

Electro magnetic

Induction

DP - Notes - By - Dipak Pandey - PHP - AbhyasGuru.com

→ Magnetic flux $\Phi_B = \vec{B} \cdot \vec{A} = BA \cos \theta$; θ is angle between \vec{B} and \vec{A} .

→ Faraday's law of induction: Emf induced in a coil is directly proportional to rate of change of flux linked to coil.

$$\mathcal{E} = -N \frac{d\Phi_B}{dt} ; N = \text{number of turns.}$$

→ Lenz's law: Polarity or direction of induced emf or current is such that it always opposes the cause that produces it.
It opposes change in magnetic flux.

→ Motional electromotive force due to translatory motion : $\mathcal{E} = BLv$; $I = \frac{BLv}{R}$

→ Motional electromotive force due to rotational motion : $\mathcal{E} = \frac{B\omega l^2}{2} = Bl^2\pi\nu = \frac{Bl^2\pi}{T}$

ν = frequency ; T = Time period

→ Inductance: Flux linkage of coil having N turns is directly proportional to current
constant of this proportionality is called inductance $N\Phi_B \propto I$

Also Ratio of Flux linkage to current $\frac{N\Phi_B}{I}$ is called inductance

→ Mutual Inductance: Phenomenon of generating induce emf in secondary coil when current linked with primary coil changes.

$$N_2 \Phi_2 = M I_1 ; N_2 I_2 = \text{flux linked with secondary coil}$$

I_1 = current in primary coil
 M = Mutual Induction between 2 coil

— As per Faraday's law, $e = -M \frac{dI}{dt}$

— Mutual Inductance of long solenoid

$$M = \mu_0 n_1 n_2 \pi r_1^2 l$$

→ Self inductance: Phenomenon of production of induced emf in a coil when current passes thru it undergoes changes.

$$N\phi = LI$$

- As per Faraday's law induced emf $\mathcal{E} = -L \frac{dI}{dt}$

- Self inductance of long solenoid $L = \mu_0 n^2 AL$ → for air or
 $L = \mu_0 \mu_r n^2 AL$ → for any material.

→ Current flowing simultaneously in 2 nearby coil

$$\mathcal{E}_1 = -L_1 \frac{dI_1}{dt} - M_2 \frac{dI_2}{dt}$$

→ Energy required to build current I $W = \frac{1}{2} LI^2$; analogous to $\frac{1}{2} mv^2$

→ Magnetic energy stored in solenoid $U_B = \frac{1}{2\mu_0} B^2 AL$

→ When coil is rotated in magnetic field induced emf is (AC generator)

$$e = NBA\omega \sin \omega t ; e_0 = e_0 \sin \omega t ; \mathcal{E}_0 = NBA\omega \rightarrow \text{max value}$$

$$e = e_0 \sin 2\pi \nu t ; \nu = \text{frequency} ; \omega = 2\pi \nu$$