Q State and explain Faraday's laws of electromagnetic Induction.

Ans:

Faraday's laws of Electromagnetic Induction:-

Michael Faraday, an English physicist stated two laws of electromagnetic induction on the basis of experiments he performed.

(i) First law:-

Whenever the flux (the number of magnetic lines of force) linking with a coil or circuit changes, an e.m.f gets induced in that coil or circuit.

- The e.m.f exists as long as magnetic flux changes.

(ii) Second law:

The magnitude of the induced e.m.f is directly proportional to the rate of change of [flux linkages (flux x turns of coil) (magnetic flux)]

Consider a coil having N turns

~~The flux linking with coil is ϕ per turn.~~

~~So total linked flux with coil = $N\phi$~~

The initial flux ~~linking~~ linking with a coil is ϕ

∴ Initial flux linkages = $N\phi_1$

For time interval t, the flux linking with the coil changes from ϕ_1 to ϕ_2

∴ Final Flux linkages $= N\phi_2$

∴ Rate of change of flux linkages

$$= \frac{N\phi_2 - N\phi_1}{t}$$

As per second law the magnitude of induced e.m.f

$$e \propto \frac{N\phi_2 - N\phi_1}{t}$$

$$e = k \times \frac{(N\phi_2 - N\phi_1)}{t} = k\frac{N(\phi_2 - \phi_1)}{t}$$

$$e = k N \frac{d\phi}{dt}$$

Where k as unity to get units of e as volts

$$\boxed{e = N \frac{d\phi}{dt}}$$

As per Lenz's law, the induced emf sets up a current in such a direction so as to produce the very cause producing it. Mathematically this opposition is expressed by a negative sign. Therefore such an induced e.m.f is mathematically expressed along with its sign as

$$\boxed{e = -N \, d\phi/dt \text{ volts}}$$