Experiment # 01

To study Hall's effect apparatus for semiconductor.

Apparatus

Hall's apparatus, Power supply for semiconductor, digital meter, voltmeter.

Theory

Hall effect definition

When a magnetic field is applied to current carrying conductor in a direction preperdicular to that of the flow of current, a potential difference or transverse electric field is created across conductor. This phenomenon is known as Hall effect.
Hall effect was discovered by Edwin Hall in 1879.
The voltage or electric field produced due to the application of magnetic field is also referred to as Hall effect voltage or Hall field.

What is Hall effect?

P-type Semiconductor and n-type Semiconductor are the two types of Semiconductor.

In n-type Semiconductor, free electrons are the majority charge carrier and holes are the minority carriers. That means most of the current in n-type Semiconductor is conducted by free electrons.

In the P-type Semiconductor, holes are majority carriers and free electrons are the minority carrier. This means most of the current in p-type Semiconductor is conducted by holes.

Free electrons and holes are the very small particles. So we can't see them directly with our eyes. But by using Hall effect we can easily identify whether Semiconductor is p-type or n-type.

When a voltage is applied to conductor or Semiconductor, electric current starts flowing through it. In conductors, the electric current is conducted by free electrons whereas in Semiconductors, electric current is conducted by both free electrons and holes.

The free electrons in a semiconductor or conductor always try to flow in a straight path However because of conduction Collision with the atoms free electrons slightly change their direction But if the applied voltage is strong enough, the free electrons forcefully follow the straight path. This happens only if no other forces are applied to it in other direction. If we apply force in other direction by using magnetic field, the free electrons in the conductor or semiconductor change their direction.
consider a material, either a semiconductor or conductor as shown in figure. When a voltage is applied, electric current starts flowing in the positive x-direction (from left to right)
If a magnetic field is applied to this current carrying conductor or semiconductor in a direction perpendicular to that flow of current, an electric field is produced in it that exert force in negtive y-direction. This Phenomenon is known as Hall effect.
Hall effect was named after American Physicist Edwin Hall, who discovered

the Phenomenon in 1879.

Hall effect in conductor

The electric field produced in the material pushes the charge carrier downwards. If the material is a conductor, the electric field pushes the free electrons downward. As a result a large number of charge carriers are accumulated at bottom surface of conductor.

Because of large accumulation of negtive charges at the bottom surface and deficiency of negtive charges at upper surface, the bottom surface is negtively charged and upper surface is postively charged.

As a result, an electrical difference or potential difference develops between the upper surface and bottom surface of conductor. This potential difference is known as Hall Voltage. In a conductor the electric field is produced due to the negtively charged free electron. So the hall voltage produced in conductor is negtive.

produced due to the postively charged holes. So the hall voltage produced in the P-type semiconductor is positive. This lead to the fact that the produced electric field is having a direction in positive Y-direction.

Hall Effect helps to determine the type of material

We can easily identify whether a semiconductor is P-type or n-type by using Hall Effect. If the voltage produced is postive then the material is said to be P-type and if voltage produced is negtive then the material is said to be n-type.

The Hall voltage is directly proportional to the current flowing through the material, and the magnetic field strength, and it is inversely proportional to the number of mobile charges in the material and the thickness of the material. So in order to produce a large Hall voltage we use a thin material with

few mobile charges per unit volume.
Mathematical expression for the Hall Voltage is given by

$$V_H = \frac{IB}{qnd}$$

V_H = Hall voltage
I = current flowing through the material
B = magnetic field Strength
q = Charge
n = number of mobile charge carriers per unit volume
d = thickness of the material

to the product of two input signals.

Procedure:

- Set the apparatus according to diagram
- Connect negtive terminal of battery with negtive terminal of Hall Effect apparatus and Positive terminal of battery with positive terminal of device.
- Change the value of Voltage in regular steps and note the corresponding Changing current.
- Take atleast ten values of Voltage and note the corresponding changing current.
- Plot the graph between voltage (x-axis) and current (y-axis)
- Find Slope from graph to find resistance R and then find 'n'.