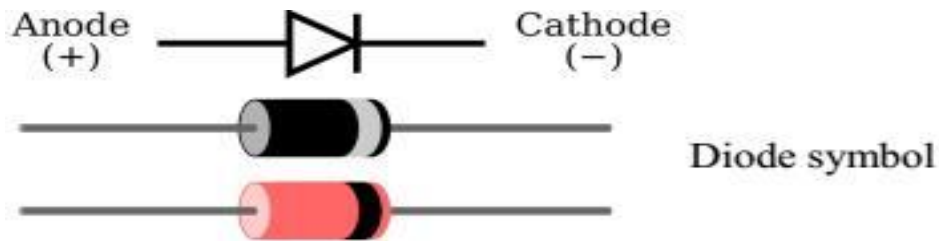


1. Diode

✚ A diode is a semiconductor device, made from a small piece of semiconductor material, such as silicon, in which half is doped as a **P-region** and half is doped as an **N-region** with a **P-N junction** and **depletion region** in between.

- 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.



Forward Bias

- Bias is the application of a D.C voltage to a diode to make it either conduct or block current.

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; bias must be greater than **0.3V** for **Germanium** or **0.7V** for **Silicon** diodes.

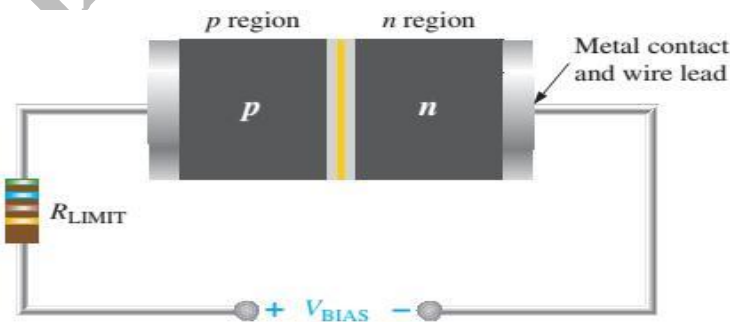


Figure 2: A diode connected for forward bias.

- 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 for them to overcome the barrier potential of the

depletion region and move on through into the p region.

- Since unlike charges attract, the positive side of the **bias-voltage** source attracts the valence electron 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, the number of positive ions is reduced. As more holes 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.*

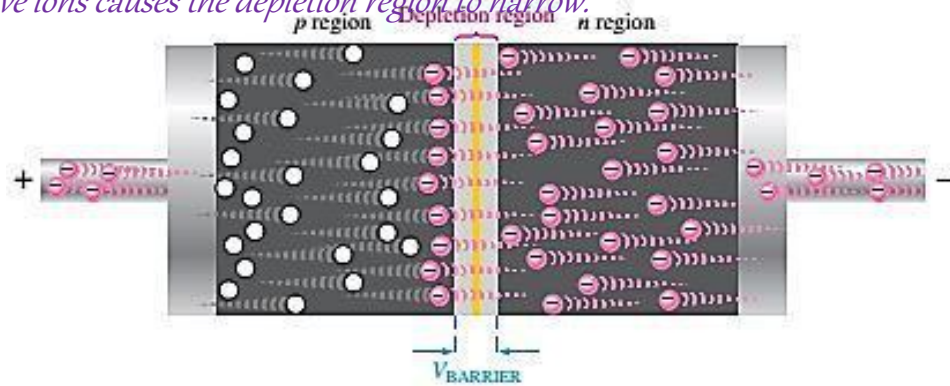


Figure 3: A forward-biased diode showing the flow of majority carriers and the voltage due to the barrier potential across the depletion region.

Reverse Bias

- + Reverse bias is the condition that essentially prevents current through the diode.

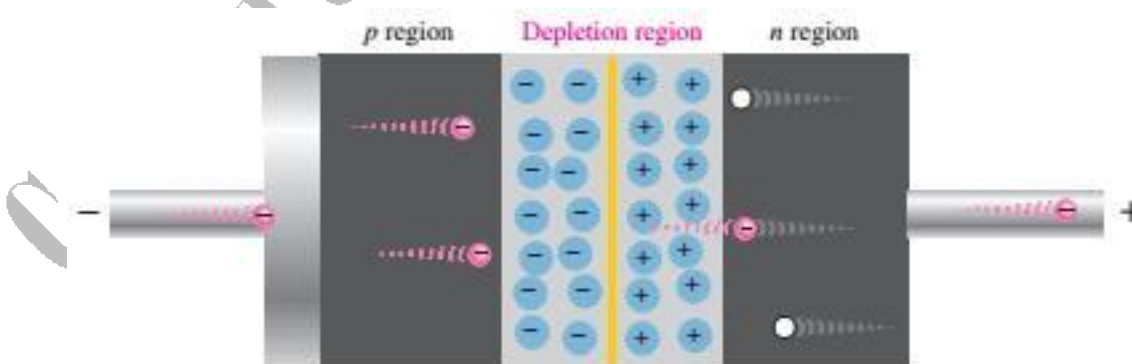


Figure 4: shows a dc voltage source connected across a diode in the direction to produce reverse bias.

- ✚ The positive side of V_{BIAS} 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 **N-region**), away from the PN junction.
- ✚ As electrons move away from junction, more positive ions are created. This results in a widening of the depletion region and a depletion of majority carriers.

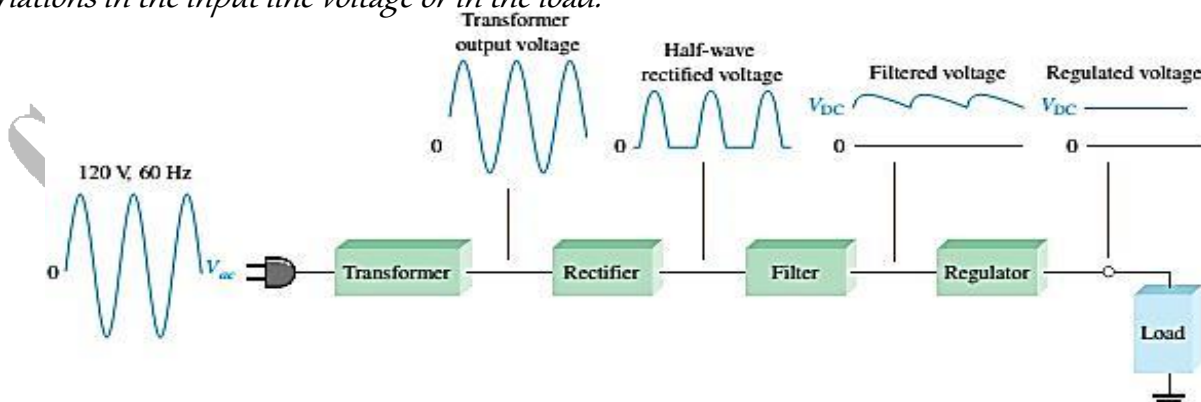
In **P-region**, electrons from negative side of battery enter as valence electrons. It moves from hole to hole toward the depletion region, creating more negative ions. This can be viewed as holes being pulled towards the negative side. The electric field increases in strength until the potential across depletion region equals the bias voltage. At this point, very small reverse current exist that can usually be neglected.

Normally, the reverse current is so small that it can be neglected. If the external reverse-bias voltage is increased to a value called the **breakdown voltage**, the reverse current will drastically increase. The high reverse-bias voltage imparts energy to the free minority electrons so that as they speed through the p region, they collide with atoms with enough energy to knock valence electrons out of orbit and into the conduction band. The newly created conduction electrons have high energy, and repeat the process, they quickly multiply. They have high energy to move through PN junction, and not combine with holes. The multiplication of conduction electrons just discussed is known as **the avalanche effect**.

- ✚ A power supply is an essential part of each electronic system from the simplest to the most complex. A basic block diagram of the complete power supply is shown in figure below.

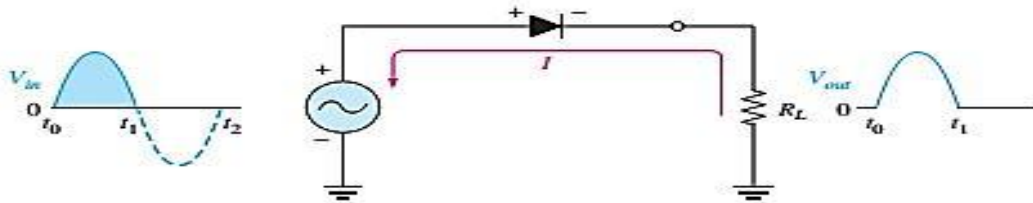
The **transformer** changes ac voltages based on the turn's ratio between the primary and secondary.

The **rectifier** converts the **AC** input voltage to DC voltage. The **filter** eliminates the fluctuations in the rectified voltage and produces a relatively smooth DC voltage. The **regulator** is a circuit that maintains a constant DC voltage for variations in the input line voltage or in the load.

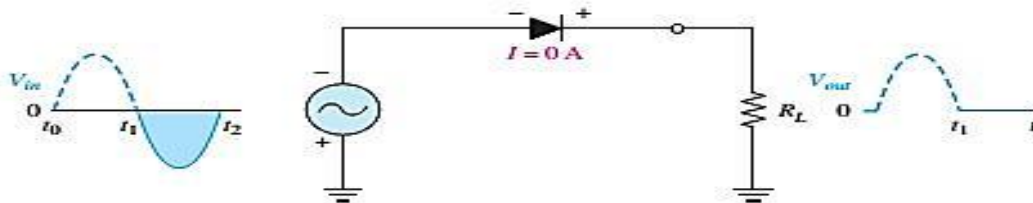


Half-Wave Rectifiers

- Because of their ability to conduct current in one direction and block current in the other direction, diodes are used in circuits called rectifiers that convert AC voltage into DC voltage.
- Rectifiers are found in all DC power supplies that operate from an AC voltage source. When connected with AC voltage, diode only allows half cycle passing through it and hence convert AC into DC.
- As the half of the wave gets rectified, the process called **half-wave rectification**. The output frequency is the same as the input.



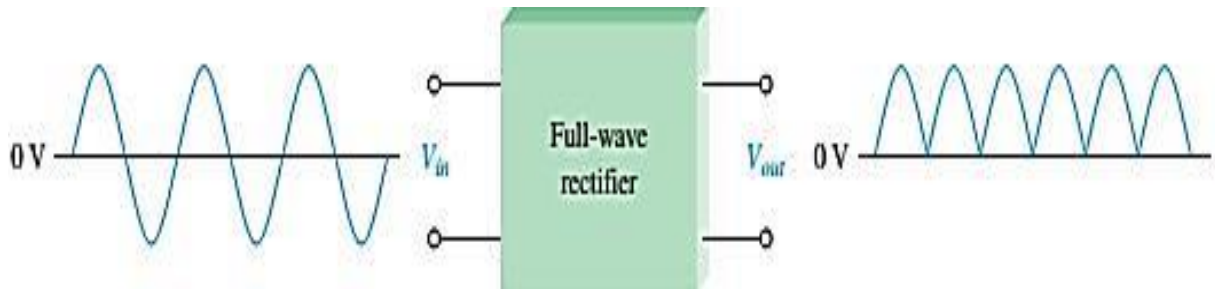
(a) During the positive alternation of the 60 Hz input voltage, the output voltage looks like the positive half of the input voltage. The current path is through ground back to the source.



(b) During the negative alternation of the input voltage, the current is 0, so the output voltage is also 0.

Full wave rectifiers

Although half-wave rectifiers have some applications, the full-wave rectifier is the most commonly used type in DC power supplies. A full-wave rectifier allows unidirectional (one-way) current through the load during the entire of the input cycle, whereas a half-wave rectifier allows current through the load only during one-half of the cycle. The output voltage has twice the input frequency.



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