Atomic Structure and Semiconductor

Lecture - 42

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B.Sc (Electronics)
TDC PART - I
Paper – 1 (Group – B)
Chapter – 4
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➢ Hall Effect (PART – 1)

(1) Introduction of Hall Effect:-

⇨ If a piece of conductor (metal or semiconductor) carrying a current is placed in a **Transverse Magnetic Field,** **(A mode of EM wave propagation in which the magnetic field is perpendicular to the direction of propagation)** an **Electric Field** is produced inside the conductor in a direction normal to both the current and the magnetic field. **This phenomenon is known as the Hall Effect,** and the **generated Electric field** as the **Hall Field.**

⇨ In other way we can say that, when a specimen conductor material (metal or semiconductor) is placed in a **Transverse Magnetic Field** and a **Direct Current** is passed through it, then an **Electric Field** is induced across specimen conductor material edges in the **Perpendicular Direction of Current** as well as **Magnetic Field**. **This phenomenon is called the Hall Effect,** and the **generated Electric field is known as the Hall Field.**

⇨ Consider a **Rectangular Piece of Conductor** carrying a **Current I** in the **Positive X-direction** and subjected to a **Magnetic Flux Density B** in the **Positive Z-direction** as shown below in **Figure (1).**

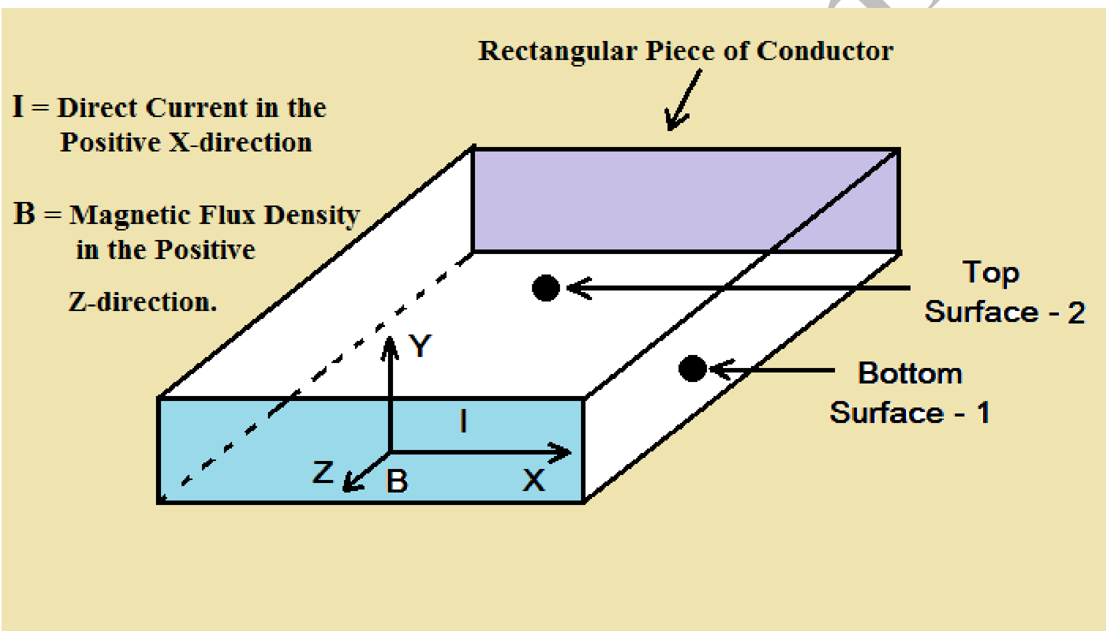

Fig. (1) Shown a **Rectangular Piece of Conductor** carrying a **Current I** in the **Positive X-direction** and subjected to a **Magnetic Flux Density B** in the **Positive Z-direction.**

⇨ The **Current carriers** will experience a **Lorentz force in the Negative Y-direction**. As a result, the **carriers** are **deflected towards the bottom surface** of the **Rectangular Piece of Conductor** and are **accumulated there.**

➢ What is Lorentz Force?

⇨ **Lorentz force is defined** as the **combination of the magnetic and electric force on a point charge due to electromagnetic fields.** It is used in electromagnetism and is **also known as the electromagnetic force. In the year 1895, Hendrik Lorentz** derived the modern formula of Lorentz force.

⇨ **Lorentz force formula** for the charged particle is as follows:-

⇨ **F = q (E + v ∗ B)**

where,

- ✓ **F** is the **force** acting on the particle,
- ✓ **q** is the **electric charge** of the particle,
- ✓ **v** is the **velocity,**
- ✓ **E** is the **external electric field,**
- ✓ **B** is the **magnetic field.**

⇨ If the **current carriers are Electrons**, as in the case of an **n-type semiconductor**, this accumulation will make the **Bottom surface-1 negatively charged** with respect to the **Top surface-2.** Therefore, an **Electric Field, called the Hall Field**, will be developed along the **Negative Y-direction.**

⇨ The **force** on the **current-carrying Electrons** due to this **Hall Field** will **oppose** the **Lorentz force**. An **equilibrium is established** when these **two forces balance each other.** At this stage, **no further accumulation of Electrons** takes place **on the Bottom Surface-1** and the **Hall Field reaches a steady value.**

- ⇨ If the **Current carriers are Holes**, i.e., when the **conductor** is a **p-type semiconductor** the **accumulation of Current carriers on the Bottom Surface-1** will make this surface **Positively charged** relative to the **Top Surface-2**. In this case, the **Hall Field** is produced along the **Positive Y-direction.**

- ⇨ The **force on the holes due to the Hall Field opposes** the **Lorentz force** and **balances it under equilibrium condition preventing further accumulation of holes.** The **Hall Field** then **attains** its **steady value.**

to be continued ....

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