Magnetic flux:

$\phi_B = B \cdot A = BA\cos\theta$

Where, θ is the angle between B and A

Units:

SI unit is weber (Wb)

1 Wb = 1T × 1 m^2

Cgs unit is maxwell (Mx)

1 Mx = 1 G × 1 cm^2

1 Wb = 10^8 Mx

Faraday's law:

A changing magnetic flux linked with a circuit induces an emf, and consequently, a current is induced in the circuit.

$$\varepsilon = -N\frac{d\phi_B}{dt}$$

Where,

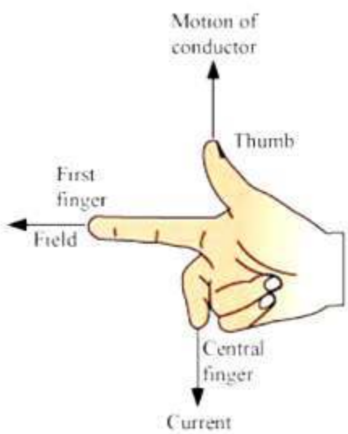
$\varepsilon \rightarrow$ Induced emf

$N \rightarrow$ Number of turns in the coil

$\phi_B \rightarrow$ Flux linked with one turn of the coil

Lenz's law: The polarity of the induced emf is such that it tends to produce a current which opposes the change in magnetic flux that produces it.

The direction of the induced current/induced emf can be found by using **Fleming's right hand rule**



When a straight conductor of length l moves with a constant velocity v in a magnetic field B, the induced emf $E = Blv$, when B, l and v are mutually perpendicular.

Eddy currents → Currents induced in a thick conductor when the conductor is placed in a changing magnetic field

Self-induction → It is the phenomenon of production of opposing induced emf in a coil, as a result of varying current in the coil itself.

Induced emf, $E = -L\frac{dI}{dt}$

Where, L is self inductance of the coil

- Self inductance of a plane coil:

  $L = \frac{\mu_0 \pi N^2 r}{2}$,

  Where.

  N → Number of turns in the coil

  r → Radius of the coil

- Self-inductance of a solenoid:

  $L = \mu_0 n^2 Al$

  Where,

  A → Cross-sectional area A of the solenoid

  l → Length of the solenoid

  n → Number of turns per unit length of the solenoid

Energy stored in an inductor:

$W = \frac{1}{2}LI_0^2$

Mutual induction: It is the phenomenon of production of induced emf in one coil, due to varying current in the neighbouring coil.

Induced emf, $E = -M\frac{dI}{dt}$

Where, M is mutual inductance of the coil

- Mutual inductance of two long solenoids:

$M = \frac{\mu_0 N_p N_s A}{l}$

Where,

N_p → Number of turns in the primary coil

N_s → Number of turns in the secondary coil

A → Cross-sectional area of the solenoid

l → Length of the solenoid

If the cross-sectional areas of two co-axial solenoids are different, then the cross-sectional area of the inner solenoid is to be considered in the numerical calculation of mutual inductance.

If the lengths of the two co-axial solenoids are different, then the length of the bigger solenoid is to be considered in the numerical calculation of mutual inductance.

- Mutual inductance of two plane coils:

$$M = \frac{\mu_0 N_p N_s}{2r_p} A$$

Where,

$N_p \rightarrow$ Number of turns in the primary coil

$N_s \rightarrow$ Number of turns in the secondary coil

$r_p \rightarrow$ Radius of the primary coil

$A \rightarrow$ Cross-sectional area of secondary coil

In an **AC generator**, mechanical energy is converted into electrical energy by virtue of electromagnetic induction. If a coil of N turns and area A is rotated at revolutions per second in a uniform magnetic field B, then the motional emf produced is

$$\varepsilon = NBA\ 2\pi\nu\ \sin\ 2\pi\nu t$$

Where, we have assumed that at $t = 0$ s, the coil is perpendicular to the field