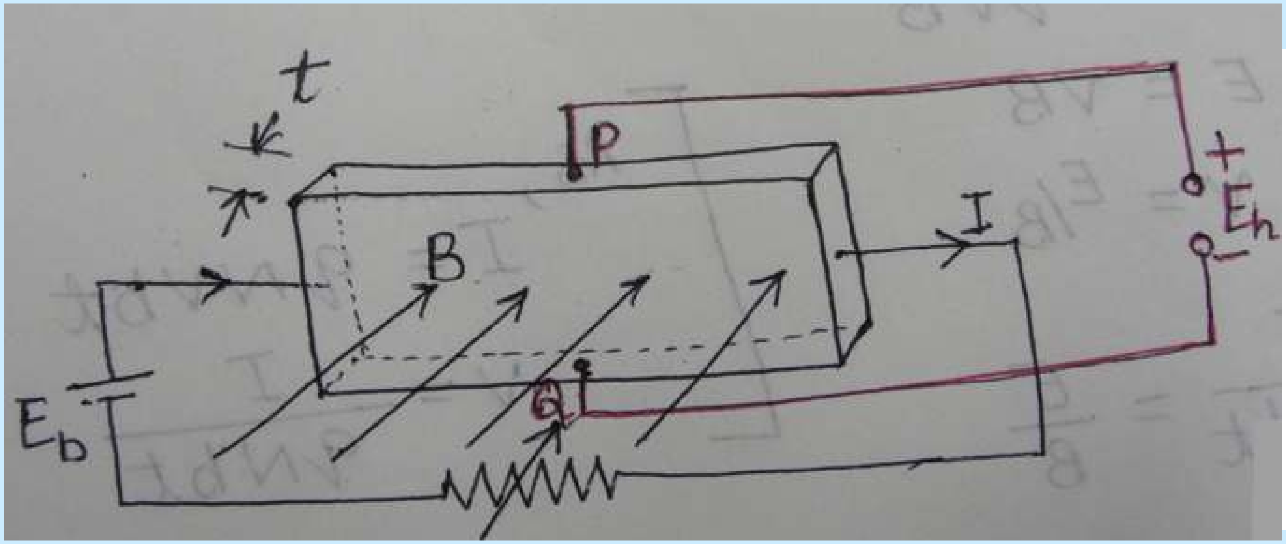
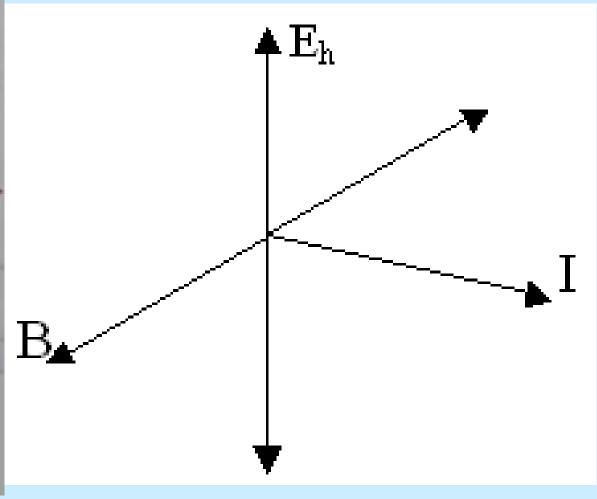
Hall Effect

Hall effect device (Edwin Hall discovered this effect in 1879)

When a conductor is kept perpendicular to the magnetic field and a direct current is passed through it then a potential difference exists across its edge in the perpendicular direction of current as well as magnetic field.

This emf is so small that it is difficult to measure.





Hall Effect

But for some semiconductors such as Germanium, this emf is enough for measurement with a moving coil instrument. This phenomenon is known as Hall effect.

Let us suppose, in a strip of semiconductor in which current I is passing, we have $I = qNvbt$

Where, q = charge of each carrier
N = no. of charge carrier per unit volume.
v= average velocity of charge carrier in the direction of current.
b= width , t= thickness

According to Fleming left hand rule they experience a force

$$F_m = qvB$$ B= flux density

an electric field starts existing because of collection of charge carriers and it exerts a force on charge carriers with opposite direction of force F_m.

Hall Effect

At equilibrium magnetic force is equal to the electric force.

Force on the charge carriers due to electric field E is given by

$$F_E = qE$$

At equilibrium : -

$$F_E = F_m$$

$$qE = qvB$$

$$E = vB$$

$$v = \frac{E}{B}$$

$$\frac{I}{qNbt} = \frac{E}{B}$$

as,

$$I = qNvbt$$

$$v = \frac{I}{qNbt}$$

$$E = \frac{IB}{qNbt}$$

Where,

q = charge of each carrier

N = no. of charge carrier per unit volume.

v= average velocity of charge carrier in the direction of current.

b= width , t= thickness

B= flux density

Hall Effect

Now Electric field is uniform throughout the width of semiconductor, so potential difference V at the opposite edges of the semiconductor

q = charge of each carrier
N = no. of charge carrier per unit volume.
v= average velocity of charge carrier in the direction of current.
b= width , t= thickness
B= flux density

$$V = E \cdot b$$

$$V = \frac{IB}{qNbt} \times b = \frac{IB}{qNt}$$

$$\frac{1}{Nq} = K_H$$ = ***Hall coefficient***

Hall Voltage $$E_H or V_H = K_H \left(\frac{BI}{t} \right)$$ B in Wb/m^2

Hall Effect

$$E_H or V_H = K_H\left(\frac{BI}{t}\right)$$

So, voltage appearing at the opposite edges of the semiconductor is directly proportional to the flux density of given magnetic field.