Junction Diode

Lecture - 12

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B.Sc (Electronics)
TDC PART - I
Paper – 1 (Group – B)
Unit – 5
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➢ P-N Junction as a Diode (Qualitative Analysis)

⇨ The essential electrical characteristics of a P-N Junction is that it constitutes a diode which **permits the easy flow of current in one direction but restrains the flow in the opposite direction.** We consider now, **qualitatively,** how this diode action comes about.

➢ A Biased P-N Junction Diode

⇨ When the **Positive (+) Terminal** of a Battery is connected to the **P –Type side (Anode)** and the **Negative (-) Terminal** to the **N – Type side (Cathode)** of a P-N Junction, the **junction allows a large current to flow through it**. In this case, the **P-N Junction is said to be Forward Biased.** The Forward Biased arrangement is **shown below in Figure (1).**

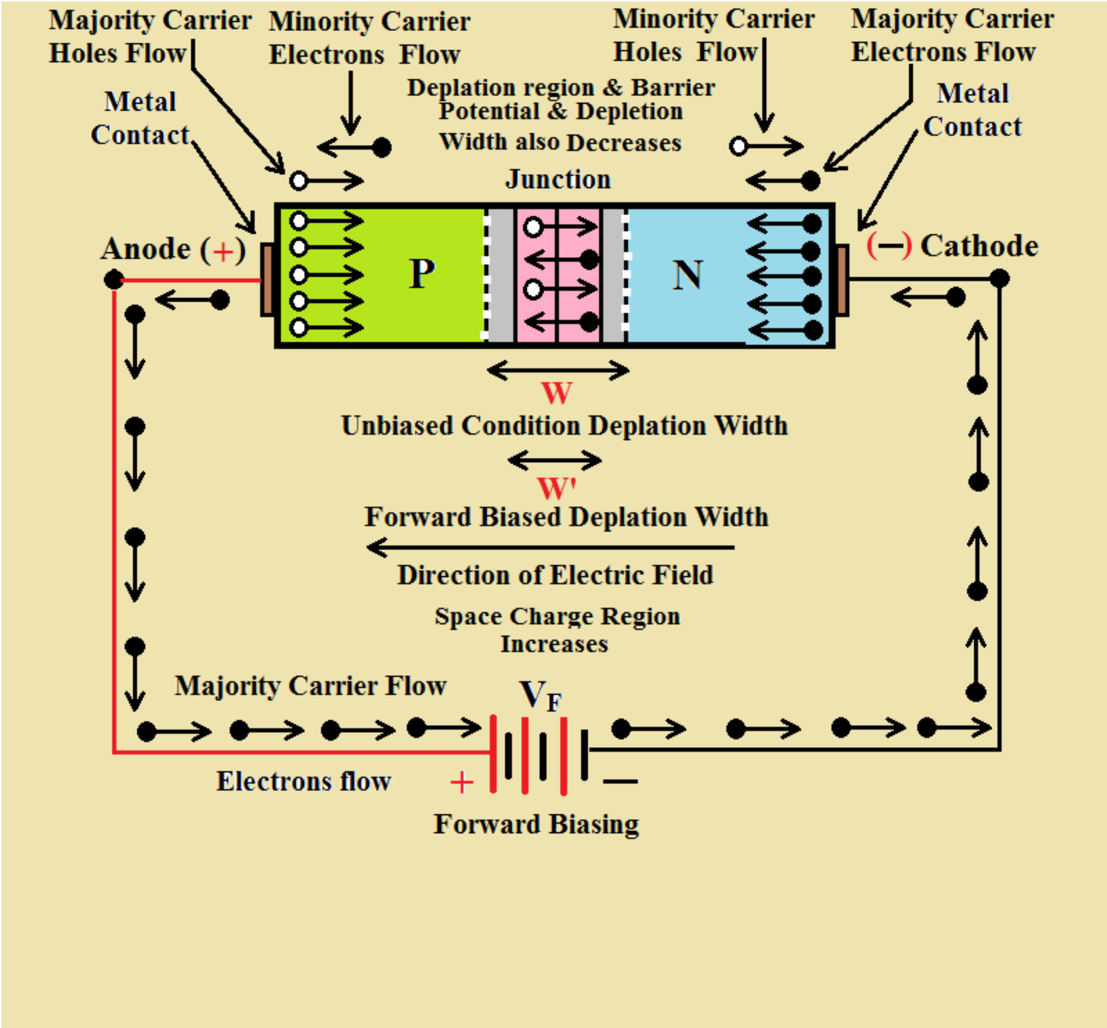

Fig. (1) Shown a Forward Biased P-N Junction Diode.

- When the terminals of the Battery are **Reversed,** i.e., the **Positive (+) Terminal** is connected to the **N – Type side (Cathode)**, and the **Negative (-) Terminal** to the **P – Type side (Anode)**, the **junction allows a very small current to flow through it.** Under this condition the **P-N Junction is called Reverse Biased.** The Reverse Biased arrangement is **shown below in Figure (2).**

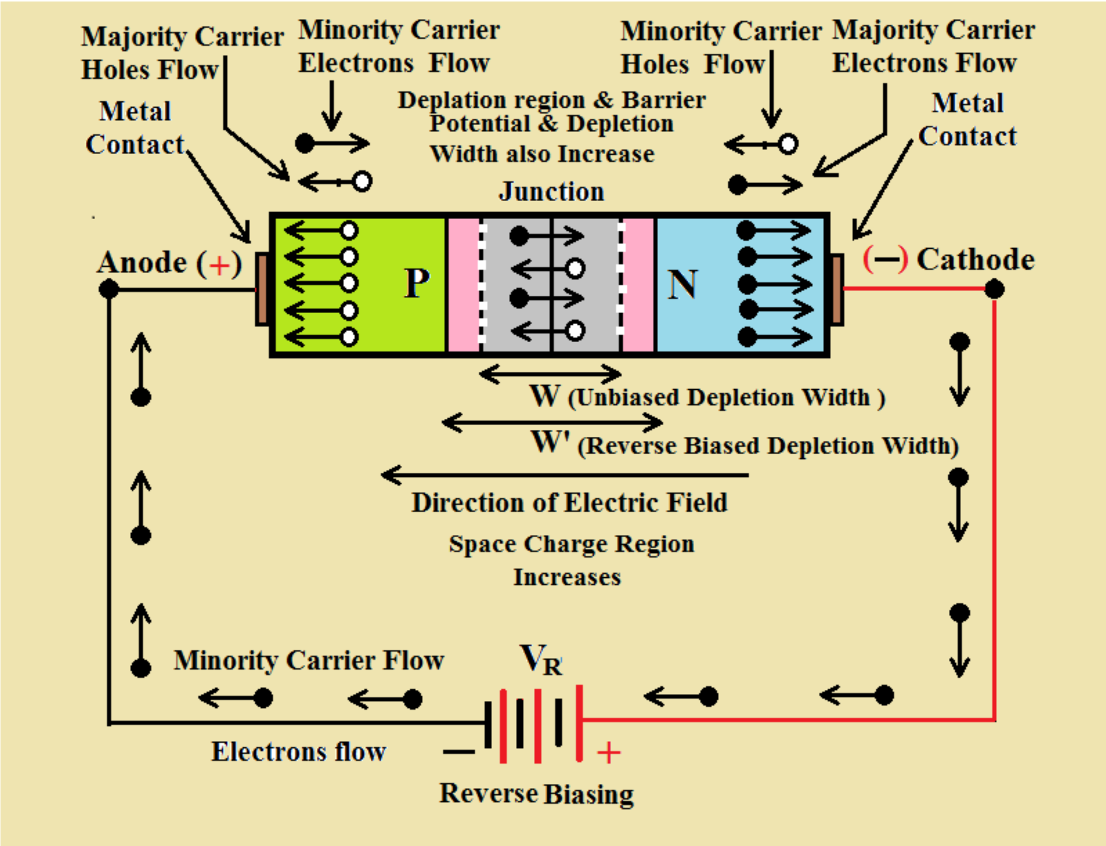

Fig. (2) Shown a Reverse Biased P-N Junction Diode.

⇨ The **above behaviour** of a P-N Junction **makes it suitable** for **use as a Rectifier.** However, a **Vacuum diode** gives **better rectification**, since while the P-N Junction diode allows a **very small current under Reverse Bias;** the **Vacuum diode** gives **zero plate current** when **Plate Voltage is Negative**. We now consider **Qualitatively** the mechanism involved when the P-N junction is in,

(1) Zero Biased Condition

(2) Forward Biased Condition

(3) Reverse Biased Condition

➢ Forward Biased P-N Junction Diode

⇨ When an external field, with **P –Type region (Anode)** connected to **Positive (+) Terminal** and **N – Type region (Cathode)** connected to **Negative (-) Terminal** of the **Battery,** is applied across the junction, as **shown below in Figure (3), the junction is said to be Forward Biased.**

⇨ In this circuit arrangement, the **Holes** on the **P – Type side** being **Positively charged particles are repelled** from the **Positive bias terminal** and driven towards the junction.

⇨ Similarly, the **Electrons** on the **N – Type side** are **rippled** from the **Negative Bias terminal** and driven towards the junction. The result is that the **depletion region is reduced in width,** and the **Barrier Potential is also reduced.** If the **applied bias voltage** is **increased** from **zero,** the **Barrier Potential** gets progressively smaller until it effectively disappears and charge carriers can easily flow across the junction.

⇨ **Electrons** from the **N – Type side** are then **attracted** across to the **Positive Bias** terminal on the **P – Type side,** and **Holes** from the **P – Type side** flow across to the **Negative bias** terminal on the N – Type side. Thus a majority carrier current flows. Since Barrier Potential is very small **(0.3 V for Ge and 0.7 V for Si),** a **small Forward Voltage is sufficient to eliminate the barrier completely.** Once the barrier is eliminated by the application of **Forward Voltage, Junction Resistance** becomes almost zero and a **low resistance path** is established in the entire circuit. The **Current called the Forward Current,** flow in the circuit.

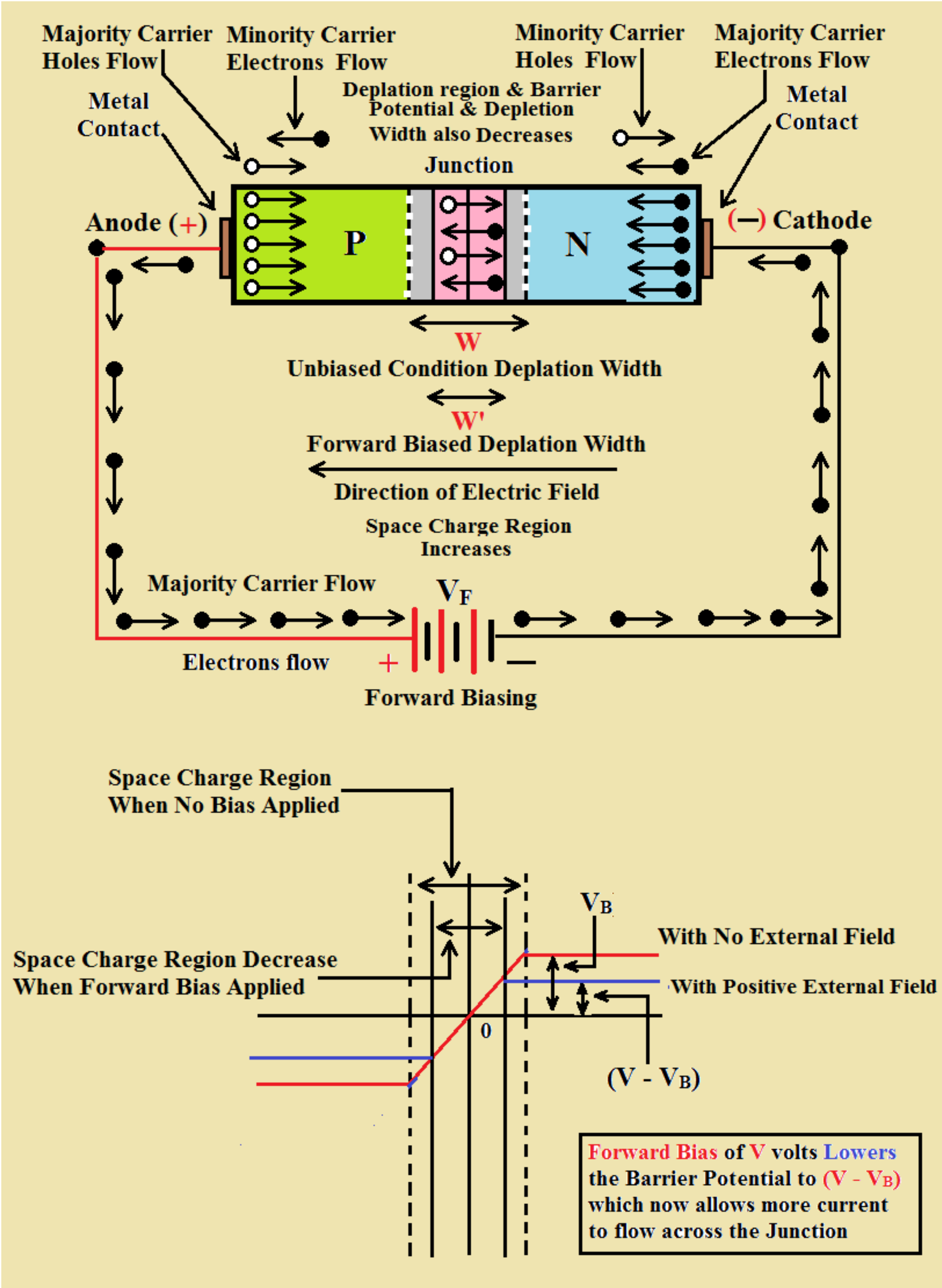

Fig. (3) Shown Forward Biased P-N Junction Diode.

⇨ In brief it can be said that when the junction is **Forward Biased** (**P – Type region (Anode)** connected to the **Positive (+) Terminal** and **N – Type region (Cathode)** connected to the **Negative (-) Terminal** of the Battery);-

(1) Barrier is **reduced** and at a **Forward Voltage of 0.3 V** in case of **Germanium** and **0.7 V** in the case of **Silicon,** it is eliminated altogether,

(2) The junction offers **Low Resistance**, called the **Forward Resistance r_f** to the flow of current and

(3) Current flows in the circuit due to establishment of **Low Resistance path** and the **magnitude of current** depends upon the **magnitude of applied Forward Voltage.**

⇨ **The mechanism of current flow** in a **Forward Biased P-N Junction** is summed up as follows:-

(1) The **Electrons** from the **Negative Bias terminal** continue to arrive into **the N – Type region** whiles the **Free Electrons** in the **N – Type region** move towards the P-N Junction.

(2) The **Electrons** travel through the **N – Type region** as **Free Electrons** i.e., the current in **N – Type region** is by **Free Electrons.**

(3) These **Free Electrons** on reaching P-N Junction combine with **Holes** and **become Valence Electrons.** Since a **Hole** is in the **Valence Band** and, therefore, when a **Free Electron** combines with a **Hole**, it becomes a **Valence Electron.**

(4) The **Electrons** travel through **P – Type region** as **Valence Electrons** and **Current** in this **P – Type region** is, therefore, by **Holes.**

(5) These **Valence Electrons**, on reaching the left end of the **P – Type crystal**, flow into the **Positive terminal** of the **Battery.**

⇨ Thus here we see that the **current** in the **N – Type region** is due to **movement of Electrons** whereas in the **P – Type region** it is carried by the **Holes**. However, in the **External Circuit (i.e. in connecting wires)** the **current** is carried only and only by **Electrons.**

⇨ In the next **Lecture - 13,** we will discuss the detailed of the **Zero Applied Biased P-N Junction Diode (PART – 1) and (1) Built-in Potential Barrier.**

to be continued ....

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