18ECO134T – Sensors and Transducers

Unit IV : Session 3 : SLO 1

Hall effect

- Its also called as Galvanomagnetic effect sensor.

- Observed in metals and semiconductors.

- When a current is sent through a very long strip of extrinsic homogenous semiconductor in the x direction and across the plane xy perpendicular to it, a magnetic field is applied to produce a flux density Bz, then an electric field Ey in the direction of y is produced which is called Hall field.

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- With electrodes across the strip in y direction, a voltage VH called the Hall voltage, can be collected with approximately is given by

$$V_H \approx B_z I_x \tag{4.33}$$

- Galvanomagnetic effects, arise because of Lorentz force on the charge carrier transport phenomena in condensed medium. Lorentz force is

$$\mathbf{F} = e\mathbf{E} + e[\mathbf{v} \times \mathbf{B}] \tag{4.34}$$

where

e is the charge of the carrier,
E is the electrical field,
v is carrier velocity, and
B is the magnetic induction.

If **J** is the total current density, then the carrier transport equation is

Cont…

- μH – Hall mobility
- Jo- current density due to electric field E
- Carrier concentration Δn
- A magnetic field also affect the electric field potential and carrier concentration and hence it is not justified to write J=J0 and B=0

$$\mathbf{J} = \mathbf{J}_0 + \mu_H[\mathbf{J}_0 \times \mathbf{B}] \qquad (4.35)$$

Cont…

- σ- conductivity
- D – diffusion coefficient

$$J_0 = \sigma E - eD\nabla n \tag{4.36}$$

- Drift – Ist term, Diffusion –IInd term, transverse transport caused by magnetic field – IInd term of eq. 4.35

Cont…

- The transport coefficients μH, σ, D are dependent on electric and magnetic field and are determined by carrier scattering process.
- Hall mobility μH is the product of drift mobility of the carrier μ and hall scattering factor r, which is given by appropriate ratio of relaxation time averages of their energy distribution, thus

$$r = \frac{\langle \tau^2 \rangle}{\langle \tau \rangle^2} \qquad (4.37a)$$

$$\mu_H = r\mu \qquad (4.37b)$$