IMPORTANT QUESTIONS CLASS – 12 PHYSICS CHAPTER – 6 ELECTROMAGNETIC INDUCTION

1. IF the rate of change of current of 2A/s induces an emf of 10mV in a solenoid. What is the self-inductance of the solenoid?
Ans.

$$L = \frac{\in}{dI/dt} = \frac{10\times10^{-3}}{2} = 5\times10^{-3}\,Henry$$

$\Rightarrow \ L = 5\times10^{-3}\,H$

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2. A circular copper disc. 10 cm in radius rotates at a speed of 2 rad/s about an axis through its centre and perpendicular to the disc. A uniform magnetic field of 0.2T acts perpendicular to the disc.
1) Calculate the potential difference developed between the axis of the disc and the rim.
2) What is the induced current if the resistant of the disc is 2?
Ans. (1) Radius = 10cm, B = 0.2T w = 2 π rad/s

$\in = \frac{1}{2}Bwr^2$

$$\in = \frac{1}{2}\times0.2\times2\pi\times(0.1)^2$$

$$\in = 0.00628\ volts$$

$$I = \frac{\in}{R} = \frac{0.0628}{2}$$

I = 0.0314 A

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3. An ideal inductor consumes no electric power in a.c. circuit. Explain?
Ans. P = E rms I rms cos ϕ

But for an ideal inductor $\phi = \frac{\pi}{2}$

$$\Rightarrow \cos\phi = \cos\frac{\pi}{2} = 0$$

$\Rightarrow$ P=0

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4. Capacitor blocks d.c. why?
Ans. The capacitive reactance

$$X_C = \frac{1}{wC} = \frac{1}{2\pi Vc}$$

For d.c. $\upsilon = 0$
$\Rightarrow X_C = \infty$
Since capacitor offers infinite resistance to the flow of d.c. so d.c. cannot pass through the capacitor.

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5. Why is the emf zero, when maximum number of magnetic lines of force pass through the coil?
Ans. The magnetic flux will be maximum in the vertical position of the coil. But as the coil rotates $\frac{d\phi}{dt} = 0$
Hence produced emf $\in = \frac{d\phi}{dt} = 0$

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6. An inductor L of reactance is connected in series with a bulb B to an a.c. source as shown in the figure.

Briefly explain how does the brightness of the bulb change when
(a) Number of turns of the inductor is reduced.
(b) A capacitor of reactance is included in series in the same circuit.
Ans. (a) Since Z = $\sqrt{R^2 + X_L^2}$
When number of turns of the inductor gets reduced X_L and Z decreases and in turn current increases
Hence the bulb will grow more brightly
(b) When capacitor is included in the circuit

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

But $X_L = X_C$ (given)
$\Rightarrow$ Z = R (minimum)
Hence brightness of the bulb will become maximum.

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7. A jet plane is travelling towards west at a speed of 1800 km/h. What is the voltage difference developed between the ends of the wing having a span of 25 m, if the Earth's magnetic field at the location has a magnitude of and the dip angle is
Ans. Speed of the jet plane, υ = 1800 km/h = 500 m/s
Wing span of jet plane, l = 25 m
Earth's magnetic field strength, B = $5.0 \times 10^{-4}\ T$

Angle of dip, $\delta = 30^0$ s
Vertical component of Earth's magnetic field,
$BV = B \sin \delta$
= $5\times10-4\ sin30°$
= $2.5\times10-4\ T$
Voltage difference between the ends of the wing can be calculated as:
$e = (B_v) \times l \times v$
= $2.5 \times 10^{-4} \times 25 \times 500$
= 3.125 V
Hence, the voltage difference developed between the ends of the wings is
3.125 V.

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8. A pair of adjacent coils has a mutual inductance of 1.5 H. If the current in one coil changes from 0 to 20 A in 0.5 s, what is the change of flux linkage with the other coil?
Ans. Mutual inductance of a pair of coils, μ = 1.5 H
Initial current, I_1 = 0 A
Final current I_2 = 20 A $dI = I_2 - I_1 = 20 - 0 = 20A$
Change in current,
Time taken for the change, t = 0.5 s
Induced emf,
Where $d\phi$ is the change in the flux linkages with the coil. $e = \frac{d\phi}{dt}$ ...(i)
Emf is related with mutual inductance as:
Equating equations (1) and (2), we get
$\frac{d\phi}{dt} = \mu \frac{dI}{dt}$
$d\phi = 1.5 \times (20)$
$= 30Wb$
Hence, the change in the flux linkage is 30 Wb.

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9. A horizontal straight wire 10 m long extending from east to west is falling with a speed of , at right angles to the horizontal component of the earth's magnetic field, Wb .
(a) What is the instantaneous value of the emf induced in the wire?
(b) What is the direction of the emf?
(c) Which end of the wire is at the higher electrical potential?
Ans. Length of the wire, l = 10 m
Falling speed of the wire, v = 5.0 m/s
Magnetic field strength, B =

(a) Emf induced in the wire,
$e = Blv$

$0.3 \times 10^{-4}\ Wb\ m^{-2}$

$= 0.3 \times 10^{-4} \times 5 \times 10$

$= 1.5 \times 10^{-3} V$

(b) Using Fleming's right hand rule, its can be inferred that the direction of the induced emf is from West to East.
(c) The eastern end of the wire is at a higher potential.

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10. A 1.0 m long metallic rod is rotated with an angular frequency of 400 rad about an axis normal to the rod passing through its one end. The other end of the rod is in contact with a circular metallic ring. A constant and uniform magnetic field of 0.5 T parallel to the axis exists everywhere. Calculate the emf developed between the centre and the ring.

Ans. Length of the rod, l = 1 m
Angular frequency, ω = 400 rad/s
Magnetic field strength, B = 0.5 T
One end of the rod has zero linear velocity, while the other end has a linear velocity of $l_{(i)}$.
Average linear velocity of the rod,
Emf developed between the centre and the ring,

$$v = \frac{1_{(i)} + 0}{2} = \frac{l_{(i)}}{2}$$

Hence, the emf developed between the centre and the ring is 100 V.

$$e = Blv = Bl\left(\frac{l_{(i)}}{2}\right) = \frac{Bl^2(i)}{2}$$

$$= \frac{0.5 \times (1)^2 \times 400}{2} = 100V$$