1) # HALL EFFECT

★ Also called Galvanomagnetic Effect Sensor

★ Observed in metals and Semiconductors

★ when a magnetic field is applied at right angles to the current flow in a thin film where an electric field is generated. It is Hall Effect

★ Hall voltage can be given by,

$$V_H \approx B_z I_x$$

★ Lorentz force is the force exerted on a charged particle q moving with velocity v through an electric Field E and magnetic field B

$$f = eE + e[v \times B] \longrightarrow (1)$$

e → charge carrier

E → Electric field

B → Magnetic Induction

v → carrier velocity

→ $I = I_0$ and $B = 0$,

$$I = I_0 + \mu_H (I_0 \times B) \longrightarrow (2)$$

where I_0 → current density due to Electric field

μ_H → Hall mobility

I → Total current density

$$I_0 = \sigma C - eD\Delta n \longrightarrow (3)$$

where σ = conductivity

D = Diffussion Coefficient

Δn = carrier concentration

★ Hall mobility μ_H is the product of drift mobility of carrier μ and hall scattering factor r.

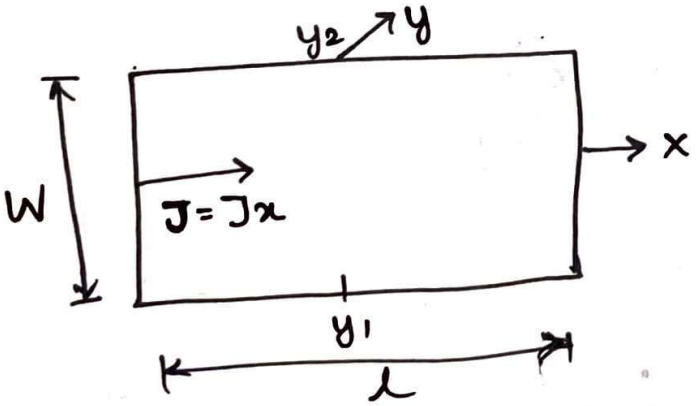
$$\mu_H = r\mu$$

$$r = \frac{[\tau^2]}{[\tau]^2}$$

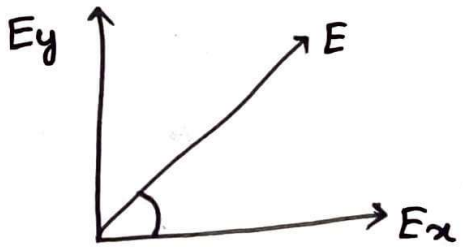
$r = 1$ for semiconductor / metals

$r = 1.93$ for ionized impurities

$r = 1.18$ for phonons



$$E_y = -\mu_H B = E_x$$



Transverse voltage called Hall Voltage V_H is given by,

$$V_H = \int_{y_2}^{y_1} E_H \, dy = -\mu_H B_z E_x W \quad \text{—— (4)}$$

The Effect leading to this phenomena called Hall Effect.

$$\tan\theta_h = \frac{E_y}{E_z} = -\mu_H B_z \longrightarrow (5)$$

Hall Coefficient h_c is defined as,

$$h_c = \frac{-E_H}{I \times B}$$

$$h_c = \frac{-E_y}{I_x \times B_z} = \frac{\mu_n E_x}{I_x}$$

$$I_x = \sigma E_x \text{ and } \sigma = e\mu_n$$

$$h = \frac{r}{en}$$

Hall voltage can be expressed in terms of Hall coefficient h_c.

$$V_H = -h_c J_x B_z W$$

$$h_c = \frac{1}{e} \frac{r_p n_p - r_n n_n (\mu_n/\mu_p)^2}{(n_p + n_n (\mu_n/\mu_p)^2)}$$

$$n_i^2 = AT^{3/2} \exp\left[\frac{-E_g}{2kT}\right]$$

A → coefficient
T → Absolute Temperature
K → Boltzman constant