

Name: Chandra Shekhar  
College: IIT Gandhinagar  
Subject: Physics  
Weightage: High  
Title: Electronic Devices

## ELECTRONIC DEVICES

### Semiconductors

Semiconductors are materials whose electrical conductivity lies between that of conductors and insulators.

#### Intrinsic Semiconductor

Pure semiconductors (e.g., Si, Ge) are called intrinsic semiconductors.

- Act as insulators at 0 K.
- Conductivity increases with temperature.
- Charge carriers: electrons and holes.
- Resistance decreases with temperature (negative temperature coefficient).

#### Extrinsic Semiconductor

Obtained by doping intrinsic semiconductors with impurities.

- **n-type:** Doped with pentavalent elements (P, As). Electrons are majority carriers.
- **p-type:** Doped with trivalent elements (B, Al). Holes are majority carriers.

### p-n Junction Diode

A junction formed by joining p-type and n-type semiconductors.

- **Depletion Region:** Region void of mobile charge carriers.
- **Barrier Potential:** Internal potential developed due to immobile ions.

#### Biasing

- **Forward Bias:** Reduces depletion width; current flows easily.
- **Reverse Bias:** Increases depletion width; negligible current.

### Rectifiers

**Rectifier:** Converts AC to DC.

#### Half-Wave Rectifier

- Single diode used.
- Converts one half cycle of AC.
- Output: Pulsating DC.

#### Full-Wave Rectifier

- Two diodes (center-tap) or four (bridge).
- Converts both half cycles.
- Higher efficiency.

### Special Purpose Diodes

- **Zener Diode:** Operates in reverse breakdown; used in voltage regulation.
- **LED:** Emits light when forward-biased.
- **Photodiode:** Generates current when exposed to light (reverse-biased).
- **Solar Cell:** Converts solar energy to electrical energy.

### Transistors

Three-terminal device with emitter, base, and collector.

- NPN and PNP types.

#### Configurations

- **Common Base (CB):**  $\alpha = \frac{\Delta I_C}{\Delta I_E}$
- **Common Emitter (CE):**  $\beta = \frac{\Delta I_C}{\Delta I_B}$ ,  $\beta = \frac{\alpha}{1-\alpha}$

## Logic Gates

- Input/output in binary (0 or 1).

### OR Gate

$$Y = A + B$$

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

### AND Gate

$$Y = A \cdot B$$

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

### NOT Gate

$$Y = \bar{A}$$

A	Y
0	1
1	0

### NAND Gate

$$Y = \overline{A \cdot B} \quad (\text{Universal gate})$$

### NOR Gate

$$Y = \overline{A + B} \quad (\text{Universal gate})$$