## 1.2 Intrinsic Semiconductors and Extrinsic Semiconductors.

Semiconductors are primarily classified into two major types: Intrinsic Semiconductors and Extrinsic Semiconductors. This classification is based on their purity.

Intrinsic Semiconductors

An intrinsic semiconductor is a pure form of a semiconductor material, such as silicon or germanium, without any added impurities. In an intrinsic semiconductor, the number of electrons in the conduction band is equal to the number of holes in the valence band.

**Key Characteristics of Intrinsic Semiconductors:**

- **Pure Material:** No impurities are added.
- **Equal Number of Electrons and Holes:** The electrical conductivity arises from the thermal generation of equal numbers of free electrons and holes.
- **Temperature Dependent:** At absolute zero, intrinsic semiconductors behave as insulators. As the temperature rises, thermal energy excites electrons from the valence band to the conduction band, making the material conductive.

Example: Silicon (Si) and Germanium (Ge) are the most commonly used intrinsic semiconductors

Extrinsic Semiconductors

Extrinsic semiconductors are intrinsic semiconductors that have been doped with small amounts of impurities to improve their electrical conductivity. The process of doping introduces either more electrons (n-type) or more holes (p-type) into the semiconductor, thereby altering its conductive properties.

Types of Extrinsic Semiconductors

- N-type Semiconductor: In an n-type semiconductor, an impurity is added that provides extra electrons, which become the majority charge carriers. The "n" stands for negative because electrons (which have a negative charge) are the majority carriers.

- P-type Semiconductor: In a p-type semiconductor, the impurity creates extra holes (positive charge carriers). The "p" stands for positive because holes (which act like positive charge carriers) are the majority carriers.

N-type vs. P-type Semiconductors

| **Property** | **N-type Semiconductor** | **P-type Semiconductor** |
|---|---|---|
| Doping Element | Donor (e.g., Phosphorus) | Acceptor (e.g., Boron) |
| Majority Carrier | Electrons | Holes |
| Minority Carrier | Holes | Electrons |
| Conductivity | High (due to free electrons) | High (due to available holes) |

N-type Semiconductor

- Doping with Donor Atoms: A donor atom, such as phosphorus, is added to the material. These atoms have more valence electrons than the semiconductor, leading to extra free electrons that increase conductivity.
- Majority Carriers: Electrons.
- Minority Carriers: Holes.

P-type Semiconductor

- Doping with Acceptor Atoms: An acceptor atom, such as boron, is added, which has fewer valence electrons than the semiconductor. This creates holes in the material, allowing for enhanced electrical conductivity.
- Majority Carriers: Holes.
- Minority Carriers: Electrons.