ELECTROMAGNETIC INDUCTION

Magnetic flux :-

→ Total no° of magnetic line of forces, crossing the surface perpendicularly.

$$\phi = BA\cos\theta$$

θ = L b/w $\vec{A}$ and $\vec{B}$

SI unit = Weber.

Electromgnetic Ind :-

→ Induced EMF production due to change of $\vec{B}$ flux linked with a circuit, is called EMI.

LAWS OF EMI :-

First = EMI is only induced when ϕ linked to it changes constantly else it won't be induced.

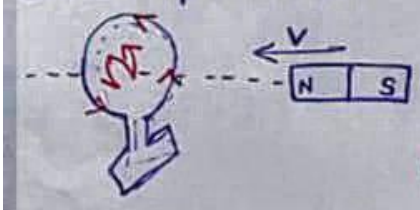
Second :- magnitude of EMF is proportional to change in flux.

$$|e| = \frac{-d\phi}{dt} \qquad e = -N\frac{d\phi}{dt}$$

-ve sign in emf indicates the dirn of induced emf such that it opposes its cause.

Lenz's Law :-

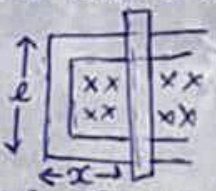
→ direction of induced current in a circuit, it opposes the cause which produce it.



Motional EMF :-

→ EMF induced across the end of a conductor due to its motion in $\vec{B}$ is called motional EMF.

$$\mathcal{E} = Blv$$



→ v (velocity) in direction of decreasing 'x'.

Fleming Right Rule :-



LORENTZ FORCE & EMF :-

$$I = \frac{Blv}{R}, \quad P = \frac{B^2l^2v^2}{R}$$

$$F = \frac{B^2l^2v}{R}$$

Method of generating EMF:

→ By changing $\vec{B}$.

→ By changing the Rod/area of the coil.

→ By change the θ b/w $\vec{A}$ and $\vec{B}$.

$$\mathcal{E} = \mathcal{E}_0 \sin\omega t$$

$$\mathcal{E}_0 = NBA\omega$$

$$\omega = 2\pi f$$

Eddy currents :-

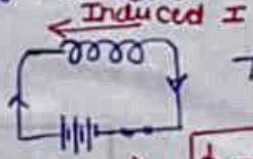
→ current induced in solid metallic masses when ϕ_B changes.

(*) Application :-

Furnace, train Break, Speedometers, Induction motor

SELF INDUCTION :-

→ The phenomenon of induced EMF in a coil while changing current. When a passes through it, is called self induction.



$$T = \frac{L}{R}$$

$\phi \propto I \Rightarrow \phi = LI$

$$\mathcal{E} = -L\frac{dI}{dt}$$

L → Henery (SI unit)

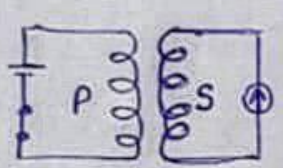
$$L = 4\pi n^2 l A$$

n = Turn density $\Rightarrow \frac{N}{l}$ (N = No° of turns)

$$\left\{ r_{avg} = \frac{r_1 + r_2}{2} \right\}$$

MUTUAL INDUCTANCE :-

→ Phenomenon of production of induced emf in one coil due to a change of current in the neighbouring coil. called mutual Inductance.



$$\phi = MI$$

$$\mathcal{E} = -M\frac{dI}{dt}$$

$$M = \frac{\mu_0 N_1 N_2 A}{l}$$

$M_{12} = M_{21} = M$

1 wrt 2 or 2 wrt 1