INTRODUCTION TO ELECTRONICS ENGINEERING

The branch of engineering which deals with current conduction through a vacuum or gas or semiconductor is known as electronics. An electronic device is that in which current flows through a vacuum or gas or semiconductor

(Or)

Electronics is the branch of science that deals with the study of the flow of electrons and their effects in a vacuum, gases, and semiconductor materials.

Applications:

Electronics has gained much importance due to its numerous applications in our daily life starting from home to any industry. For simplification we categorise them in some area such as

- **Consumer Electronics**. Electronics devices which make our life easy and better such as air conditioner, cooking appliances, dryer, personal computer, mobile phones, etc.
- **Commercial applications**. Electronic devices and gadgets are widely used for the commercial purpose such as Telephone, Airconditioning, heating, Digital Advertising, power supplies, Personal computer, MP3s, office equipment, light dimmer, uninterruptible power supplies (UPS), etc.
- **Medical applications**. With the advancement of the electronics field, and particularly that of computer technology has made possible many of the application which made possible for nurses and doctors to examine his patient. Many machines like NMR, ECE, x-ray, etc use electronics.

- **Agriculture application**. Electronics has proved to be the biggest problem solver in the agriculture field. Today number of electronics devices and sensors are used to monitor a crop or enhance the production of Agriculture. Like e-Agri Sensors and other electronic gadgets which are used for measuring the salinity of soil, moisture level, and nutrition level in the soil.
- **Industrial automation**. Electronics applications are widely utilized in Arc and Industrial furnaces such as blowers, fans, pumps and compressors, industrial lasers, transformer tap changers, rolling mills, textile mills, excavators, cement mills, welding. Nowadays most of the firms use robotics technology Such as in the manufacturing of cars.
- **Communication**. In order to communicate for far distance, Electronic devices and systems are used such as Am Radio, FM Radio, Television, processing, Memory storage, display, analysis, protection, etc.
- **Military & defense applications**. Electronics devices and machinery are also widely used in the military such as UAV and drones which are used in the military for aerial attack as well as for monitoring. Magnetic anomaly detector, People sniffer, Night vision device, infrared detector, RADAR, PNS , and night vision camera etc. are some gadgets used by the military.

- **Automobiles**. Electronics are used in road vehicles, such as Lighting system of the car, telematics, in- car sound systems, etc. Initially, electronics were used to in cars to control engines. Nowadays almost every things are controlled using electronics whether its a chair in car or speed limitation in car, or Gas management in the car. Now electronic with its advancement.
- **Aerospace**. Today with advancement in electronics engineering application in the field of aerospace has open many impossible ways to humans. Most of the parts used in the Space shuttle, Satellite power supplies, aircraft power management, and other communication instruments are electronics devices. Even in commercial airlines, there are numerous electronic devices which are used to measure different physical parameters like humidity, temperature, pressure, elevation, etc.

Basic Concept of Electron Emission & its types.

Electron emission is defined as the liberation of electrons from any surface of a substance.

Any metal consists of plenty of free electrons. Even at room temperature, these free electrons moves randomly inside the metal from one atom to another but can not leave the surface of the metal to provide electron emission.

This is because the free electrons reach the extreme boundary of the metal are pulled back by the positive nuclei behind them & their kinetic energy decreases. Thus at the surface of a metal, a free electron encounters forces that prevent it to leave the metal.

In other words, the metallic surface offers a barrier to free electrons and is known as surface barrier. However, if sufficient external energy is given to the free electron, its kinetic energy is increased and thus electron will cross over the surface barrier to leave the metal.

This additional energy required by an electron to overcome the surface barrier of the metal is called work function of the metal. The amount of additional energy required to emit an electron from a metallic surface is known as work function of that metal.

Types of Electron Emission.

The process of emission happens by supplying Energy equal to or greater than the work function to the metal & the electron absorbs the energy, thus able to overcome the surface barrier and leaves the metal surface. Depending on the process of supplying external energy to the metal surface, the emission is of different types.

(i) Thermionic Emission.
(ii) Field emission.
(iii) Secondary emission.
(iv) Photo-electric emission.

(i) Thermionic Emission.
The process of electron emission from a metal surface by supplying thermal energy to it is known as thermionic emission. In this method, the metal is heated to sufficient temperature (about 2500°C) to enable the free electrons to leave the metal surface. The number of electrons emitted depends upon the temperature. The higher the temperature, the greater is the emission of electrons. This type of emission is employed in vacuum tubes.

(ii) Field emission.
The process of electron emission by the application of strong electric field at the surface of a metal is known as field emission. In this method, when a sufficiently high positive charge is placed in front of the emitter surface, due to the strong electrostatic force of the created electric field, the free electron can get sufficient energy to overcome the surface barrier and can get emitted from the surface of the emitter body. As this type of electron emission is caused by the electric field present in the space, it is called field emission. The stronger the electric field, the greater is the electron emission.

(iii) Secondary emission.

Electron emission from a metallic surface by the bombardment of high- speed electrons or other particles is known as secondary emission. In this method, When a beam of high-velocity electrons stricks on the metal surface, the kinetic energy of high velocity striking electrons, transferred to the free electrons on the metal surface. Thus the free electrons may get sufficient kinetic energy to overcome the surface barrier and knocked out from the surface &start electron emission. This type of emission is known as secondary electron emission.The electrons that strike the metal are called primary electrons while the emitted electrons are known as secondary electrons.

(iv) Photo-electric emission.

Electron emission from a metallic surface by the application of light is known as photo electric emission. In this method, the energy of light falling upon the metal surface is transferred to the free electrons within the metal to enable them to leave the surface. The greater the intensity (i.e. brightness) of light beam falling on the metal surface, the greater is the photo-electric emission.

Principle of working and use of PN junction diode, Zener diode and Light Emitting Diode (LED)

PN Junction:
When ap-type & n-types emi conductor properly join together it form span junction. It is the basic building block for many semiconductor devices. After the formation of junction a large difference in carrier density exists which results holes in the p-side tends to diffuse into n-side leaving behind trivalent ion and electrons in the n-side are tends to diffuse into p- side leaving behind pentavalent ion.

Due to this charge separation a layer of negative charges (trivalent ions) in p-type & positive charges (pentavalent ions) in n- type near the junction created. These two layers of positive and negative charges form the depletion region(or depletion layer).

Once pn junction is formed and depletion layer created, the diffusion of free electrons stops. In other words, the depletion region acts as a barrier to the further movement of free electrons across the junction. Since the holes in p-side encounters a positive charge in n-side near the junction similarly electrons in n-side encounters a negative charge in p-side near the junction. The positive and negative charges set up an electric field. The electric field is a barrier to the free electrons in the n-region. There exists a potential difference across the depletion layer and is called barrier potential (V0)

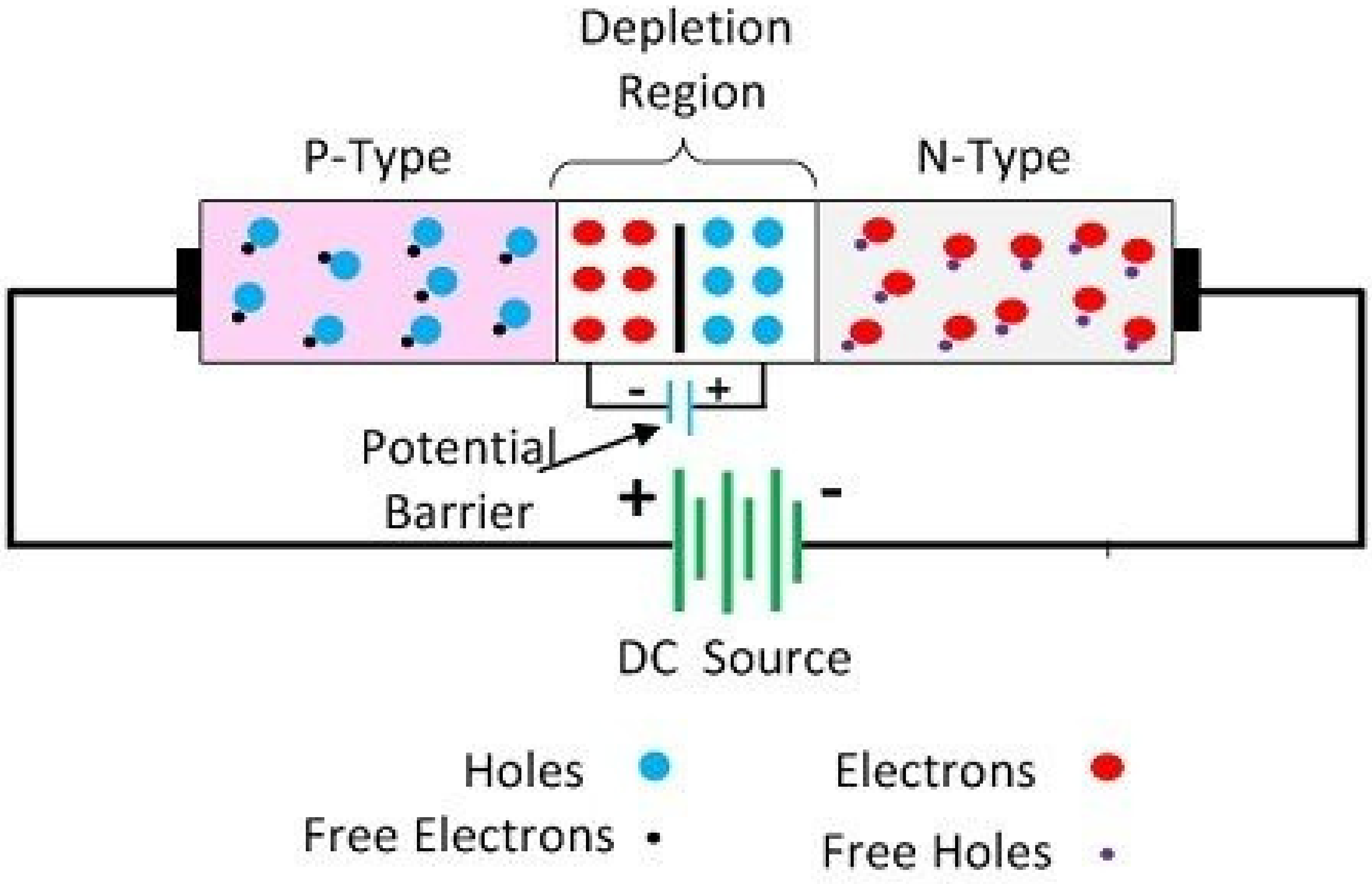
Pn- junction Diode: A pn junction is known as a semi- conductor or crystal diode. It is a two terminal unidirectional (allows current only in single direction) semiconductor device. The lead connected to p-side called anode and the lead connected to n-side called cathode of the diode. The circuit symbol of diode is shown in figure.

This pn junction does not allow flow of current. To make it suitable for electronics circuits we need to biasing (applying external voltage) pn- diode.

There are two ways of biasing pn-diode
(i) Forward biasing
(ii) Reverse biasing

(i) Forward biasing When a diode is connected in a Forward Bias condition, a negative voltage is applied to the N-type material and a positive voltage is applied to the P-type material. Like charges repel, so the free electrons are pushed toward the PN junction.

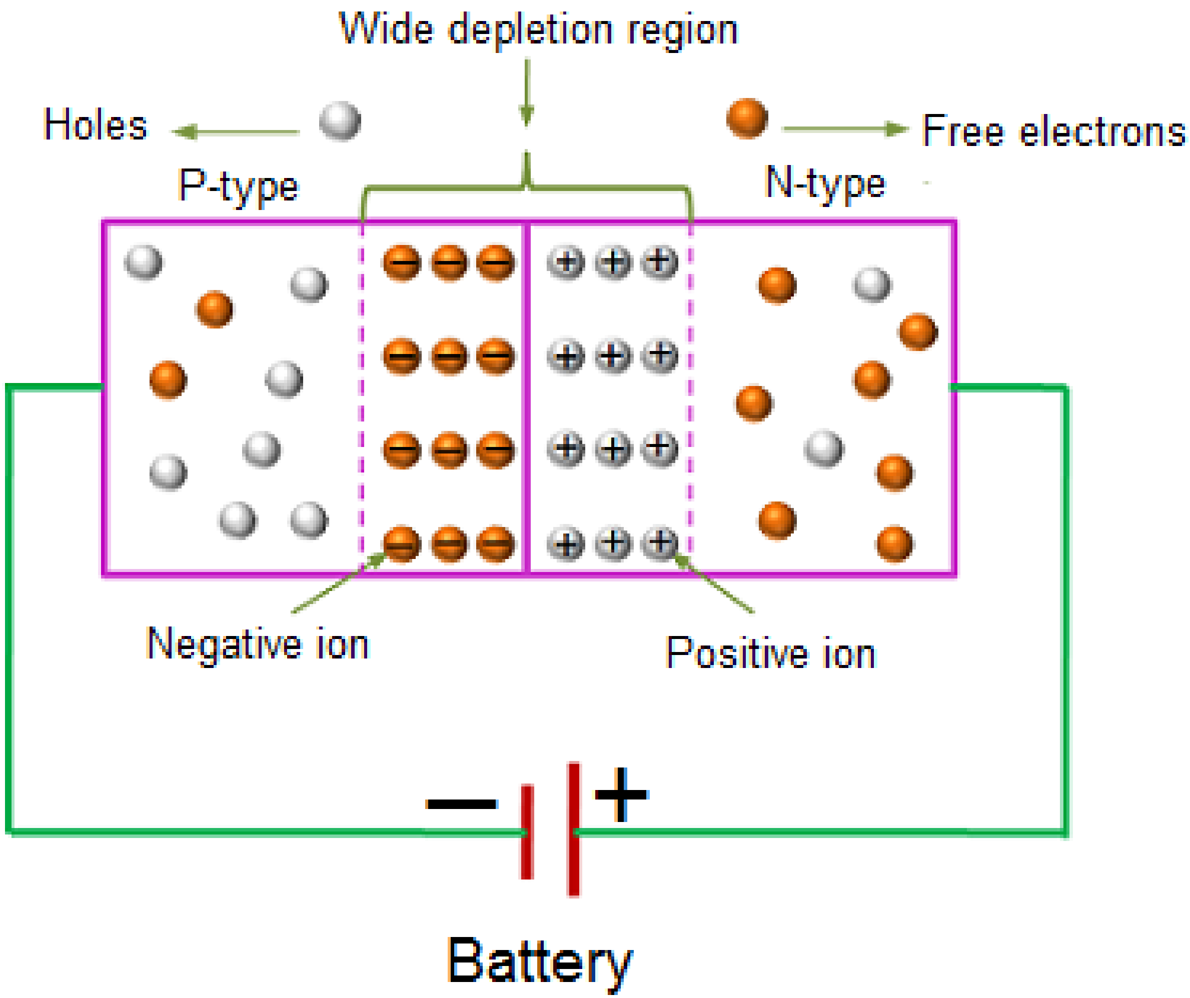
- Similarly, the holes are repelled by the positive terminal of the battery toward the PN junction. If the voltage pushing the electrons and holes has sufficient strength to overcome the depletion zone (approximately 0.7 V for typical silicon diode) the electrons and holes combine at the junction and current passes through the diode.
- The forward voltage at which the depletion region vanishes and the current in diode raises rapidly is called **Knee voltage**



Forward Biasing

ii) Reverse biasing When a diode is connected in a Reverse Bias condition, a positive voltage is applied to the N-type material and a negative voltage is applied to the P-type material.

- The negative terminal attracts the positive holes in the P-type silicon and the positive terminal of the battery attracts the free electrons in the N-type silicon. All the charge carriers are pulled away from the PN junction which essentially creates a larger depletion region. In reverse bias condition there is a small reverse leakage current because of minority carriers which is independent of reverse supply voltage called **Reverse saturation current**.
- The minimum reverse voltage at which pn junction breaks down with sudden rise in reverse current is called **Breakdown voltage**.



Reverse bias

VI characteristics of pn-diode

The graphical (V-I) characteristics of pn-diode is representation of the curve between voltage across the junction and the current through the circuit. Normally the voltage is taken along the x-axis and current along y-axis.

Applications of Diode

In forward bias condition, the diode allows electric current whereas in reverse bias condition, the diode does not allow electric current. Due to this characteristic, the diode finds number of applications as given below:

i. Rectification
ii. Clipper & Clamping circuits
iii. Voltage regulating circuits
iv. Light emitting diodes(LED) & Laser diodes
v. Switching Circuits

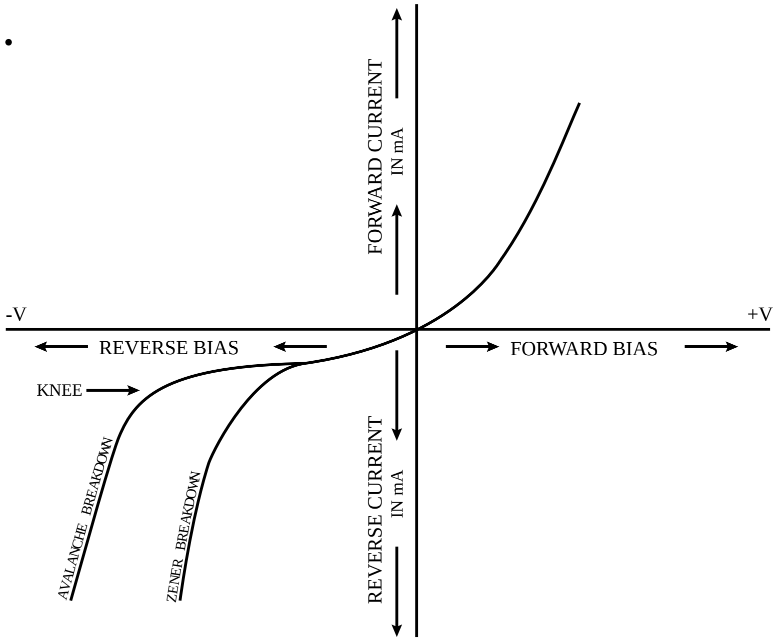
The breakdown occurs In reverse bias condition is two types as described below

i. Avalanche Breakdown
ii. Zener Breakdown.

i. Avalanche Breakdown

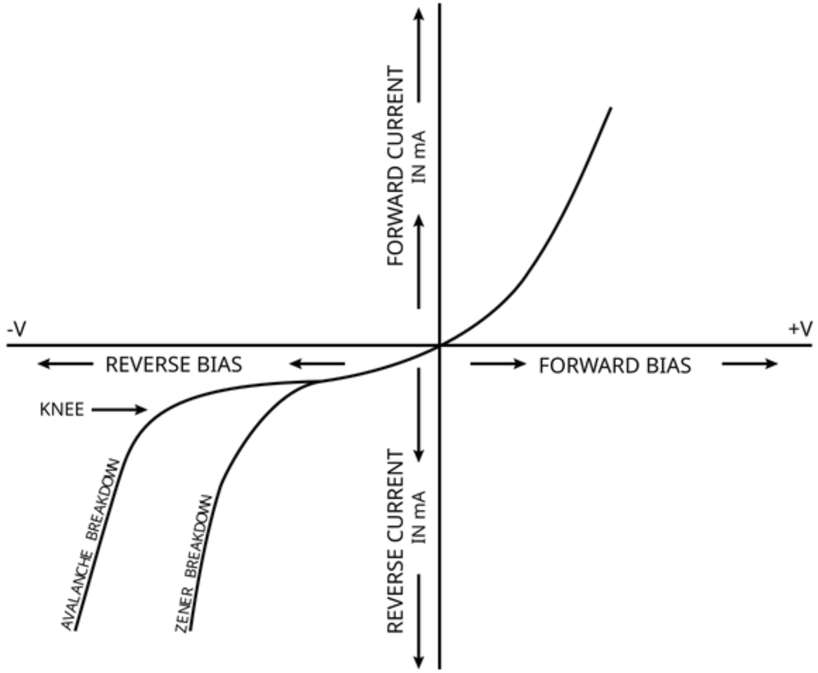
When the electric field is applied across the diode, the velocity of the charge carrier increases. This charge carrier collides with the other atoms and creates the pairs of hole and electrons. The free charge carrier further collides with other atoms and creates more pairs of electron and hole.

These free electrons start moving across the junction and develop the reverse bias current. The reverse bias current completely destroys the junction. And once the junction breakdown occurs, it cannot regain its original position. It occurs in the lightly doped pn junction having thick depletion region.

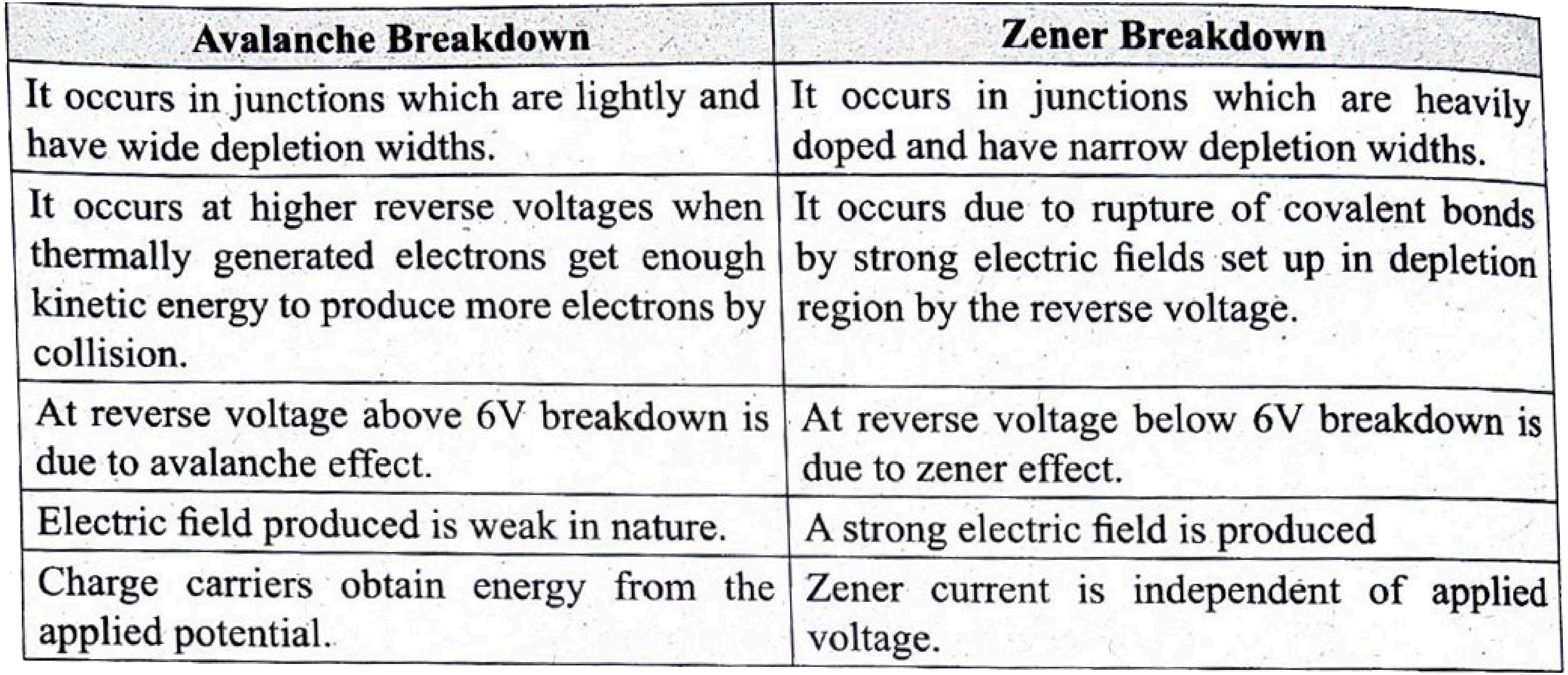


ii. Zener Breakdown.

When the high electric field is applied across the junction, the charge carrier starts jumping across the junction. These electrons constitute the heavy current in the reversed direction. In Zener breakdown, the temporary breakdown of junction occurs. The junction regains its original position when the reverse voltage removes. It occurs in the heavily doped pn junction having thin depletion region.



Difference between avalanche breakdown and zenerbreakdown



Avalanche Breakdown	Zener Breakdown
It occurs in junctions which are lightly and have wide depletion widths.	It occurs in junctions which are heavily doped and have narrow depletion widths.
It occurs at higher reverse voltages when thermally generated electrons get enough kinetic energy to produce more electrons by collision.	It occurs due to rupture of covalent bonds by strong electric fields set up in depletion region by the reverse voltage.
At reverse voltage above 6V breakdown is due to avalanche effect.	At reverse voltage below 6V breakdown is due to zener effect.
Electric field produced is weak in nature.	A strong electric field is produced
Charge carriers obtain energy from the applied potential.	Zener current is independent of applied voltage.

Thank You

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