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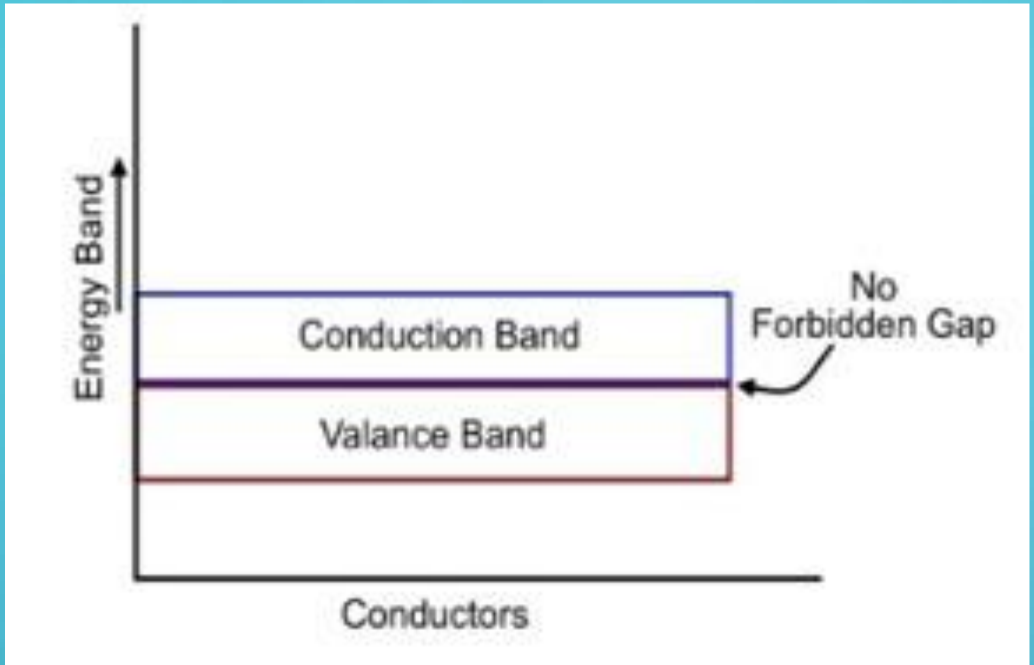
SUBJECT- AE(COMP.)
SEMESTER-2nd

Conductor

A conductor is a material that permits electric current to pass through it, i.e. it has the lowest resistance in the path of free electrons—the valance and conduction bands of a conductor overlap. A minor potential difference across a conductor allows the free electrons to produce an electric current due to this overlapping. Figure shows the energy band diagram.



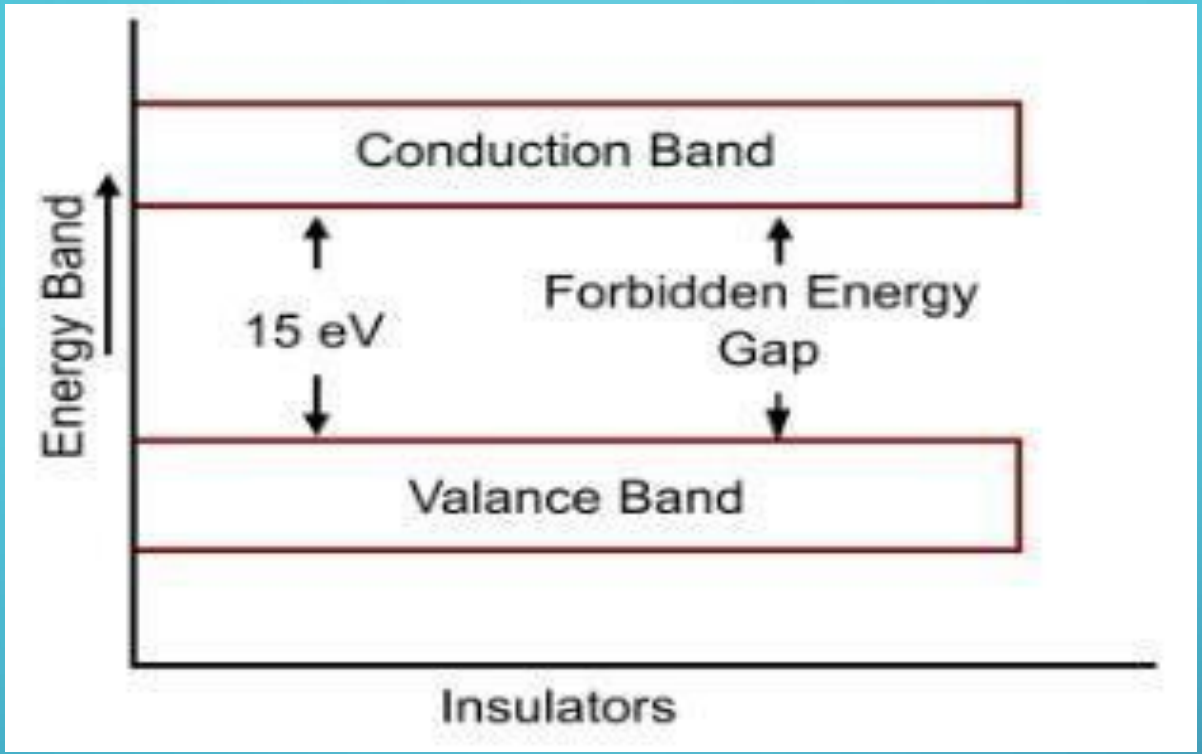
All metals are conductors. The resistance of the conductors rises as the temperature rises. As a result, the conductor has a positive temperature coefficient of resistance.

Applications:

1. For making conducting wires and cables for carrying electric current.

Insulator

An insulator is a material that, due to its high electrical resistance, does not allow an electric current to flow through it. The energy difference between the valance and conduction bands in insulators is quite large (approximately 15 eV). As a result, a very strong electric field is needed to force the valance electrons into the conduction band. As a result, no free electrons exist in the conduction band. As a result, the electrical conductivity of insulators is extremely low and may be recognized as inactive under normal conditions. Figure shows the energy band diagram for insulator.



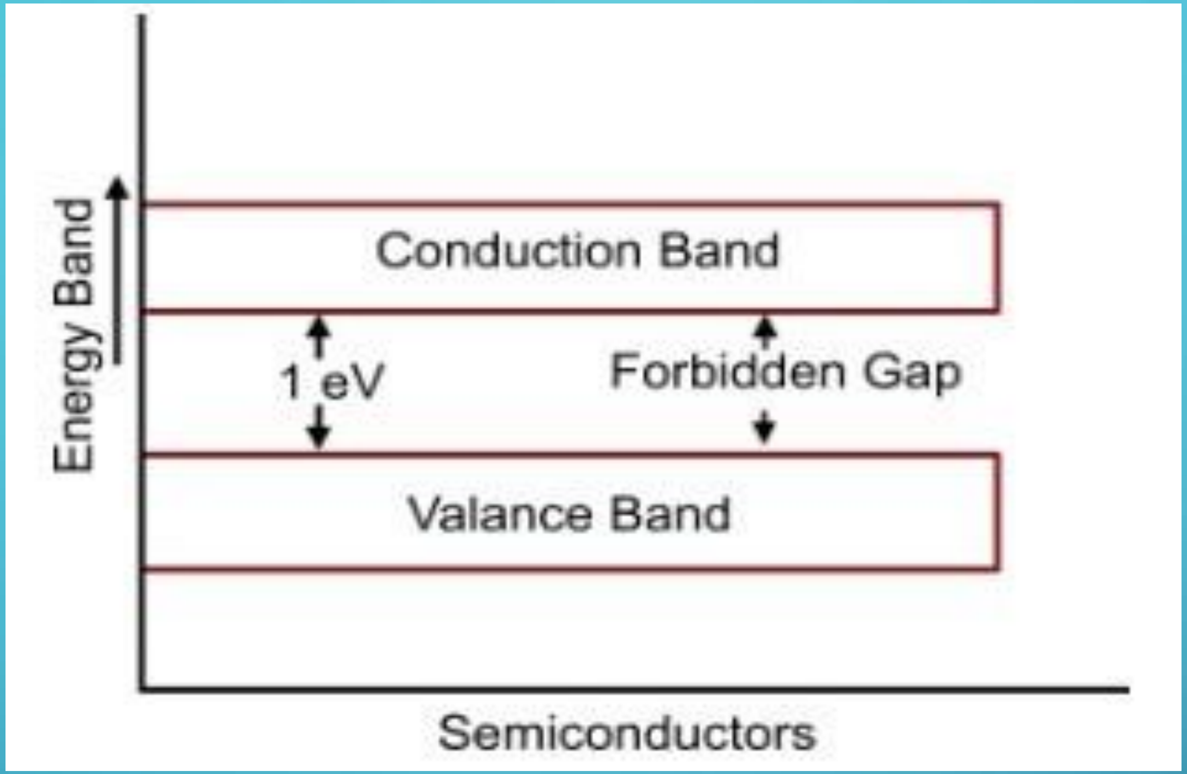
At room temperature, the valance electrons of the insulator do not have enough energy to jump over to the forbidden energy gap. But, if the temperature is increased, some of the electrons may get enough energy to jump over to the forbidden energy gap. Hence, the resistance of the insulator decreases (but negligible) with the increase in temperature. Therefore, the insulators have negative temperature co-efficient of resistance.

Application:

Due to high electrical resistance, the insulators are used for protection against electric shocks.

Semiconductor

The semiconductors are the materials having conductivity in-between conductors and insulators. In a semiconductor, the forbidden energy gap between valance and conduction bands is very small (about 1 eV) as compared to insulators. Therefore, a smaller electric field (smaller than insulators but greater than conductors) is required to push the free electrons from valance band to the conduction band.



At low temperature, the valance band of semiconductor is completely full and the conduction band is completely empty. Thus, a semiconductor behaves as an insulator at low temperature. However, at room temperature, some electrons can cross the forbidden energy gap, imparting a little conductivity to the semiconductor.

As temperature is increased, more valance electrons cross over to the energy gap to reach to the conduction band and the conductivity increases. This shows that electrical conductivity of semiconductor increases with the rise in temperature. Hence, a semiconductor has negative temperature coefficient of resistance.

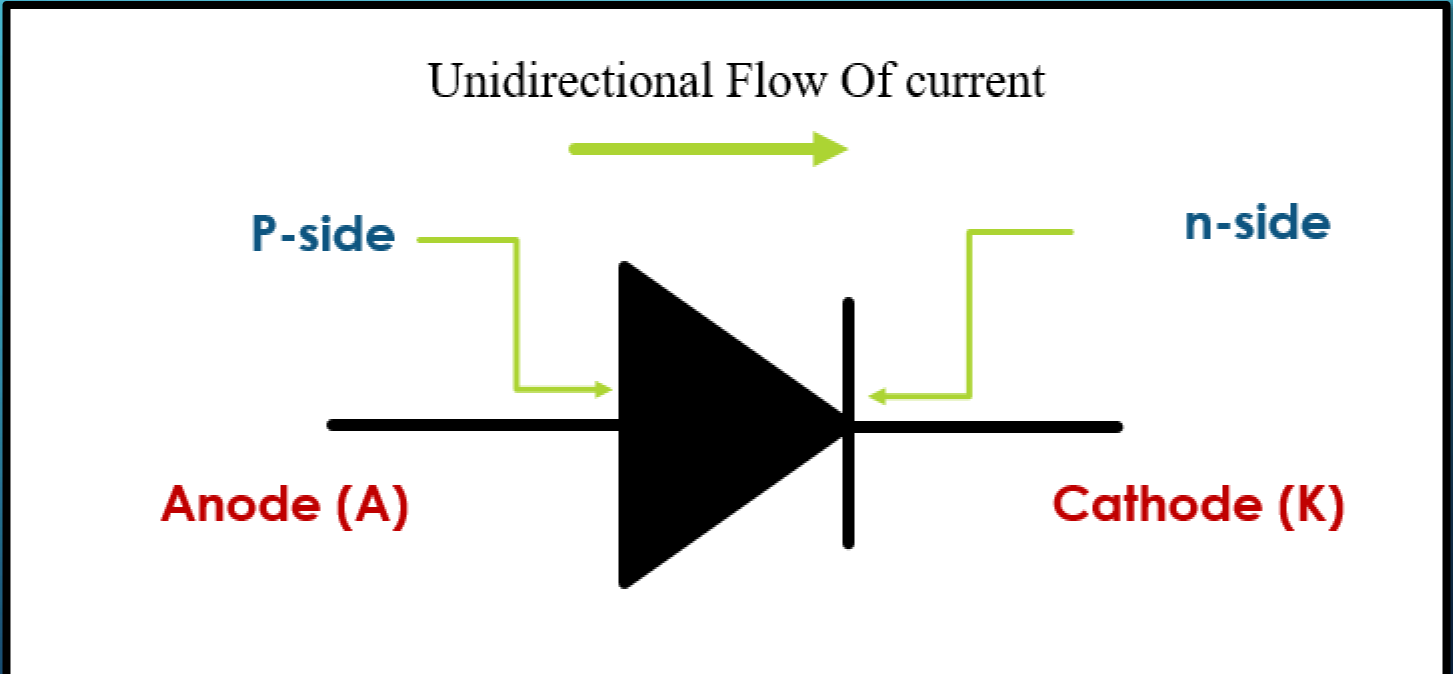
The conductivity of semiconductors can also be increased by adding some impurity in the pure semiconductor material, called doping. The semiconductors are commonly used in manufacturing of solid state electronic devices.

Difference between Conductor, Semiconductor and Insulator

Parameter	Conductor	Semiconductor	Insulator
Definition	A material that allows electric current to pass through it very easily.	A material that has conductivity in between conductors and insulators.	Materials that do not allow the electric current to pass through them.
Forbidden Energy Gap	No energy gap i.e. the conduction band overlap the valance band.	Small energy gap (approx. 1 eV).	Very large energy gap (approx. 15 eV).
Conductivity	High Conductivity	Intermediate conductivity	Very low conductivity
Conduction	Due to free electrons.	Due to movement of both electrons and holes	No conduction
Resistivity	Low	Intermediate	Very high
Temperature Coefficient of Resistivity	Positive	Negative	Negative
Valance Electrons in Outermost Shell	Less than 4	4	More than 4
Examples	Metals like gold silver, copper, aluminium etc.	Silicon, Germanium, Gallium, Arsenide etc.	Air, Mica, Glass, Paper, Porcelain, Wood etc.
Application	In the manufacturing of conducting wires and cables.	In the manufacturing of solid state electronic devices like ICs, diodes, transistors etc.	Used for providing insulation electrical and electronic devices, for preventing electric shock etc.

DIODE

A diode is a semiconductor device that essentially acts as a one-way switch for current. It allows current to flow easily in one direction, but severely restricts current from flowing in the opposite direction.



Symbol Of Diode

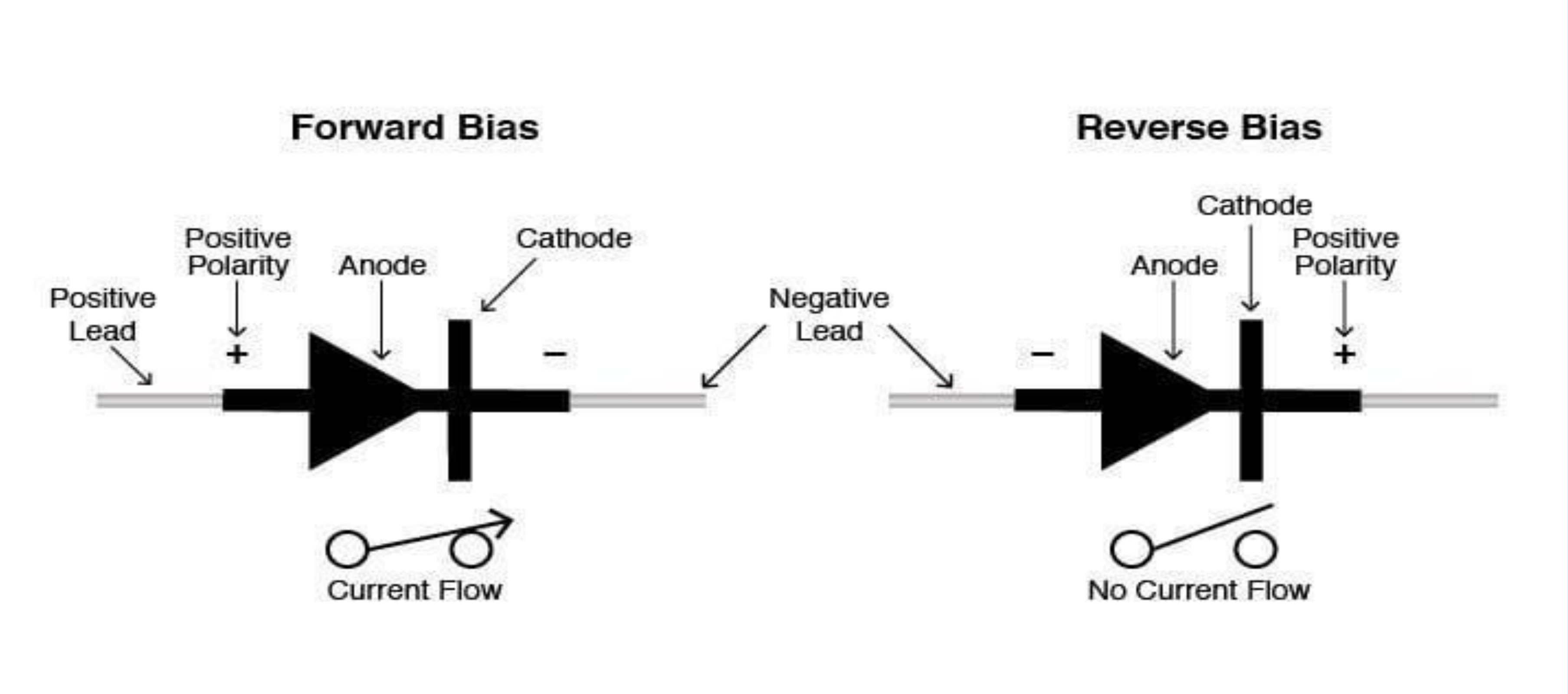
Diodes are also known as rectifiers because they change alternating current (ac) into pulsating direct current (dc).

Diodes are rated according to their type, voltage, and current capacity.

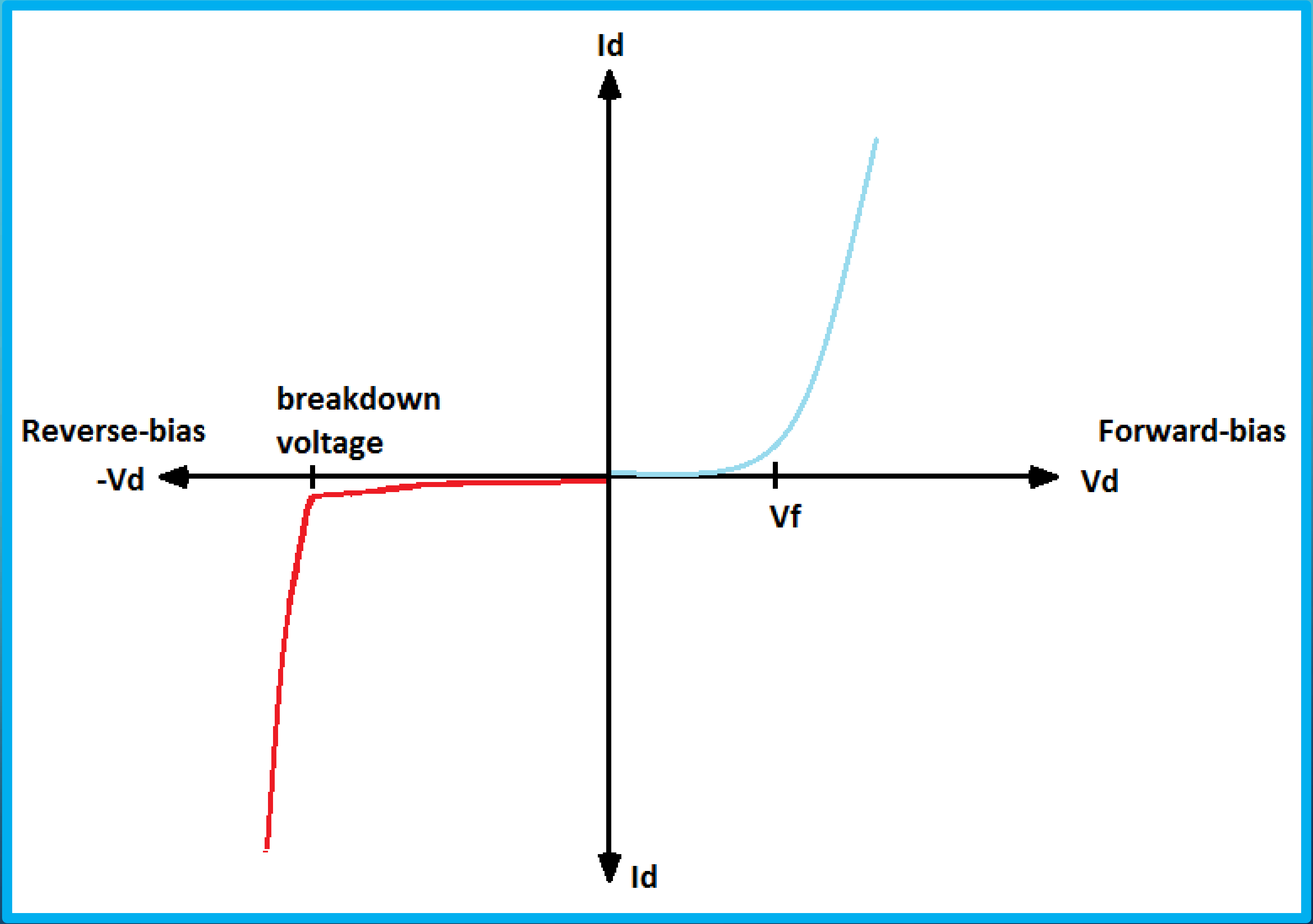
Diodes have polarity, determined by an anode (positive lead) and cathode (negative lead).

When a diode allows current flow, it is forward-biased.

When a diode is reverse-biased, it acts as an insulator and does not permit current to flow.

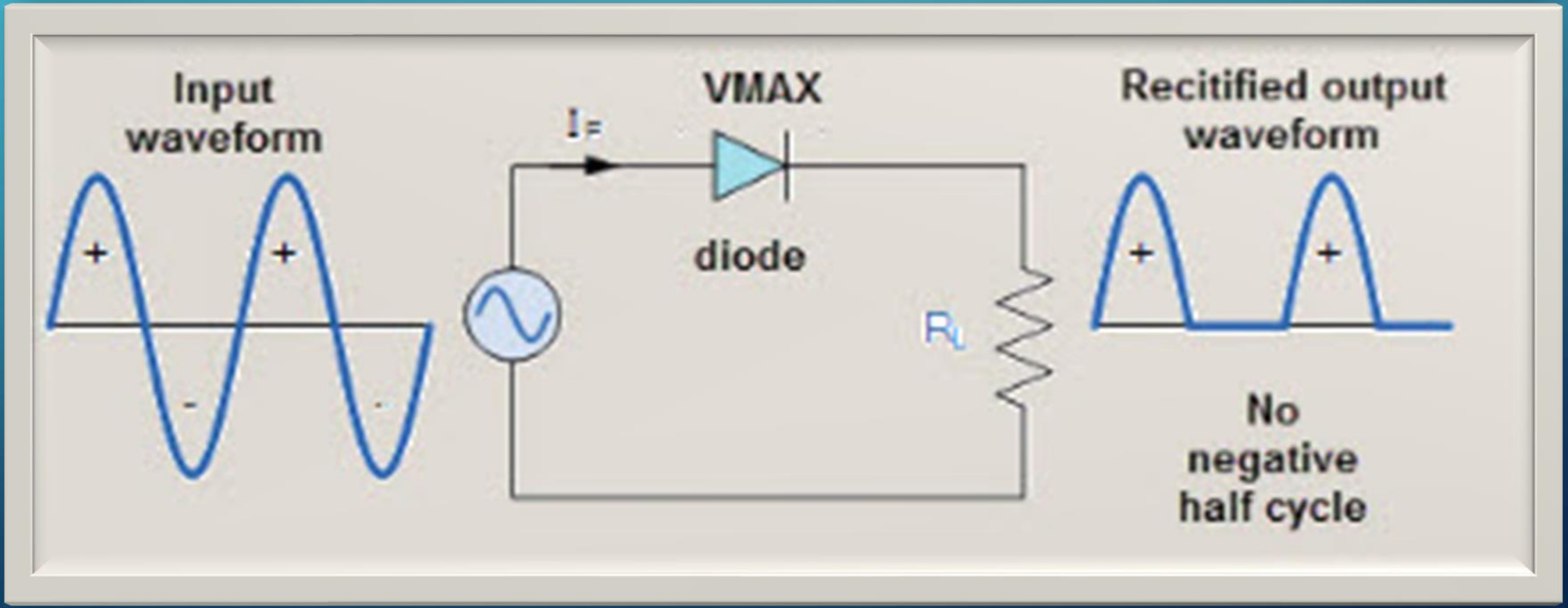


V-I Characteristics



Half-Wave Rectifier

One of the most common uses for the diode is to rectify the AC voltage into a DC power supply. Since, a diode can only conduct current one way, when the input signal goes negative, there will be no current. This is called a half-wave rectifier. The below figure shows the half-wave rectifier diode circuit.



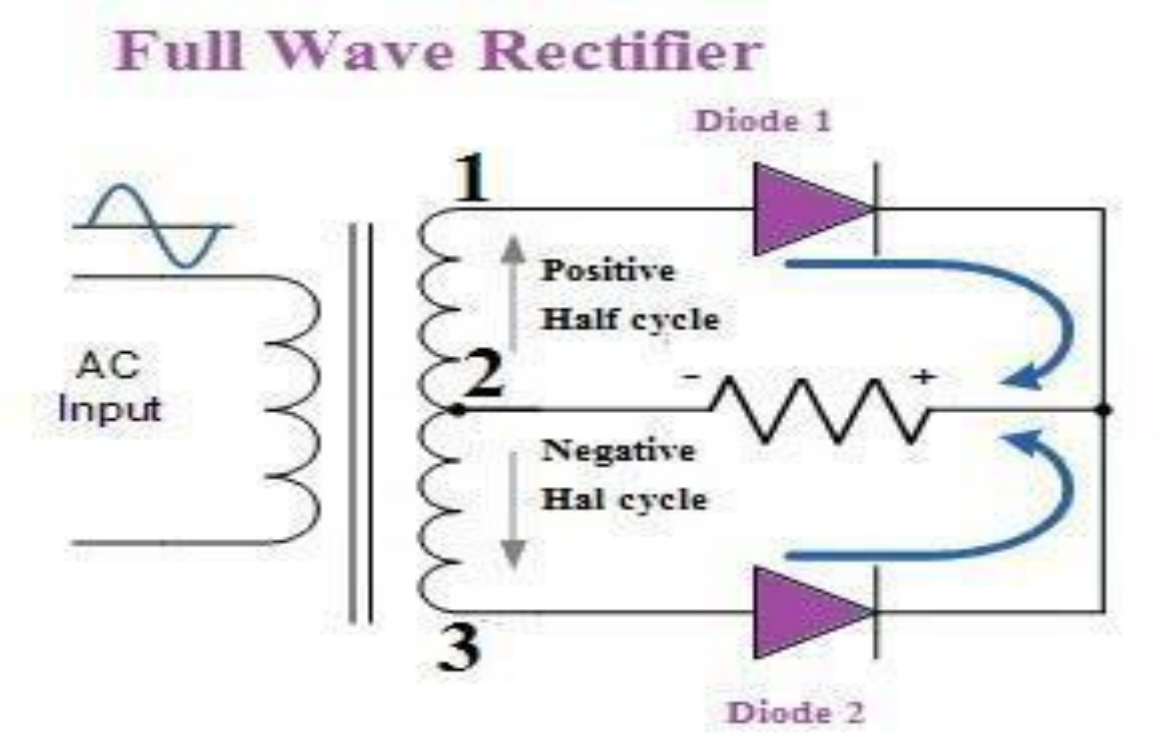
Full-Wave Rectifier

A full-wave rectifier diode circuit builds with four diodes, by this structure we can make both halves of the waves positive. For both positive and negative cycles of the input, there is a forward path through the diode bridge.

While two of the diodes are forward biased, the other two are reverse biased and effectively eliminated from the circuit. Both conduction paths cause current to flow in the same direction through the load resistor, accomplishing full-wave rectification.

The Full-wave rectifiers are used in power supplies to convert AC voltages to DC voltages. A large capacitor in parallel with the output load resistor reduces the ripple from the rectification process.

The below figure shows the full-wave rectifier diode circuit.

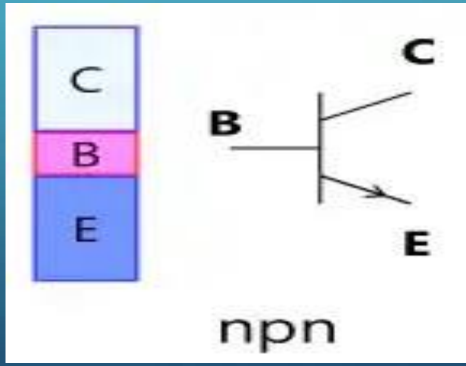


Bipolar junction transistor (BJT)

It is the type of transistor and three-terminal semiconductor device, which has two p-n junctions. A bipolar transistor consists of a three-layer **sandwich** of extrinsic semiconductor materials, either P-N-P or N-P-N.

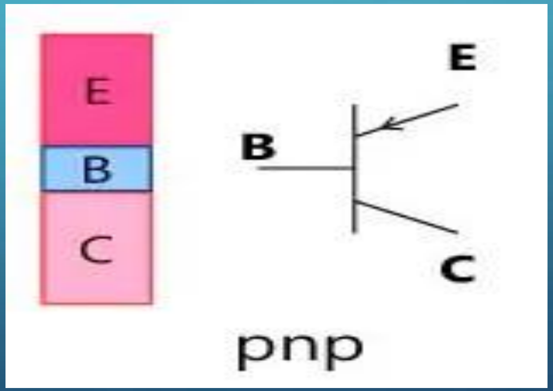
NPN Transistor

In NPN transistors, one p-type semiconductor is placed between two n-type semiconductors and it forms the two p-n junctions. These NPN transistors are widely used in many electronic devices, mainly to amplify weak signals. In the NPN transistors, the current flow will be usually from the emitter to the collector region.



PNP Transistor

In PNP transistors, one n-type semiconductor is sandwiched between the two p-type semiconductors and creates two p-n junctions. The PNP transistors are mainly used to control current flow through the circuit. Usually, the p-n junction is considered a diode. So, the transistors look like two crystal diodes connected in series. In the PNP transistor, the left side diode is known as the emitter-base diode. The right side diode is known as the collector-base diode.

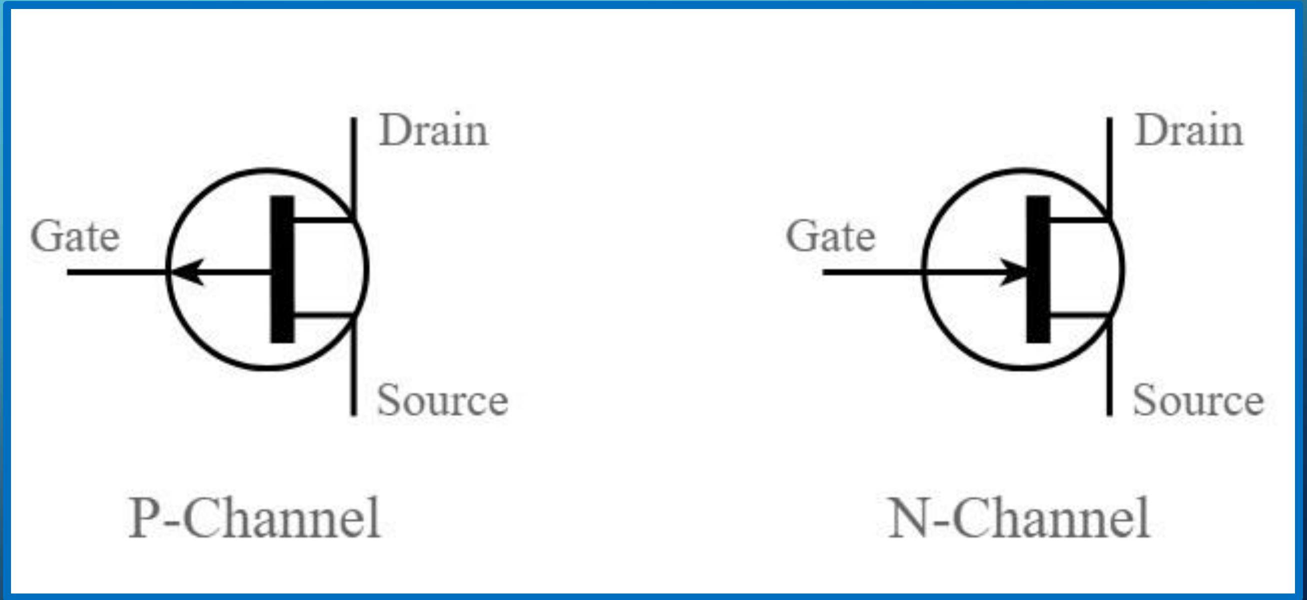


Field-effect transistor (FET)

The **field-effect transistor** (**FET**) is a type of transistor that uses an electric field to control the flow of current in a semiconductor. It comes in two types: Junction Gate FET (JFET) and Metal oxide semiconductor FET (MOSFET).

FETs have **three terminals:**

- *Source* (S)
- *Gate* (G)
- *Drain* (D)



Advantages and disadvantages of FET

Advantages of FET :

- High input impedance
- Longer life
- Less effect by radiation
- High efficiency
- Higher Temperature stability
- Less noise
- Smaller in size
- Can be fabricated with fewer processing

Disadvantages of FET :

- Smaller gain bandwidth
- Low voltage gain
- Costlier than junction transistor
- Special handling is required during installation
- Lower switching time
- When FET performance degrades as frequency increases