

6. Electromagnetic Induction

Self-Assessment

Module 1: Faraday's laws of Electromagnetic Induction

Q.6.1.1 If the magnetic field through a coil in the form of a square is tripled and the sides of the square are increased by 1.5 fold, then the factor by which flux changes is equal to .

- (A) 27
- (B) 9
- (C) $27/2$
- (D) $27/4$

Q.6.1.2 A coil is placed perpendicular to the direction of a uniform magnetic field. Find the factor by which the flux through the coil changes when the plane of the coil is turned through 60°

- (A) $\frac{1}{2}$
- (B) $\frac{1}{3}$
- (C) $\frac{1}{\sqrt{2}}$
- (D) $\frac{\sqrt{2}}{3}$

Q.6.1.3 A closed coil having a resistance R and area A is placed normally to a magnetic field B . It is turned through 180° in 1 second. Find the instantaneous current that flows through the coil during this time.

- (A) $\frac{BA}{R}$
- (B) $\frac{2BA}{R}$
- (C) $\frac{1}{2} \frac{BA}{R}$
- (D) Zero

Q.6.1.4 volt/weber has the dimension same as that of



- (A) Time
- (B) Square of time
- (C) Reciprocal of time
- (D) Square root of time

Q.6.1.5 $\left\{ \left(\frac{\text{weber}}{\text{tesla}} \right)^{\frac{1}{2}} (\text{Frequency}) \right\}$ has the same dimension as that of

- (A) Angular velocity of a particle executing uniform circular motion
- (B) Relative velocity of two bodies
- (C) Angular acceleration of a motion
- (D) Acceleration due to gravity

Q.6.1.6 A square loop of side l and resistance, R is placed in a vertical plane. A uniform magnetic field B is set up across the plane such that the angle between the direction of the field and the normal to plane is ϕ . The strength of the magnetic field is reduced to half its original value at a steady rate in time t . Find the magnitude of the induced current.

- (A) $\frac{Bl^2 \sin \phi}{Rt}$
- (B) $\frac{Bl^2 \sin \phi}{2Rt}$
- (C) $\frac{Bl^2 \cos \phi}{Rt}$
- (D) $\frac{Bl^2 \cos \phi}{2Rt}$

Q.6.1.7 If the dimension of current is A, the dimension of magnetic flux will be

- (A) $ML^2 T^{-1} A$
- (B) $MLT^{-2} A^{-1}$
- (C) $ML^2 T^{-2} A^{-1}$
- (D) $ML^{-1} T^2 A$

Q.6.1.8 If the dimension of current is A, the dimension of induced emf is

- (A) $ML^2T^{-3}A^{-1}$
- (B) $ML^3T^{-2}A^{-1}$
- (C) $ML^2T^{-3}A$
- (D) $ML^3T^{-2}A$

Stem for 6.1. 9/10/11.

A rectangular loop of sides a and b ($a > b$) with a small cut moving out of a region of uniform magnetic field B perpendicular to the plane of the loop. You have to find the emf developed across the cut if the magnitude of the velocity of the loop is v

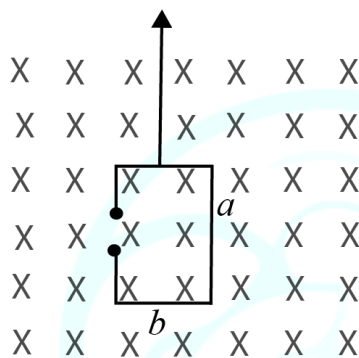


Fig.6.1.1

Q.6.1.9 When the direction of the velocity is normal to the longer side (Fig.6.1.1).

- (A) Bva
- (B) Bvb
- (C) $\frac{1}{2}Bva$
- (D) $\frac{1}{2}Bvb$

Q.6.1.10 When the direction of the velocity is normal to the shorter side.

- (A) Bva
- (B) Bvb
- (C) $Bvb\sqrt{a^2 + b^2}$
- (D) $\frac{1}{2}Bv\sqrt{a^2 + b^2}$

Q.6.1.11 How long does the induced voltage last in cases of Q.6.1.9 and Q.6.1.10 respectively?

- (A) $\frac{a}{v}$ and $\frac{b}{v}$
- (B) $\frac{b}{v}$ and $\frac{a}{v}$
- (C) $\sqrt{\frac{a^2+b^2}{v}}$ in each case
- (D) $\frac{1}{2}\sqrt{\frac{a^2+b^2}{v}}$ in each case

Module 2 : Lenz's Law and Eddy Currents

Q.6.2.1 Electric current in the wire is flowing from left to right. If this current increases, the direction of induced currents in the coil A & B will respectively be (Fig.6.2.1)

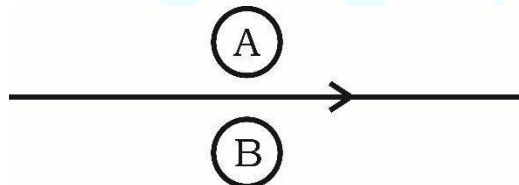


Fig.6.2.1

- (A) Clockwise in A and anticlockwise in B
- (B) Anticlockwise in A and in clockwise B
- (C) Clockwise in A and B both
- (D) Anticlockwise in A and B both

Q.6.2.2 Electric current flowing in the wire is decreasing, the induced current in the coil (Fig.6.2.2):

- (A) Will be clockwise
- (B) Will be anticlockwise
- (C) Will change direction alternately between clockwise and anticlockwise
- (D) Will be absent

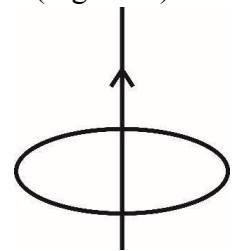


Fig.6.2.2

Q.6.2.3 An irregular loop of wire is turned into a circular loop as shown schematically in the Fig.6.2.3 The current induced in the wire will be:

- (A) Anticlockwise
- (B) Clockwise
- (C) Alternating current
- (D) Absent

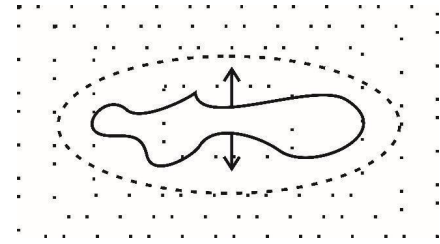


Fig.6.2.3

Q.6.2.4 Two coils 'abcd' and 'pqrs' are being drawn out of a uniform inward magnetic field (Fig.6.2.4) with velocity v . The direction of induced current in the coils will respectively be:

- (A) abcd and pqrs
- (B) dcba and pqrs
- (C) abcd and srqp
- (D) adcb and rqps

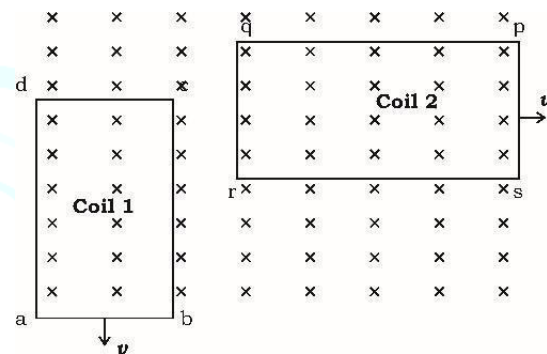


Fig.6.2.4

Q.6.2.5 A metal rod PQ rests on the smooth metal rails M and N which are placed in a uniform upward magnetic field (Fig.6.2.5). A capacitor 'C' is connected between two left ends of the rails. If the metal rod PQ is moved towards right with velocity ' v ' then the polarities on the plates of capacitor will be:

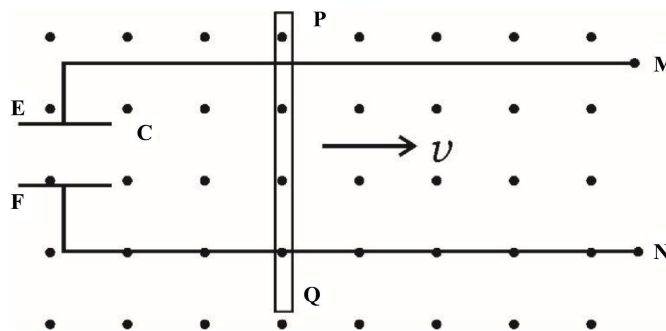


Fig.6.2.5

- (A) Positive on E and F both
- (B) Positive on E and negative on F
- (C) Positive on F and negative on E

(D) Negative on E and F both

Q.6.2.6 The direction of current induced in coil 2 when key 'K' in coil 1 is just pressed, kept pressed and released respectively:

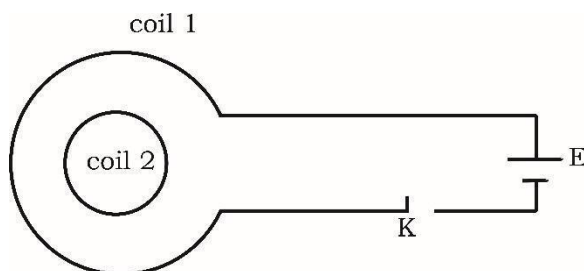


Fig.6.2.6

- (A) Clockwise, No current induced, Anticlockwise
- (B) Anticlockwise, No current induced, Clockwise
- (C) No current induced, clockwise, Anticlockwise
- (D) No current induced, Anticlockwise, Clockwise

Q.6.2.7 A bar magnet falls through a coil in which a cut is provided. The direction of induced current in the coil will be:

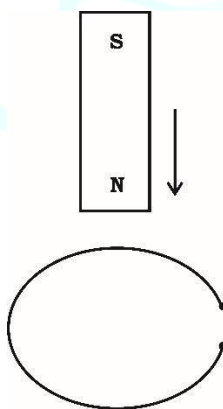


Fig.6.2.7

- (A) Clockwise
- (B) Anticlockwise when magnet approaches & clockwise, when magnet recedes away from the coil
- (C) Clockwise, when magnet approaches, Anticlockwise when magnet recedes away from the coil
- (D) No current induced

Q.6.2.8 The direction of current induced in coil 1 and coil 2 will respectively be:

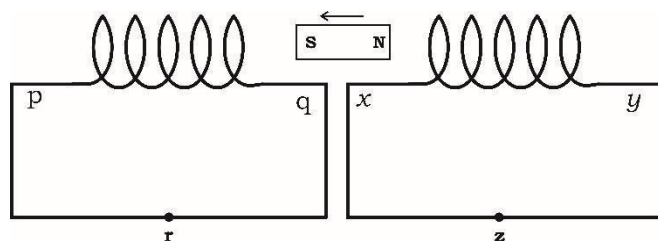


Fig.6.2.8

- (A) prq and xyz
- (B) prq and yzx
- (C) qrp and xzy
- (D) qrp and yzx

Q.6.2.9 Which of the following is not based on the application of eddy currents.

- (A) Induction furnace
- (B) Brakes of train
- (C) Induction stove
- (D) Microwave oven

Q.6.2.10 Three bar magnets fall through three pipes as shown in Fig.6.2.9. The acceleration of magnets while falling through the pipes are g_1 , g_2 & g_3 respectively. The relation between g_1 , g_2 and g_3 will be

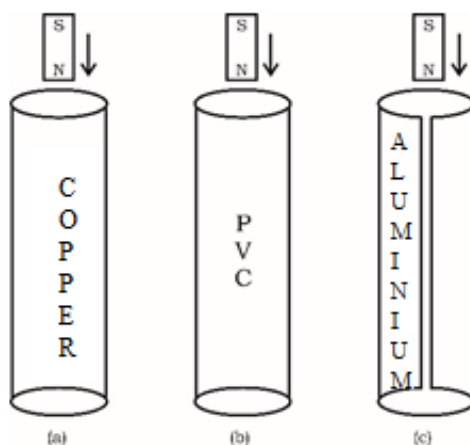


Fig.6.2.9

- (A) $g_1 = g_2 = g_3$
- (B) $g_1 > g_2 > g_3$
- (C) $g_1 < g_3 < g_2$
- (D) $g_1 > g_3 > g_2$

Q.6.2.11 Three identical spherical magnets M_1 , M_2 and M_3 are suspended with the help of a string from the rigid support as shown in figure and three similar discs made up of iron, wood and iron (slotted) respectively are placed just below each magnet. If the magnets are allowed to oscillate by giving small angular displacement then the relation between their time periods will be

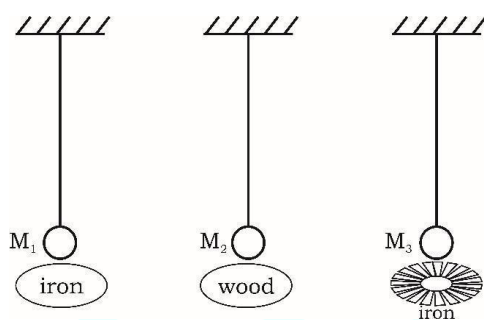


Fig.6.2.10

- (A) $T_1 = T_2 = T_3$
- (B) $T_1 < T_2 < T_3$
- (C) $T_2 > T_3 > T_1$
- (D) $T_2 < T_3 < T_1$

Module 3 : Mutual Inductance and Self-Inductance

Q.6.3.1 If A is the dimension of current, what is the dimensional formula of self-inductance?

- (A) $ML^2T^{-1}A^{-1}$
- (B) $MLT^{-2}A^{-2}$
- (C) $ML^2T^{-2}A^{-2}$

(D) $ML^2T^{-2}A^{-1}$

Q.6.3.2 $\frac{\text{henry}}{\text{ohm}} =$

- (A) metre
- (B) $(\text{metre})^{-1}$
- (C) $(\text{sec})^{-1}$
- (D) sec

Q.6.3.3 Current in a circuit falls from 3.0 A to 0.0 A in 0.02 s. If an average emf of 150 V is induced, give an estimate of the self-inductance of the circuit.

- (A) 0.1 H
- (B) 1 H
- (C) 1.5 H
- (D) 2 H

Q.6.3.4 A pair of adjacent coils has a mutual inductance of 2 H. If the current in one coil changes from 10 A to 20 A in 1 s, what is the magnitude of e.m.f getting linked with the other coil?

- (A) 0.5 V
- (B) 1 V
- (C) 10 V
- (D) 20 V

Q.6.3.5 Find the mutual inductance between a long straight wire and a square loop of side 4 cm as shown in the Fig.6.3.1. Take $\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$

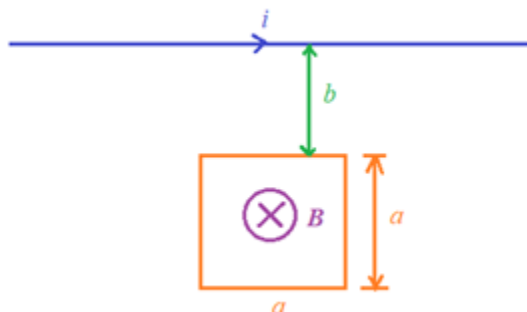


Fig.6.3.1

(A) $2 \ln \frac{3}{2} \times 10^{-9} \text{ H}$

(B) $\ln \frac{3}{2} \times 10^{-8} \text{ H}$

(C) $2 \ln \frac{3}{2} \times 10^{-7} \text{ H}$

(D) $\ln \frac{3}{2} \times 10^{-7} \text{ H}$

Q.6.3.6 Two self inductances 12 mH and 3 mH are connected in series. What will be the effective value of the self inductance of the combination?

(A) 2.4 mH

(B) 6 mH

(C) 9 mH

(D) 15 mH

Q.6.3.7 Two self-inductances 10 H and 5 H are connected in parallel. What is the effective value of the self-inductance of the combination?

(A) 3.33 H

(B) 5 H

(C) 7.05 H

(D) 15 H

Q.6.3.8 A rectangular coil of area 2 m^2 having 50 turns is rotated between the poles of a magnet, producing a uniform magnetic field 2 Wm^{-2} , at the rate of 1200 revolutions per min. Find an expression of the magnitude of emf induced (in volts) in terms of time t .

- (A) $2000 \pi \sin 60\pi t$
- (B) $2400 \pi \sin 60\pi t$
- (C) $4000 \pi \sin 40\pi t$
- (D) $8000 \pi \sin 40\pi t$

Q.6.3.9 Current in a circuit having a battery of emf, 1 V a resistor, 1 ohm and an inductor, 1 H at a time t after switching on the circuit is given by $i = 1 - e^{-t}$.

Find the time in which the current reaches within 1% of its final steady value.

- (A) 2.3 s
- (B) 4.6 s
- (C) $\ln \frac{100}{99}$ s
- (D) $\ln \frac{200}{99}$ s

Q.6.3.10 The mechanical analogue of inductance is

- (A) displacement
- (B) velocity
- (C) mass
- (D) linear momentum

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