❖ **Hall effect:** In 1879 E. H. Hall observed that when a sample is placed in a magnetic field and a current passes through the sample perpendicular to the applied magnetic field then there will be a potential difference proportional to the current and to the applied magnetic field developed across the material in a direction perpendicular to both the current and to the magnetic field. This effect is known as the Hall effect.

With the measurements, Hall was able to determine for the first time the sign of charge carriers in a conductor. Even today, Hall Effect measurements continue to be a useful technique for characterizing the electrical transport properties of metals and semiconductors.

Consider a conducting slab as shown in Figure 8 with length *L* in the *X* direction, width *W* in the *Y* direction and thickness *t* in the *Z* direction.

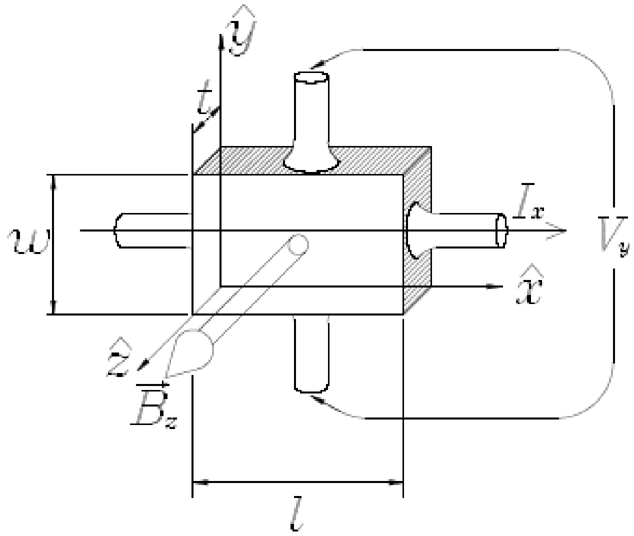

Figure: Geometry of fields and samples in Hall Effect Experiment.

Let *q* be the charge of the charge carrier, *n* be the charge carrier density, and charge carrier drift velocity v_x when a current I_x flows in the positive x direction.

Therefore, $I_x = J_x wt = nqv_x wt$ ………… (1)

According to Ohm's law,

$$J_x = \sigma E_x \quad \text{………….. (2)}$$

Where, E_x is the electric field along X direction due to the application of electric current along X-direction. σ is the electrical conductivity of the material.

The charge carrier will experience a Lorentz force due to the acting of magnetic field B_Z

$$F_B = qv_x B_z$$

Due to the Lorentz force, the charge carrier will deflect towards on side of the slab. The result of this deflection is to cause an accumulation of charges along one side of the slab which creates a transverse electric field E_y along y direction that counteracts the force of the magnetic field.

In steady state, the electric force and Lorentz force is balanced

Therefore, $$qE_y = qv_xB_z$$

$$E_y = v_xB_z \qquad \ldots\ldots\ldots\ldots\ldots \quad (3)$$

E_y is called Hall field,

The Hall voltage which is related to the Hall field can be expressed as

$$V_H = -\int_0^w E_y dy = -E_y w \qquad \ldots\ldots\ldots\ldots\ldots \quad (4)$$

Thus from equation (1), (3) and (4) , we obtain

$$V_H = -\frac{1}{nq}\frac{I_xB_Z}{t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \; (5)$$

$$R_H = \frac{1}{nq} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \; (6)$$

It is positive if the charge carriers are positive, and negative if the charge carriers are negative. In practice, the polarity of V_H determines the sign of the charge carriers. The SI units of the Hall coefficient are [m^3/C] or more commonly stated [m^3/A-s].