



جامعة المستقبل  
AL MUSTAQBAL UNIVERSITY



# Analogue Electronic

# **Diode and its Application**

## **Lecture 3**

# Diode

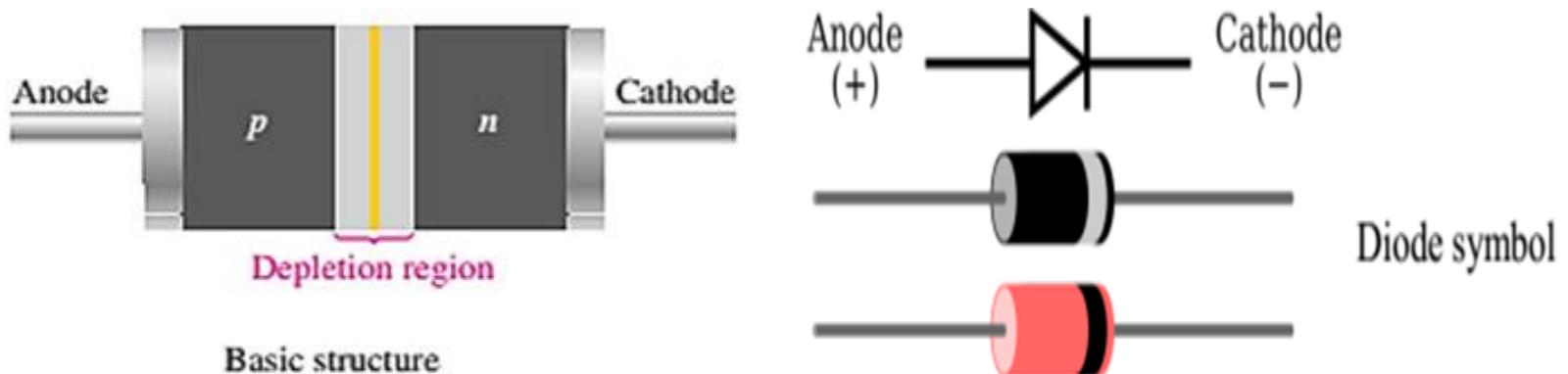
**Diode** is a **semiconductor** device, **made** from a **small piece of semiconductor material**, such as **silicon**.

It is consisting of **two part** that divided in equal, the **first half** is doped as a **p region** and **second half** is doped as an **n region**.

Theses two part with the depletion region in between produced the **pn junction**.

The **p region** is called the **anode** and **n region** is called the **cathode**.

It conducts **current** in **one direction** and offers **high resistance** in **other direction**. The basic diode structure and symbol are shown in Fig.1.



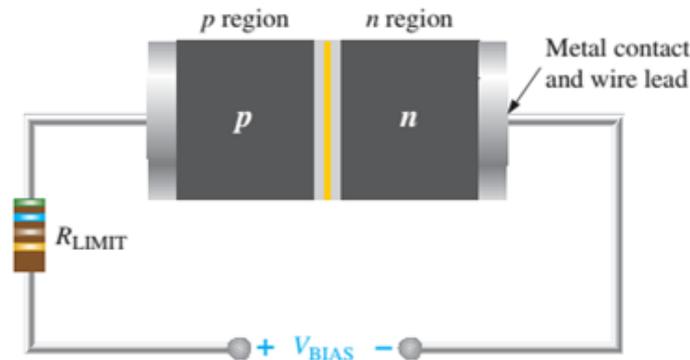
# Forward Bias

**Bias** is the application of a **dc voltage to a diode** to make it either **conduct current or not**.

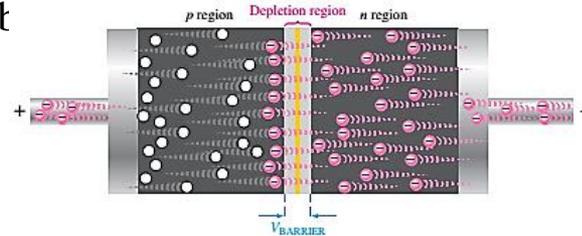
**Forward bias** is the condition that allows current through the pn junction. This external bias voltage is designated as  $V_{BIAS}$ .

The **resistor limits** the **forward current** to a value that **will not damage** the diode.

In the **forward bias**, the **negative side** of  $V_{BIAS}$  is connected to the **n region** of the diode, and the **positive side** is connected to the **p region**. The **bias voltage**,  $V_{BIAS}$ , must be greater than the **barrier potential**; the bias must be greater than **0.3V for germanium** or **0.7V for silicon** diodes.



- **Negative side** of bias voltage ‘**pushes**’ free electrons towards pn junction.
- The **negative side of the source** also **provides** a **continuous flow of electrons** through the external connection (conductor) and into the n region as shown in Figure 3.
- The **bias-voltage source imparts** sufficient energy to the **free electrons** to overcome the depletion region's **barrier** and push them into the p region.



- Since unlike charges attract, the **positive side of the bias-voltage source attracts** the **valence electrons** toward the **left end of the p region**.
- The holes in the p region provide the medium for these valence electrons to move through the p region. The holes, (majority in p region), move to the right toward the junction.
- As the electrons flow out of the p region through the external connection (conductor), **these electrons** become **conduction electrons** in the **metal conductor**.
- As **more electrons move into the depletion region**, positive ions are **reduced**.
- **As more hole's flow into the depletion region** on the other side of the pn junction, the **number of negative ions is reduced**.
- This **reduction in positive and negative ions causes** the depletion region to narrow.

# Reverse Bias

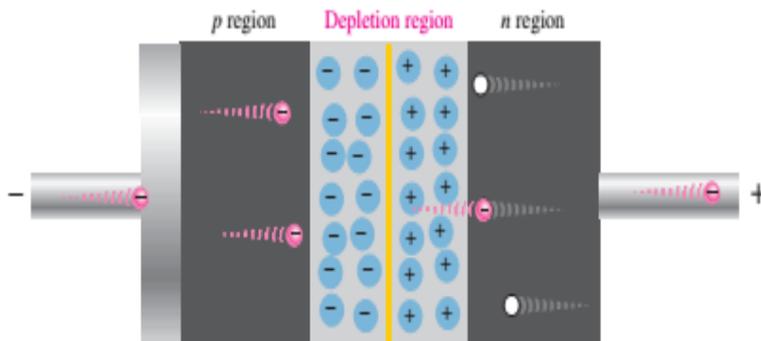
**Reverse bias** is the condition that essentially **prevents current** through the diode. Figure 4 shows a DC voltage source connected across a diode in the direction to produce reverse bias.

The **positive side** of VBIAS is **connected** to the **n region** of the diode, and the **negative side** is connected to the **p region**.

Also, **note** that the **depletion region** is shown **much wider** than in **forward bias or equilibrium**.

The **positive side** of the bias-voltage source **pulls** the free electrons, (**majority in the N region**), **away** from the **pn junction**.

As electrons move away from the junction, **more positive ions** are created. This **results** in a **widening of the depletion region** and a depletion of the majority carriers.



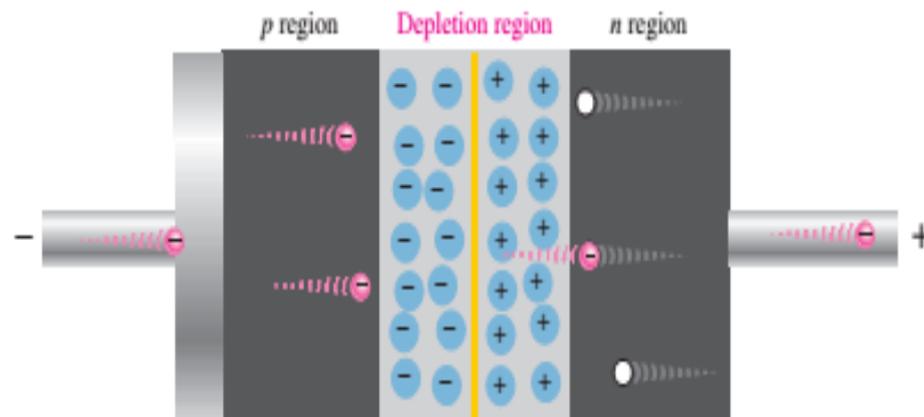
# Reverse Bias

In **p region**, electrons from the negative side of the battery enter as **valence electrons**. It moves from **hole to hole** toward the **depletion region**, creating **more negative ions**.

This can be viewed as **holes being pulled towards the negative side**.

The **electric field** increases in strength until the potential across the depletion region equals the bias voltage.

At this point, a very small **reverse current** exist that can usually be neglected.

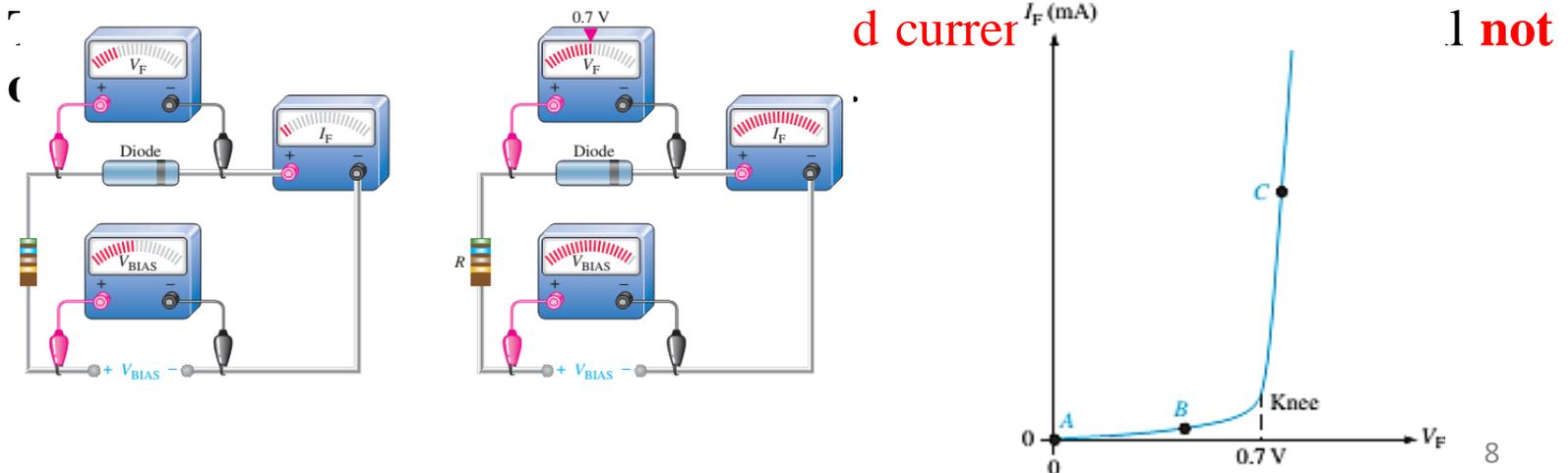


# ▪ Voltage-Current (V-I) Characteristic of A Diode

## ▪ V-I $I_F$ characteristic for Forward Bias

The **current in forward biased** called **forward current** and is designated  $I_F$ .

At **0V** ( $V_{bias}$ ) across the diode, there is **no forward current**. Figure 5 illustrates what happens as the forward-bias voltage is increased positively from 0 V.



With a **gradual increase of  $V_{\text{bias}}$** , the **forward voltage and forward current increase.**

A portion of **forward-bias voltage ( $V_f$ ) drops** across the limiting resistor.

The continuing **increase of  $V_f$  causes a rapid increase of forward current**

**but** the **voltage** across the diode **increases only gradually above 0.7 V.**

The **resistance of the forward-biased diode is not constant, but** it changes over the entire