPCET 2025 - 22nd May Morning Shift

Options:

A.

0.32 mV

B.

0.50 mV

C.

0.72 mV

D.

0.96 mV

Answer: C

Solution:

Given:

- Number of turns, $N = 45$

- Radius, $r = 4$ cm $= 0.04$ m

- Change in magnetic field, $\Delta B = 0.70$ T $- 0 = 0.70$ T

- Time interval, $\Delta t = 220$ s

- The plane of the coil is **perpendicular to the magnetic field**, so flux is maximum.

Step 1: Rate of change of magnetic field

$\frac{dB}{dt} = \frac{0.70}{220} = 3.18 \times 10^{-3}$ T/s

Step 2: Area of the coil

$A = \pi r^2 = \pi(0.04)^2 = \pi \times 1.6 \times 10^{-3} = 5.027 \times 10^{-3}$ m^2

Step 3: Induced emf (Faraday's law)

$\varepsilon = NA\frac{dB}{dt}$

Substitute values:

$\varepsilon = 45 \times 5.03 \times 10^{-3} \times 3.18 \times 10^{-3}$

$\varepsilon = 45 \times 1.6 \times 10^{-5} = 7.2 \times 10^{-4}$ V

$\varepsilon = 0.72$ mV

✅ **Final Answer:**

0.72 mV

Correct option: C

Question8

A horizontal telegraph wire of length 30 m spread east to west fell down freely from a height of 20 m . If the resistance of the wire is 40Ω and the horizontal component of the Earth's magnetic field at

the place is 2×10^{-5} T, then the induced current when the wire reaches the ground is

(Acceleration due to gravity $= 10$ ms^{-2})

AP EAPCET 2025 - 21st May Evening Shift

Options:

A.

0.3 mA

B.

3 mA

C.

3 A

D.

0.03 A

Answer: A

Solution:

Velocity of wire
$$v^2 = u^2 + 2gh$$
$$= 0 + 2 \times 10 \times 20 = 400$$
$$\therefore \quad v = 20 \text{ m/s}$$
$$\therefore \text{ Induced current } = \frac{e}{R} = \frac{Bvl}{R}$$
$$= \frac{2 \times 10^{-5} \times 20 \times 30}{40} = 3 \times 10^{-4} \text{ A}$$
$$= 0.3 \times 10^{-3} \text{ A} = 0.3 \text{ mA}$$

Question9

In a circuit the current falls from a 14 A to 4 A in a time 0.2 ms . If the induced emf is 150 V , then the self-inductance of the circuit is

AP EAPCET 2024 - 23th May Morning Shift

Options:

A. 6 H

B. 6 mH

C. 3 mH

D. 3 H

Answer: C

Solution:

Given:

Initial current, $I_1 = 14\,\text{A}$

Final current, $I_2 = 4\,\text{A}$

Change in current, $\Delta I = I_2 - I_1 = 4\,\text{A} - 14\,\text{A} = -10\,\text{A}$

Time duration, $\Delta t = 0.2\,\text{ms} = 0.2 \times 10^{-3}\,\text{s}$

Average induced emf, $\varepsilon = 150\,\text{V}$

To find the self-inductance L of the circuit, we use the formula for induced emf in terms of self-inductance:

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

Rearrange to solve for L:

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

The rate of change of current $\left(\frac{dI}{dt}\right)$ can be calculated as:

$\frac{dI}{dt} = \frac{\Delta I}{\Delta t} = \frac{-10\,\text{A}}{0.2 \times 10^{-3}\,\text{s}}$

Plug the values into the formula:

$L = \frac{150\,\text{V}}{\frac{-10\,\text{A}}{0.2 \times 10^{-3}\,\text{s}}}$

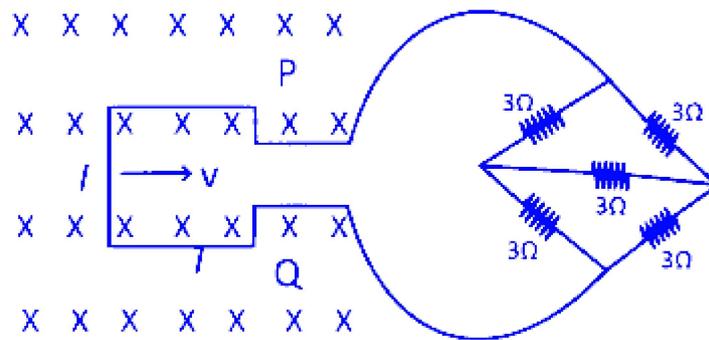Calculate:

$L = \frac{150 \times 0.2 \times 10^{-3}}{-10}$

$L = 3\,\text{mH}$

Thus, the self-inductance of the circuit is $3\,\text{mH}$.

Question10

A metallic wire loop of side $(l)0.1\ \text{m}$ and resistance of 1Ω is moved with a constant velocity in a uniform magnetic field of 2Wm^{-2} as shown in the figure. The magnetic field is perpendicular to the plane of the loop. The loop is connected to a network of resistors. The velocity of loop, so as to have a steady current of 1 mA in loop is

AP EAPCET 2024 - 22th May Evening Shift

Options:

A. $0.67\ \text{cm s}^{-1}$

B. $2\ \text{cm s}^{-1}$

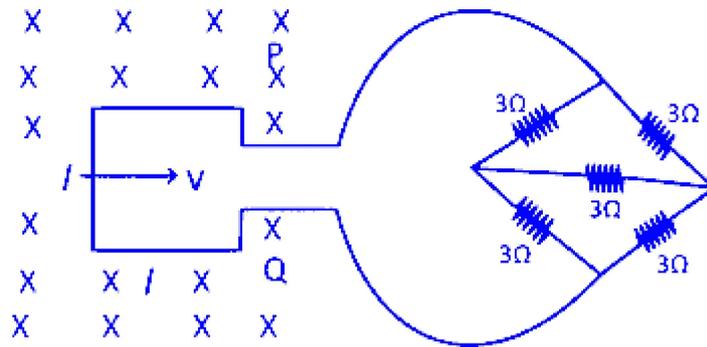C. $3\ \text{cm s}^{-1}$

D. $4\ \text{cm s}^{-1}$

Answer: B

Solution:

Given, $l = 0.1$ m

Resistance of wire $= 1\Omega$

$B = 2 \text{ Wb/m}^2$

$i = 1 \text{ mA} = 10^{-3}$ A

Calculate equivalent resistance for Wheatstone bridge,

$R_1 = 3 + 3 = 6\Omega$

$R_2 = 3 + 3 = 6\Omega$

$R_{\text{eq}} = \dfrac{R_1 \times R_2}{R_1 + R_2} = \dfrac{6 \times 6}{6 + 6} = \dfrac{36}{12} = 3\Omega$

So, total resistance in the circuit is,

$R_{\text{total}} = 3 + 1 = 4\Omega$

The induced emf in the loop,

$e = Bvl$

So, induced current, $i = \dfrac{e}{R} = \dfrac{Bvl}{R} \Rightarrow v = \dfrac{iR}{Bl}$

$v = \dfrac{10^{-3} \times 4}{2 \times 0.1}$

$v = 2 \times 10^{-2} \text{ m/s} = 2 \text{ cm/s}$

Question11

A coil of inductance L is divided into 6 equal parts. All these are connected in parallel. The resultant inductance of this combination is

AP EAPCET 2024 - 22th May Morning Shift

Options:

A. $\frac{L}{6}$

B. $\frac{L}{36}$

C. $\frac{L}{24}$

D. 6 L

Answer: B

Solution:

Given that a coil with inductance L is divided into six equal parts, these parts are connected in parallel. To find the resultant inductance of this parallel combination, we use the formula for inductors in parallel:

$$\frac{1}{L_{\text{parallel}}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \frac{1}{L_4} + \frac{1}{L_5} + \frac{1}{L_6}$$

Since each part has equal inductance, we can express each as:

$$L_1 = L_2 = L_3 = L_4 = L_5 = L_6 = \frac{L}{6}$$

Substituting into the parallel inductance formula gives:

$$\frac{1}{L_{\text{parallel}}} = 6 \times \frac{1}{L/6}$$

Simplifying this, we find:

$$L_{\text{parallel}} = \frac{L}{36}$$

Therefore, the resultant inductance of the combination is $\frac{L}{36}$.

Question12

The current passing through a coil of 120 turns and inductance 40 mH is 30 mA . The magnetic flux linked with the coil is

AP EAPCET 2024 - 21th May Evening Shift

Options:

A. 20×10^{-6} Wb

B. 5×10^{-6} Wb

C. 12×10^{-6} Wb

D. 10×10^{-6} Wb

Answer: D

Solution:

Given the following parameters:

Number of turns, $N = 120$

Inductance, $L = 40 \, \text{mH} = 40 \times 10^{-3} \, \text{H}$

Current, $I = 30 \, \text{mA} = 30 \times 10^{-3} \, \text{A}$

The magnetic flux linked with the coil can be calculated using the formula:

$\phi = \frac{L \cdot I}{N}$

Substituting the given values into the formula:

$\phi = \frac{40 \times 10^{-3} \times 30 \times 10^{-3}}{120}$

Simplifying this:

$\phi = 10 \times 10^{-6}$ Wb

Thus, the magnetic flux linked with the coil is 10×10^{-6} Wb.

Question13

X and Y are two circuits having coefficient of mutual inductance 3 mH and resistance 10Ω and 4Ω respectively. To have induced current 60×10^{-4} A in circuit Y, the amount of current to be changed in circuit X in 0.02 s is

AP EAPCET 2024 - 21th May Morning Shift

Options:

A. 1.6 A

B. 0.16 A

C. 0.32 A

D. 3.2 A

Answer: B

Solution:

Given:

Induced current in circuit Y, $i_Y = 60 \times 10^{-4}$ A

Resistance of circuit Y, $R_Y = 4\,\Omega$

Mutual inductance, $m = 3\,\text{mH} = 3 \times 10^{-3}$ H

Time, $t = 0.02$ s

Formula:

The induced EMF (ε_Y) in circuit Y is given by:

$$|\varepsilon_Y| = m \frac{di_X}{dt}$$

The current in circuit Y due to the induced EMF can be given by:

$$i_Y R_Y = m \frac{di_X}{dt}$$

Calculation:

Substitute the known values into the equation:

$$
\begin{aligned}
di_X &= \frac{60 \times 10^{-4} \times 4 \times 0.02}{3 \times 10^{-3}} \\
&= \frac{60 \times 10^{-4} \times 8 \times 10^{-2}}{3 \times 10^{-3}} \\
&= 160 \times 10^{-6} \times 10^3 \\
&= 160 \times 10^{-3} \\
&= 0.16\,\text{A}
\end{aligned}
$$

Thus, the change in current required in circuit X is 0.16 A.

Question14

The ratio of the number of turns per unit length of two solenoids A and B are 1:3 and the lengths of A and B are in the ratio $1:2$. If the two solenoids have same cross-sectional area, the ratio of the self-inductances of the solenoids A and B is

AP EAPCET 2024 - 20th May Evening Shift

Options:

A. $1:12$

B. 1 : 6

C. 1 : 18

D. 1 : 9

Answer: C

Solution:

For solenoid A:

Let n be the number of turns per unit length for solenoid A, and l be its length.

The total number of turns N_A is given by:

$N_A = n \cdot l$

For solenoid B:

The number of turns per unit length for solenoid B is $3n$ (since the ratio is 1 : 3).

The length of solenoid B is $2l$.

The total number of turns N_B is:

$N_B = (3n) \times (2l) = 6nl$

Self-Inductance Formulas:

The self-inductance L of a solenoid is given by the formula:

$L = \frac{\mu_0 N^2 A}{l}$

where μ_0 is the permeability of free space, N is the number of turns, A is the cross-sectional area, and l is the length.

For solenoid A:

$L_A = \frac{\mu_0 (N_A)^2 A}{l} = \frac{\mu_0 (n \cdot l)^2 A}{l} = \mu_0 n^2 l A$

For solenoid B:

$L_B = \frac{\mu_0 (N_B)^2 A}{l} = \frac{\mu_0 (6n \cdot l)^2 A}{2l} = \frac{\mu_0 36 n^2 l^2 A}{2l} = 18 \mu_0 n^2 l A$

Ratio of Self-Inductances:

Now, the ratio of the self-inductances $\frac{L_A}{L_B}$ is:

$\frac{L_A}{L_B} = \frac{\mu_0 n^2 l A}{18 \mu_0 n^2 l A} = \frac{1}{18}$

Thus, the ratio of the self-inductances of solenoids A and B is 1 : 18.

Question15

Magnetic field at a distance of r from Z-axis is $B = B_0 \, rt\hat{\mathbf{k}}$ present in the region. B_0 is constant and t is time. The magnitude of induced electric field at a distance of r from Z-axis is

AP EAPCET 2024 - 19th May Evening Shift

Options:

A. $\frac{B_0 r^3}{3}$

B. $\frac{2\pi B_0 r}{3}$

C. $\frac{B_0 r^2}{2\pi}$

D. $\frac{B_0 r^2}{3}$

Answer: D

Solution:

To find the magnitude of the induced electric field at a distance r from the Z-axis in the presence of a time-dependent magnetic field, we begin with the magnetic flux:

Magnetic Flux

Given that the magnetic field **B** is expressed as $B = B_0 rt\hat{\mathbf{k}}$, we can calculate the magnetic flux ϕ through a circular region of radius r:

$\phi = \int \mathbf{B} \cdot d\mathbf{A} = \int B \cdot 2\pi r \, dr$

Substituting the expression for B:

$\phi = 2\pi B_0 t \int r^2 \, dr = 2\pi B_0 t \frac{r^3}{3}$

Induced Electric Field

According to Faraday's law of electromagnetic induction, the induced electromotive force (EMF) $\oint \mathbf{E} \cdot d\mathbf{l}$ is related to the rate of change of magnetic flux:

$\oint \mathbf{E} \cdot d\mathbf{l} = \frac{d\phi}{dt}$

Substituting the expression for ϕ:

$E(2\pi r) = \frac{d}{dt}\left(2\pi B_0 t \frac{r^3}{3}\right)$

Differentiating with respect to time t:

$$E(2\pi r) = \frac{2\pi B_0 r^3}{3}$$

Solving for E:

$$E = \frac{2\pi B_0 r^3}{3 \times 2\pi r} = \frac{B_0 r^2}{3}$$

Therefore, the magnitude of the induced electric field at a distance r from the Z-axis is given by:

$$E = \frac{B_0 r^2}{3}$$

Question16

If the current through an inductor increases from 2A to 3A. The magnetic energy stored in the inductor increases by

AP EAPCET 2024 - 18th May Morning Shift

Options:

A. 125%

B. 225%

C. 50%

D. 75%

Answer: A

Solution:

The magnetic energy stored in an inductor is given by the formula:

$$U = \tfrac{1}{2}LI^2$$

Where:

U is the energy stored,

L is the inductance,

I is the current through the inductor.

In this case, the current increases from $I_1 = 2\,\text{A}$ to $I_2 = 3\,\text{A}$.

Calculating the initial energy stored U_1 when the current is I_1:

$U_1 = \frac{1}{2}LI_1^2 = \frac{1}{2} \times L \times 4 = 2L$

Calculating the energy stored U_2 when the current is I_2:

$U_2 = \frac{1}{2}LI_2^2 = \frac{1}{2} \times L \times 9 = 4.5L$

The increase in energy stored, ΔU, is:

$\Delta U = U_2 - U_1 = 4.5L - 2L = 2.5L$

To find the percentage increase in energy stored:

Percentage Increase $= \frac{\Delta U}{U_1} \times 100\% = \frac{2.5L}{2L} \times 100\% = 125\%$

Question17

A circular loop of wire of radius 14 cm is placed in magnetic field directed perpendicular to the plane of the loop. If the field decreases at a steady rate of $0.05\ \mathrm{Ts^{-1}}$ in some interval, then the magnitude of the emf induced in the loop is

AP EAPCET 2022 - 5th July Morning Shift

Options:

A. 2.08 mV

B. 3.08 mV

C. 2.16 mV

D. 3.24 mV

Answer: B

Solution:

Given :

Radius of the circular loop of wire :

$r = 14\,\mathrm{cm} = 0.14\,\mathrm{m}$

Rate of change of the magnetic field with respect to time :

$$\frac{dB}{dt} = 0.05\,\text{Ts}^{-1}$$

Using Faraday's law of electromagnetic induction, the induced emf $|e|$ is given by :

$$|e| = \left|\frac{d\Phi}{dt}\right|$$

Where the magnetic flux Φ through the loop is :

$$\Phi = B \cdot A$$

Here, A is the area of the loop. Therefore :

$$\frac{d\Phi}{dt} = A \cdot \frac{dB}{dt} = \pi r^2 \cdot \frac{dB}{dt}$$

Substituting the given values :

$$|e| = \pi(0.14)^2 \cdot 0.05$$

$$= \frac{22}{7} \times 0.14 \times 0.14 \times 0.05$$

$$= 0.00308\,\text{V}$$

$$= 3.08 \times 10^{-3}\,\text{V}$$

$$= 3.08\,\text{mV}$$

Question18

A circular coil has 100 turns, radius 3 cm and resistance 4Ω. This coil is co-axial with a solenoid of 200 turns/cm and diameter 4 cm . If the solenoid current is decreased from 2 A to zero in 0.04 s , then the current induced in the coil is

AP EAPCET 2022 - 4th July Evening Shift

Options:

A. $4\pi^2$ mA

B. 8πmA

C. 30.3 mA

D. 45.5 mA

Solution:

No. of turns in circular coil, $N = 100$

Radius, $r = 3$ cm $= 3 \times 10^{-2}$ m

Resistance, $R = 4\Omega$

No. of turns per unit length in the solenoid, $n = 200$ turns/cm $= 20000$ turns/m

$\because$ Magnetic field inside the solenoid, $B = \mu_0 n I$

Hence, induced emf

$$e = \frac{N d}{dt} BA$$
$$= \frac{N d}{dt} \mu_0 n I A = N \mu_0 n A \frac{dI}{dt}$$
$$= 100 \times 4\pi \times 10^{-7} \times 20000 \times \pi r^2 \left(\frac{2 - 0}{0.04} \right)$$
$$= 4\pi \times 10^{-7} \times 2 \times 10^6 \times \pi \times \left(2 \times 10^{-2} \right)^2 \times 50$$

Induced current, $I = \dfrac{e}{R}$

$$= \frac{4\pi \times 10^{-7} \times 2 \times 10^6 \times \pi \times \left(2 \times 10^{-2} \right)^2 \times 50}{4}$$
$$= 4\pi^2 \text{ mA}.$$

Question19

An AC generator consists of a coil of 100 turns and is of cross-sectional area 3 m^2. It is rotating at a constant angular speed of 60 rads^{-1} in a uniform magnetic field of 0.04 T. Resistance of the coil is 360Ω. What is the maximum power dissipation in the coil?

AP EAPCET 2021 - 20th August Evening Shift

Options:

A. 720 W

B. 518 W

C. 360 W

D. 100 W

Answer: A

Solution:

Given, number of turns, $n = 100$

Cross-sectional area, $A = 3 \text{ m}^2$

Angular speed, $\omega = 60 \text{rads}^{-1}$

Magnetic field, $B = 0.04 \text{ T}$

Resistance, $R = 360\Omega$

Let, maximum power be P,

Internal resistance, $r = R$

and equivalent resistance $= R_{eq}$

Since, $\text{emf}(\varepsilon) = BnA\omega$

and $P = \varepsilon^2 / R_{eq}$

$$\therefore \quad P = \frac{B^2 n^2 A^2 \omega^2}{2R} (\because \text{ For max. } P, R_{eq} = r + R)$$
$$= \frac{(0.04 \times 100 \times 3 \times 60)^2}{2 \times 360}$$
$$= \frac{720 \times 720}{360 \times 2} = 720 \text{ W}$$

Question20

Assertion (A) Magnetic flux is a vector quantity.

Reason (R) Value of magnetic flux can be positive negative or zero.

AP EAPCET 2021 - 20th August Evening Shift

Options:

A. Both A and R are true and R is a correct explanation for A.

B. Both A and R are true but R is not a correct explanation for A.

C. A is true, R is false.

D. A is false, R is true.

Answer: D

Solution:

Magnetic flux (ϕ) is given by the formula:

$\phi = \mathbf{B} \cdot \mathbf{A} = BA \cos\theta$

Here, B is the magnetic field, and A is the area.

The dot product ($\cdot$) in the formula means that magnetic flux is a scalar quantity, not a vector.

This means magnetic flux does not have a direction, only a size (magnitude).

The value of ϕ depends on the angle θ between the field and the area:

- If $\theta = 0°$, then $\phi = BA$, which is positive.
- If $\theta = 90°$, then $\phi = 0$.
- If $\theta = 180°$, then $\phi = -BA$, which is negative.

So, the Assertion (A) is false because magnetic flux is not a vector.

The Reason (R) is true because the value of magnetic flux can be positive, negative, or zero.

Question21

The induced emf cannot be produced by

AP EAPCET 2021 - 20th August Morning Shift

Options:

A. moving a magnet near a circuit

B. moving a circuit near a magnet

C. changing the current in one circuit placed near the other

D. maintaining large but constant current in a circuit

Answer: D

Solution:

As we know that,

By using Faraday's law, emf induced in coil due torelative motion of coil with field causes increaseand decrease of current continuously.

Thus, emf cannot be produced by maintaininglarge but constant current in a circuit.

Question22

Assertion (A) When plane of coil is perpendicular to magnetic field, magnetic flux linked with the coil is minimum, but induced emf is zero.

Reason (R) $\phi = nAB\cos\theta$ and $e = \frac{d\phi}{dt}$

AP EAPCET 2021 - 20th August Morning Shift

Options:

A. Both A and R are true and R is the correct explanation for A.

B. Both A and R are true but R is not the correct explanation for A.

C. A is true, R is false.

D. A is false, R is true.

Answer: D

Solution:

According to Faraday's second law,

emf $= -\frac{d\phi}{dt}$, i.e. rate of change of flux and flux, $\phi = \mathbf{B} \cdot \mathbf{A} = BA\cos\theta$

where, B is magnetic field.

A is area of cross-section.

$$\therefore \phi = BA \cos 0\Upsilon = BA \Rightarrow \phi_{\max} = BA$$

$\therefore$ Induced emf is not zero.

Therefore, A is false and R is true.

When plane of coil is perpendicular to the magnetic field, then, $\theta = 0\Upsilon$.

Question23

A solenoid of length 60 cm with 15 turns per cm and area of cross-section 4×10^{-3} m^2 completely surrounds another co-axial solenoid of same length and area of cross-section 2×10^{-3} m^2 with 40 turns per cm. Mutual inductance of the system is

AP EAPCET 2021 - 19th August Evening Shift

Options:

A. 9 mH

B. 6 mH

C. 3 mH

D. 10 mH

Answer: A

Solution:

Length of solenoid, $l_1 = 60$ cm $= 60 \times 10^{-2}$ m

Turns per cm (n_1) and (n_2) are 1500 turns/m and 4000 turns/m.

For 1st solenoid, area of cross-section, $A_1 = 4 \times 10^{-3}$ m^2

For 2nd solenoid, area of cross section, $A_2 = 2 \times 10^{-3}$ m^2

$\because$ Mutual inductance is same. (i.e., $M_{12} = M_{21} = M$)

$$\begin{aligned}
\therefore M &= (\mu_0 n_1 n_2 A_2 l) \\
&= 4\pi \times 10^{-7} \times 1500 \times 4000 \times 2 \times 10^{-3} \times 60 \times 10^{-2} \\
&= 9.04 \times 10^{-3} = 9.04\text{mH} \simeq 9\text{mH}
\end{aligned}$$

Question24

An electric generator is based on

AP EAPCET 2021 - 19th August Morning Shift

Options:

A. Faraday's laws of electromagnetic induction

B. Motion of charged particles in an electromagnetic field

C. Fission of uranium by slow neutrons

D. Newton's laws of motion

Answer: A

Solution:

As we know that,According to Faraday's law of electromagneticinduction, when we move a conductor in magneticfield region, there will be induced current in theconductor and the same phenomenon is used incase of electric generator where we find electricalenergy from mechanical energy due to motion ofconductor in magnetic field region.

Question25

Assertion (A) It is more difficult to move amagnet into a coil with more loops.

Reason (R) This is because emf induced ineach current loop resists the motion of themagnet.

AP EAPCET 2021 - 19th August Morning Shift

Options:

A. Both A and R are true and R is a correct explanation for A.

B. Both A and R are true but R is not a correct explanation for A.

C. A is true and R is false.

D. A is false, R is true.

Answer: A

Solution:

As, we know that,

emf induced, $\varepsilon = -\frac{nd\phi}{dt}$

where, ϕ is magnetic flux $\phi = B \cdot A$

n is number of turn

B is magnetic field strength

and A is area of cross-section.

$\therefore \quad \varepsilon = -\frac{nBA\cos\theta}{t}$

$\Rightarrow \quad \varepsilon \propto n$

$\therefore$ If n increases, emf also increases and this back emf resist motion of magnet.Hence, option (a) is correct.

Question26

Two inductors A and B when connected inparallel are equivalent to a single inductor ofinductance 1.5 H and when connected inseries are equivalent to a single inductor ofinductance 8H. Find the difference in theinductances of A and B.

AP EAPCET 2021 - 19th August Morning Shift

Options:

A. 3 H

B. 7.5 H

C. 2 H

D. 4 H

Answer: D

Solution:

Given,

Series equivalent inductance,

$L_{eq_1} = 8H$

Parallel equivalent inductance,

$L_{eq2} = 1.5H = 3/2H$

Let two inductors used here be L_1 and L_2, then

$$L_{eq_1}(\text{ series }) = L_1 + L_2$$
$$\therefore \quad L_{eq_1} = L_1 + L_2 = 8 \quad \ldots\ldots(i)$$
$$\text{and} \quad \frac{1}{L_{eq_2}}(\text{ parallel }) = \frac{1}{L_1} + \frac{1}{L_2} \Rightarrow L_{eq_2} = \frac{L_1 L_2}{L_2 + L_1}$$
$$\Rightarrow \quad \frac{3}{2} = \frac{L_1(8-L_1)}{8} \Rightarrow 12 = 8L_1 - L_1^2$$
$$\Rightarrow \quad L_1^2 - 8L_1 + 12 = 0$$
$$\Rightarrow \quad L_1^2 - 6L_1 - 2L_1 + 12 = 0$$
$$\Rightarrow \quad L_1(L_1 - 6) - 2(L_1 - 6) = 0$$
$$\therefore \quad L_1 = 2H \text{ or } 6H$$
$$\text{and} \quad L_2 = (8-2) \text{ or } (8-6)$$
$$= 6H \text{ or } 2H$$

$\therefore$ Difference between inductances is

$$(L_1 - L_2) \text{ or } (L_2 - L_1) = 6 - 2$$
$$= 4H$$

Question27

The law which states that a variation in anelectric field causes magnetic field, is

AP EAPCET 2021 - 19th August Morning Shift

Options:

A. Faraday's law

B. Bio-Savart law

C. Modified Ampere's law

D. Lenz's law

Answer: C

Solution:

According to modified Ampere's law or Maxwell-Ampere's law,

$\nabla \times B = \propto_0 (J + \varepsilon_0 dE/dt)$

where, B is magnetic field,

J is current density

and ε_0 is free-space permittivity.