UNIT V - Special Purpose Devices:
Zener Diode - Characteristics, Zener diode as Voltage Regulator, Principle of Operation - SCR, Tunnel diode, UJT, Varactor Diode, Photo diode, Solar cell, LED, Scottky diode.

5.1 Special Purpose Electronic Devices:

- There are few diodes which are designed to serve some special purposes.
  - Zener Diode
  - Tunnel Diode
  - Varactor Diode
  - Silicon Control Rectifier
  - UJT
  - Photo diode
  - Solar Cell
  - Schottky diode
  - LED

5.2 Zener Diode

- The zener diode is a silicon p-n junction semiconductor device, which is generally operated in its reverse breakdown region.

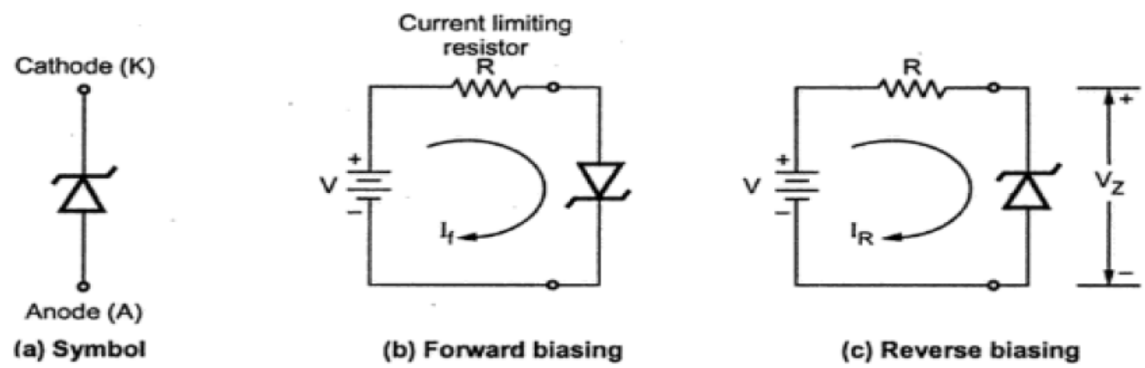


Fig. 5.10 Zener diode

- The zener diodes are fabricated with precise breakdown voltages, by controlling the doping level during manufacturing.
- The zener diodes have breakdown voltage range from 3 V to 200 V.
- The Fig. 5.10 (a) shows the symbol of zener diode.
- The d.c voltage can be applied to the zener diode so as to make it forward biased or reverse biased. This is shown in the Fig. 5.10 (b) and (c).
- Practically zener diodes are operated in **reverse biased mode**.

5.10.1 Characteristics of Zener Diode

- In the forward biased condition, the normal rectifier diode and the zener diode operate in similar fashion.
- But the zener diode is designed to be operated in the reverse biased condition.
- In reverse biased condition the diode carries reverse saturation current till the reverse voltage applied is less than the reverse breakdown voltage.
- When the reverse voltage exceeds reverse breakdown voltage, the current through it changes drastically but the voltage across it remains almost constant.
- Such a breakdown region is a normal operating region for a zener diode.
- VI characteristic of Zener diode is shown in figure 5.11.
- The first quadrant is the forward biased region. Here the Zener diode acts like an ordinary diode. When a forward voltage is applied, current flows through it.
- The third quadrant is the reverse biased region, when we apply a reverse bias to the diode.
- The Zener breakdown voltage (V_Z) is the reverse bias voltage after which a significant amount of current starts flowing through the Zener diode.

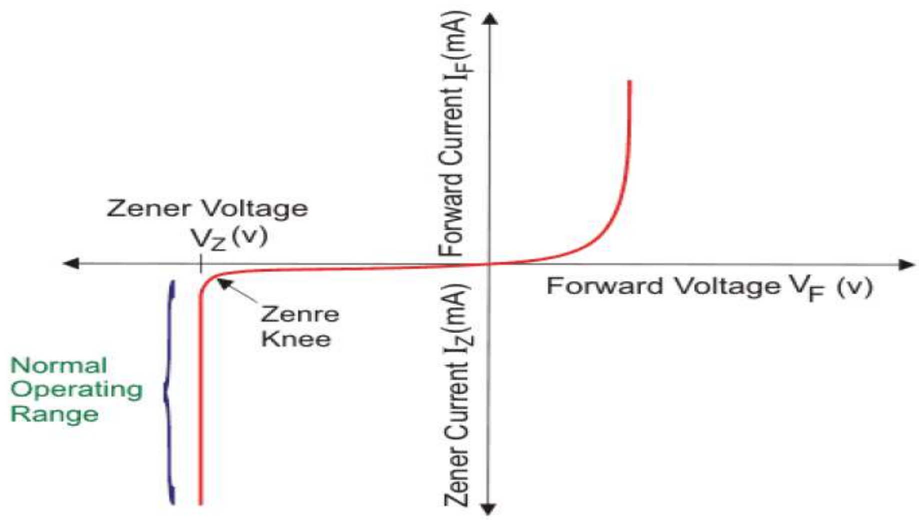


Fig. 5.11 V-I characteristics of Zener diode

- Until the voltage reaches Zener breakdown level, tiny amount of current flows through the diode.
- Once the reverse bias voltage becomes more than the Zener breakdown voltage, a significant amount of current starts flowing through the diode due to Zener breakdown.
- The voltage remains at the Zener breakdown voltage value, but the current through the diode increases when the input voltage gets increased.

5.10.2 Applications of Zener Diode

- Voltage Regulator
- Protection circuits
- Voltage Limiters

5.11 Zener Voltage Regulator

- As the voltage across the zener diode remains constant equal to V_z, it is connected across the load and hence the load voltage V_o is equal to the zener voltage V_z.
- Thus zener diode acts as an ideal voltage source which maintains a constant load voltage, independent of the current

5.11.1 Regulation with Varying Input Voltage

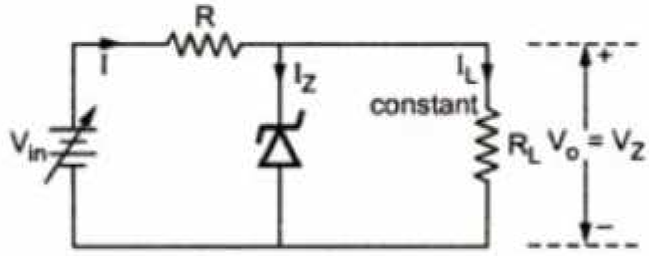


Fig. 5.12 Varying Input condition

- The Fig. 5.12 shows a zener regulator R under varying input voltage condition.
- It can be seen that the output is

$$V_o = V_Z \text{ is constant.}$$

$$\therefore \quad I_L = \frac{V_o}{R_L} = \frac{V_Z}{R_L} = \text{Constant}$$

$$\text{And } I = I_Z + I_L$$

- Now if V_{in} increases, then the total current I increases. But I_L is constant as V_z is constant. Hence the current I_z increases to keep $I_L$constant. But as long as I_z is between I_{Zmin} and I_{Zmax}, the V_zi.e. output voltage V_0 is constant.
- Similarly if V_{in} decreases, then current I decreases. But to keep I_L constant, $I_z$decreases. As long as I_z is between I_{Zmin} and I_{Zmax} , the output voltage remains constant.
- Process flow chart for zener regulator under varying V_{in} is,

V_{in} increases	→	$I = I_L + I_Z$ increases	→	I_L is constant (V_Z/R_L)	→	So I_Z increases ($I_Z = I - I_L$)	→	As long $I_Z < I_{Zmax}$, V_Z is constant i.e. output voltage is constant
V_{in} decreases	→	$I = I_L + I_Z$ decreases	→	I_L is constant (V_Z/R_L)	→	So I_Z decreases ($I_Z = I - I_L$)	→	As long $I_Z > I_{Zmin}$, V_Z is constant i.e. output voltage is constant

5.11.2 Regulation with Varying Load

- The Fig. 5.13 shows a zener regulator under varying load condition and constant input voltage.

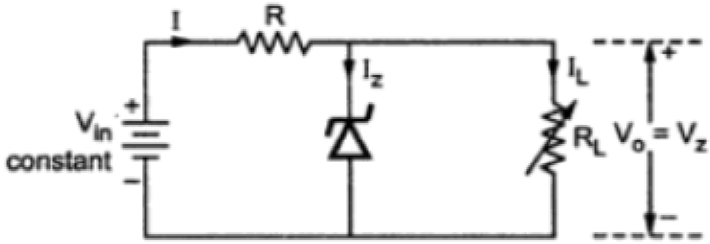


Fig. 5.13 Varying load condition

- The input voltage is constant while the load resistance R_L is variable.
- As V_{in} is constant and $V_o = V_z$ is constant, then for constant R the current I is constant.

$$\therefore I = \frac{V_{in} - V_Z}{R} \text{ constant } = I_L + I_Z$$

- Now if R_L decreases so I_L increases, to keep I constant I_z decreases. But as long as it is between I_{Zmin} and I_{Zmax}, output voltage $V_o$will be constant.
- Similarly if R_L increases so I_L decreases, to keep I constant I_z increases. But as long as it is between I_{Zmin} and I_{Zmax}, output voltage V_o will be constant.
- Process flow chart for zener regular under varying load is,

R_L increases I_L decreases	→	$I = \frac{V_{in} - V_Z}{R}$ constant	→	$I_Z = I - I_L$ increases	→	As long $I_Z < I_{Zmax}$, V_Z is constant i.e. output voltage is constant
R_L decreases I_L increases	→	$I = \frac{V_{in} - V_Z}{R}$ constant	→	$I_Z = I - I_L$ decreases	→	As long $I_Z > I_{Zmin}$, V_Z is constant i.e. output voltage is constant

5.12Tunnel Diode (Esaki Diode)

- A Tunnel diode is a heavily doped p-n junction diode in which the electric current decreases as the voltage increases.
- It is used mainly for low voltage high frequency switching applications.
- It works on the principle of Tunneling effect.
- It is also called as Esaki diode

Tunneling

A direct flow of electrons across the small depletion region from n-side conduction band into the p-side valence band.

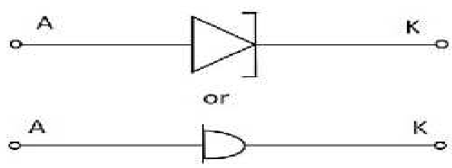


Fig. 5.14 Symbol of tunnel diode

5.12.1 Operation of Tunnel diode

Operation of tunnel diode can be done in three ways

- Under Open Circuit Condition (Unbiasing)
- Forward Biasing

Step 1: Unbiased tunnel diode

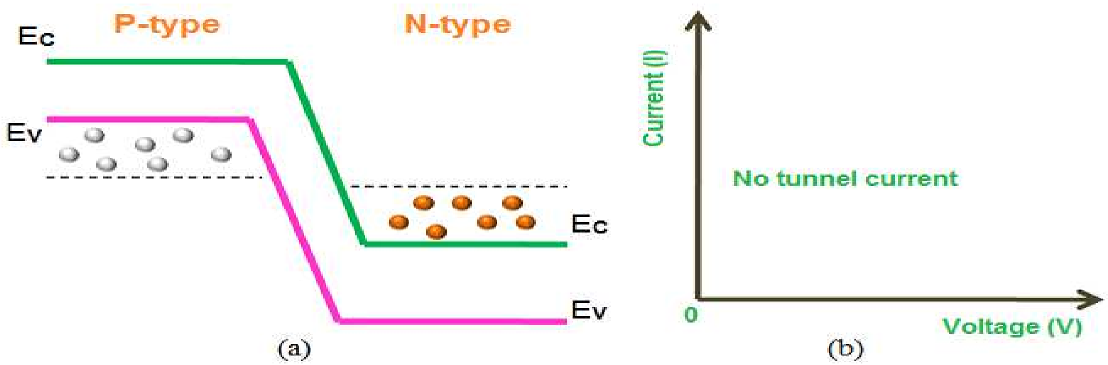


Fig. 5.15 a) Energy Band Diagram b) VI Characteristics

- When no voltage is applied to the tunnel diode, it is said to be an unbiased tunnel diode.
- In tunnel diode, the conduction band of the n-type material overlaps with the valence band of the p-type material because of the heavy doping.
- So when the temperature increases, some electrons tunnel from the conduction band of n-region to the valence band of p-region.
- In a similar way, holes tunnel from the valence band of p-region to the conduction band of n-region.
- However, the net current flow will be zero because an equal number of charge carriers (free electrons and holes) flow in opposite directions.

Step 2: Small voltage applied to the tunnel diode

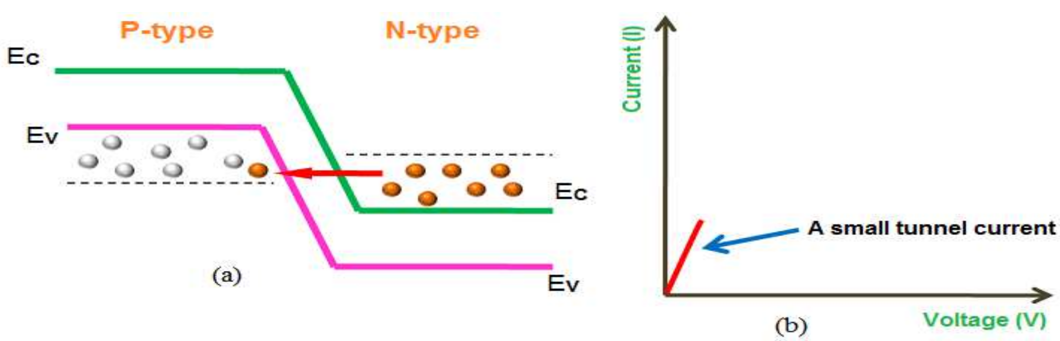


Fig. 5.16 a) Energy Band Diagram b) VI Characteristics

- When a small voltage is applied to the tunnel diode which is less than the built-in voltage of the depletion layer, no forward current flows through the junction.
- However, a small number of electrons in the conduction band of the n-region will tunnel to the empty states of the valence band in p-region.
- This will create a small forward bias tunnel current. Thus, tunnel current starts flowing with a small application of voltage.

Step 3: Applied voltage is slightly increased

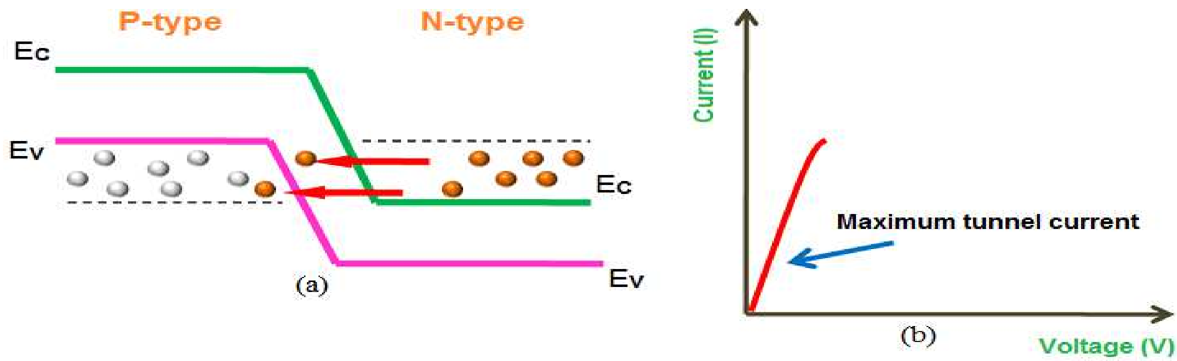


Fig. 5.17a) Energy Band Diagram b) VI Characteristics

- When the voltage applied to the tunnel diode is slightly increased, a large number of free electrons at n-side and holes at p-side are generated.
- Because of the increase in voltage, the overlapping of the conduction band and valence band is increased.
- In simple words, the energy level of an n-side conduction band becomes exactly equal to the energy level of a p-side valence band. As a result, maximum tunnel current flows.

Step 4: Applied voltage is further increased

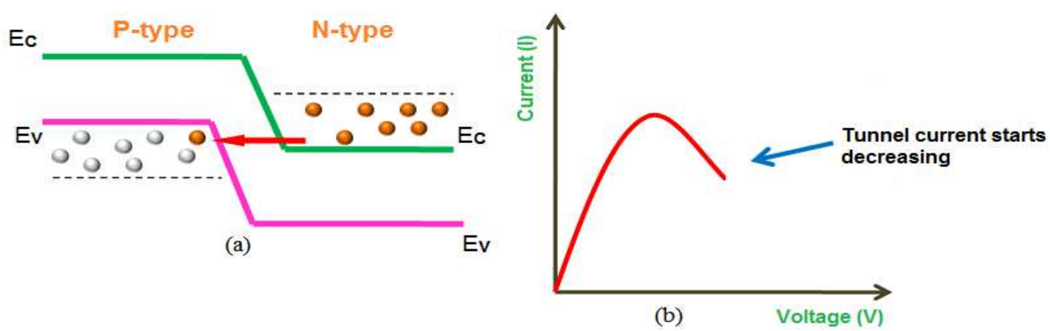


Fig. 5.18 a) Energy Band Diagram b) VI Characteristics

- If the applied voltage is further increased, a slight misalign of the conduction band and valence band takes place.
- Since the conduction band of the n-type material and the valence band of the p-type material sill overlap.

- The electrons tunnel from the conduction band of n-region to the valence band of p-region and cause a small current flow.
- Thus, the tunneling current starts decreasing.

Step 5: Applied voltage is largely increased

- If the applied voltage is largely increased, the tunneling current drops to zero.
- At this point, the conduction band and valence band no longer overlap and the tunnel diode operates in the same manner as a normal p-n junction diode.

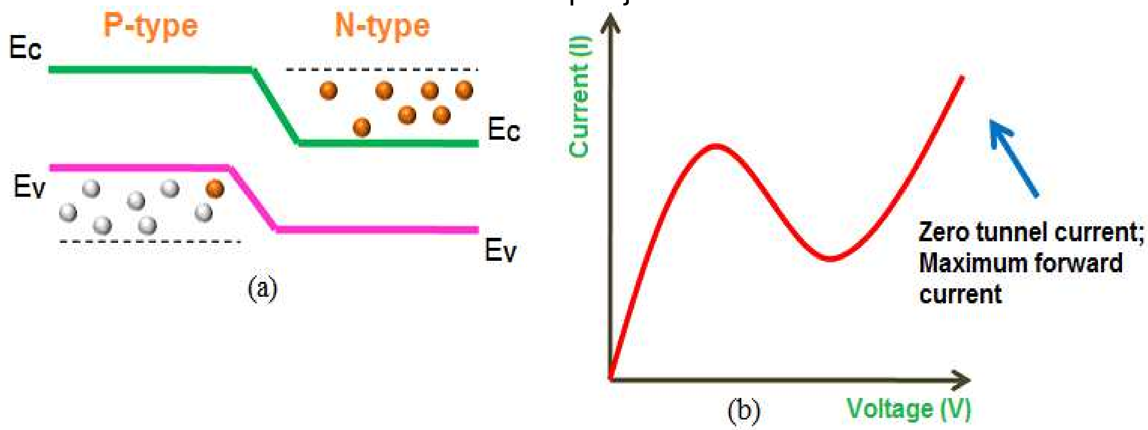


Fig. 5.19a) Energy Band Diagram b) VI Characteristics

- If this applied voltage is greater than the built-in potential of the depletion layer, the regular forward current starts flowing through the tunnel diode.
- The portion of the curve in which current decreases as the voltage increases is the negative resistance region of the tunnel diode.
- The negative resistance region is the most important and most widely used characteristic of the tunnel diode.

5.12.2 V-I Characteristics of a Tunnel diode

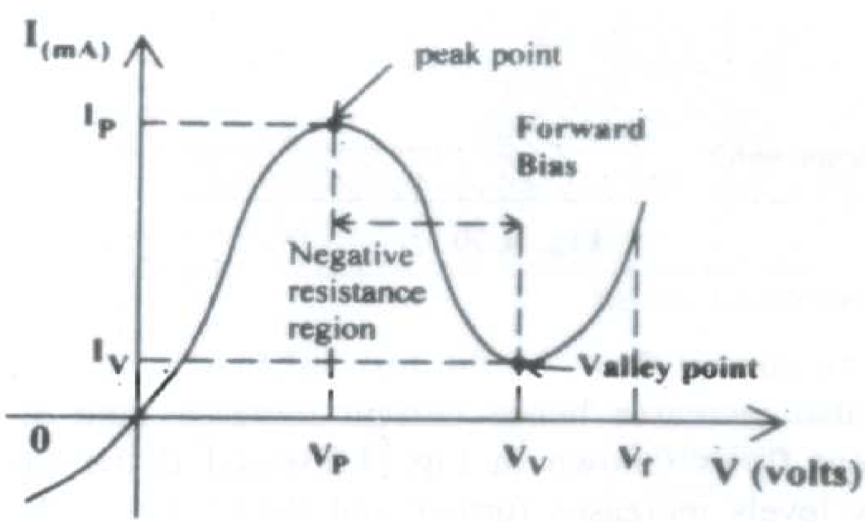


Fig. 5.20 VI characteristics of tunnel diode

- From V-I characteristics in forward bias up to some applied voltage current increases and at one voltage maximum current flows, that point is called peak point and the voltage at that point is called peak Voltage (V_P) and current at that point is called peak current (I_P).
- After this point current decreases with increases in applied voltage and at one voltage nearly zero current flows, that point is called valley point and the voltage at that point is called valley voltage (V_V) and current is called valley current (I_V).
- The region from peak point to valley point is called Negative Resistance Region.
- The tunnel diode is used as an oscillator and switch whenever it is operated in this region.

5.12.3 Advantages of tunnel diode

- High speed operation.
- Ease of operation.
- Low noise.
- Low cost.
- Low power.

5.12.4 Disadvantages of tunnel diode

- It is two terminal device, there is no isolation between the input and output circuit.
- Voltage range over which it can be operated is 1 V or less.

5.12.5 Applications of tunnel diode

- As a high speed switch
- In pulse and digital circuits
- In negative resistance and high frequency oscillator
- In switching networks
- In timing and computer logic circuitry.
- Design of pulse generators and amplifiers.

5.13 Varactor Diode

- In practice, special type of diodes is manufactured with transition capacitance. Such diodes are called Varactor diodes, Varicap, VVC (voltage variable capacitance), or tuning diodes.

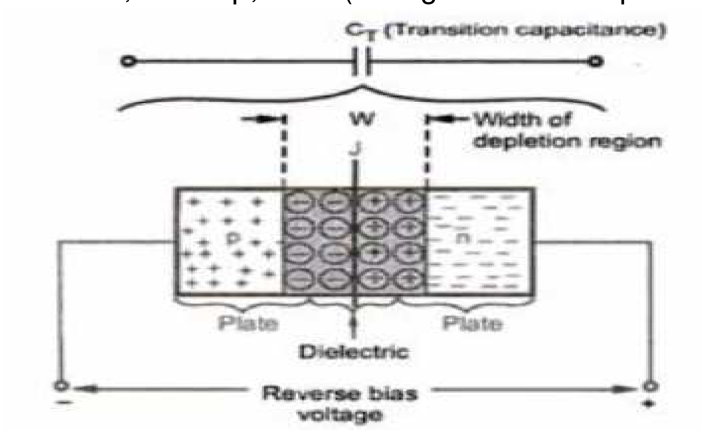


Fig. 5.21 Varactor diode

- When a diode is reverse biased, the width of the depletion region increases.

- So there are more positive and negative charges present in the depletion region.
- Due to this, the p-region and n-region act like the plates of capacitor while the depletion region acts like dielectric.
- Thus there exists a capacitance at the p-n junction called transition capacitance, junction capacitance, space charge capacitance, barrier capacitance or depletion region capacitance.
- It is denoted as C_T and is shown in figure 5.21.
- Mathematically it is given by the expression,

$$C_T = \frac{\varepsilon A}{W} \qquad \dots (1)$$

where ε = permittivity of semiconductor = $\varepsilon_0 \varepsilon_r$

$$\varepsilon_0 = \frac{1}{36\pi \times 10^9} = 8.849 \times 10^{-12} \text{ F/m}$$

ε_r = relative permittivity of semiconductor = 16 for Ge, 12 for Si

A = area of cross section

W = width of depletion region

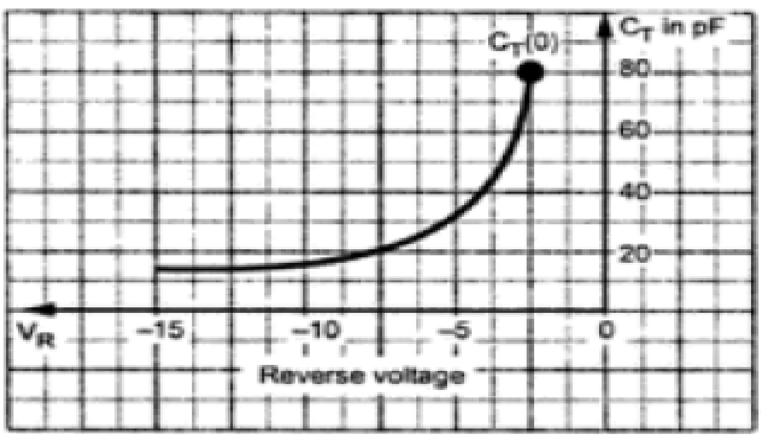


Fig. 5.22 Variation of C_T versus Reverse voltage

- As the reverse bias applied to the diode increases, the width of the depletion region (W) increases. Thus the transition capacitance Cr decreases.
- In short, the capacitance can be controlled by the applied voltage. The variation of C_T with respect to the applied reverse bias voltage is shown in the Fig. 5.22.
- As reverse voltage is negative, graph is shown in the second quadrant.
- For a particular diode shown, C_T varies from 80 pF to less than 5 pF as V_R changes from 2 V to 15 V.

5.13.1 Symbol and Equivalent Circuit of Varactor diode

- The Fig. 5.23 (a) shows the symbol of Varactor diode while the Fig. 5.23 (b) shows the first approximation for its equivalent circuit in the reverse bias region.

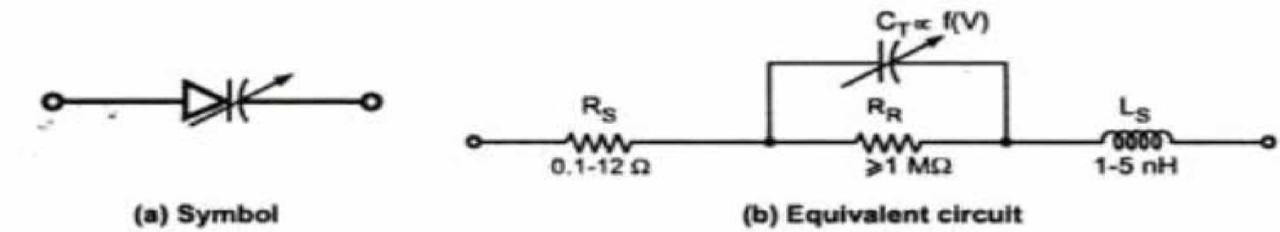


Fig. 5.23 Varactor diode

Where

R_R is the reverse resistance which is very large

R_S is the geometric resistanceof diode which is very small.

The inductance $L_S$indicates that there is a high frequencylimits associated with the use of varactor diodes.

- For a varactor diode, the transition capacitance in terms of applied reverse bias voltage is given by,

$$C_T = \frac{K}{(V_J + V_R)^n}$$

where
K = Constant depends on semiconductor material and construction technique
V_J = Junction potential
V_R = Magnitude of reverse bias voltage
$n = \frac{1}{2}$ for the alloy junctions
$= \frac{1}{3}$ for the diffused junctions

5.13.2 Applications of Varactor diode

- Tuned circuits
- FM modulators
- Automatic frequency control devices
- Adjustable bandpass filters
- Parametric amplifiers
- Television receivers

5.14 Silicon Controlled Rectifier (SCR)

- The SCR is an unidirectional device and it allows the current flow in only one direction.
- It has a built in feature to switch 'ON' and 'OFF'.

- The switching of SCR is controlled by the additional input called gate and biasing conditions.
- This switching property of SCR allows to control the 'ON' periods of the SCR thus controlling average power delivered to the load.
- It can be used as a rectifier element like diode to convert a.c signals to d.c signals.

5.14.1 Construction of SCR

- The SCR is a four layer p-n-p-n device where p and n layers are alternately arranged.
- The outer layers are heavily doped.
- There are three p-n junctions called J_1, J2 and J_3.
- The outer p layer is called anode while outer n layer is called cathode.
- Middle p layer is called gate.
- The three terminals are taken out respectively from these three layers, as shown in the Fig. 5.24.

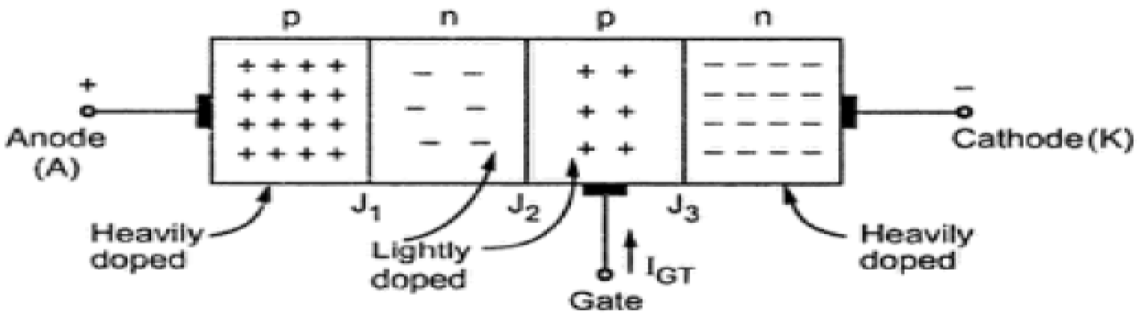


Fig. 5.24 Construction of SCR

- Anode must be positive with respect to cathode to forward bias the SCR But this is not sufficient criterion to turn SCR ON.
- To make it ON, a current is to be passed through the gate terminal denoted as I_{GT}. Thus it is a current operated device.
- The Fig. 5.25 shows the symbol of SCR

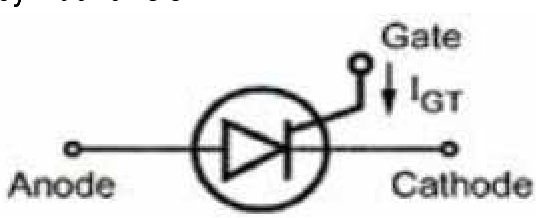


Fig. 5.25 Symbol of SCR

5.14.2 Operation of SCR

The operation of SCR is divided into two categories.

- When gate is open
- When gate is closed

5.14.2.1 When gate is open

- Consider that the anode is positive with respect to cathode and gate is open.

- Then junctions J_1 and J_3 are forward biased and junction J_2 is reverse biased.
- There is depletion region around J_2 and only leakage current flows which is negligibly small.
- Practically the SCR is said to be OFF.
- This is called forward blocking state of SCR and voltage applied to anode and cathode with anode positive is called forward voltage.
- This is shown in the Fig. 5.26 (a).
- With gate open, if cathode is made positive with respect to anode, the junctions J_1, J_3 become reverse biased and J_2 forward biased.
- Still the current flowing is leakage current, which can be neglected as it is very small.
- The voltage applied to make cathode positive is called reverse voltage and SCR is said to be in reverse blocking state.

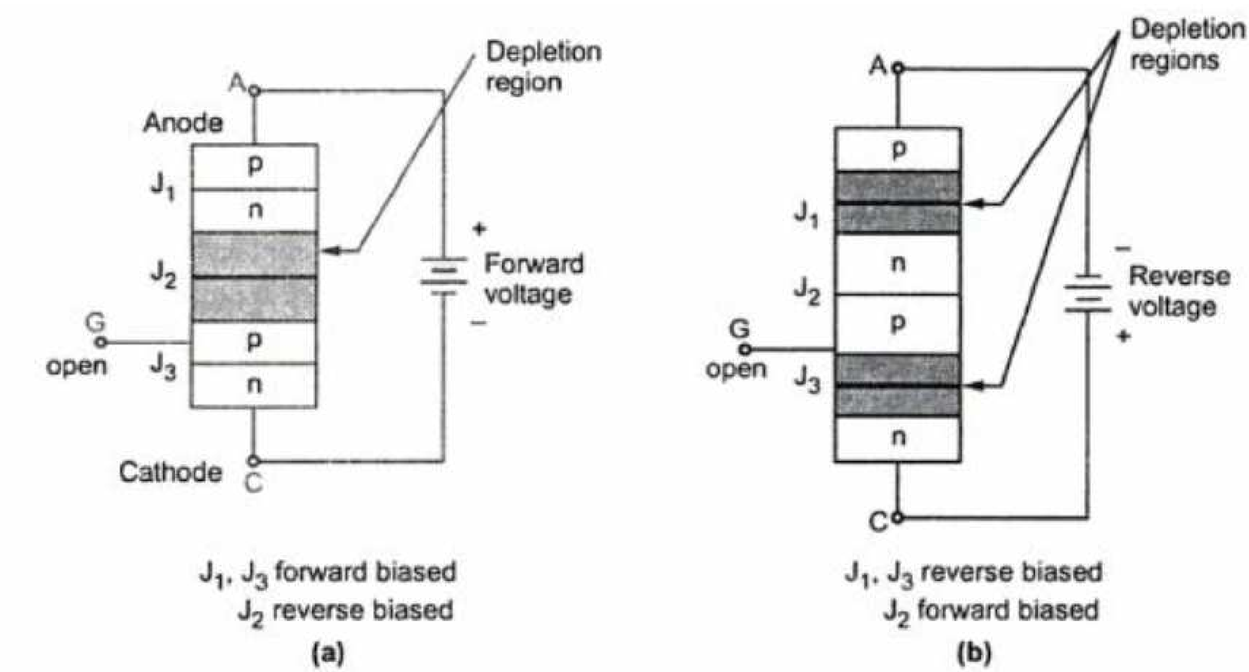


Fig. 5.26 Operation of SCR when Gate is open

- This is shown in the Fig. 5.26(b).
- In forward blocking state, if the forward voltage is increased, the current remains almost zero upto certain limit.
- At a particular value, the reverse biased junction J_2 breaks down and SCR conducts heavily. This voltage is called forward breakover voltage V_{BO}.
- In such condition SCR is said to be ON or triggered.

5.14.2.2 When gate is closed

- Consider that the voltage is applied between gate and cathode when the SCR is in forward blocking state.
- The gate is made positive with respect to the cathode.

- The electrons from n-type cathode which are majority in number, cross the junction J_3 to reach to positive of battery.

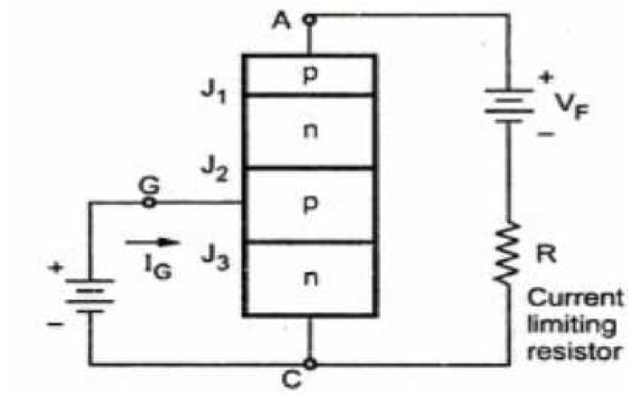


Fig. 5.27 Operation of SCR when Gate is closed

- While holes from p-type move towards the negative of battery, this constitutes the gate current. This current increases the anode current as some of the electrons cross junction J_2.
- As anode current increases, more electrons cross the junction J_2 and the anode current further increases.
- Due to regenerative action, within short time, the junction J_2 breaks and SCR conducts heavily. The connections are shown in the Fig. 5.27.
- The resistance R is required to limit the current.
- Once the SCR conducts, the gate loses its control.

5.14.3 VI Characteristics of SCR

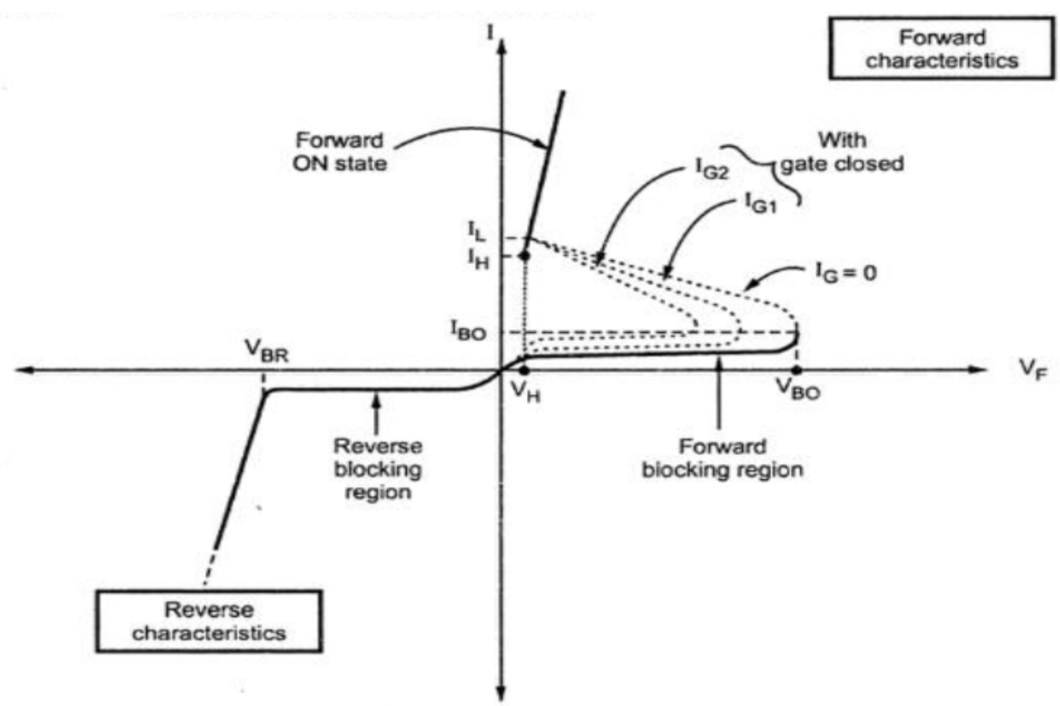


Fig. 5.28 VI Characteristics of SCR

- The Fig. 5.28 shows the characteristics of SCR. The characteristics are divided into two sections.
    - Forward characteristics
    - Reverse characteristics

5.14.3.1 Forward characteristics

- It shows a forward blocking region, when $I_G = 0$.
- It also shows that when forward voltage increases upto V_{BO}, the SCR turns ON and high current results.
- The drop across SCR reduces suddenly which is now the ohmic drop in the four layers.
- The current must be limited only by the external resistance in series with the device.
- It also shows that, if gate bias is used then as gate current increases, less voltage is required to turn ON the SCR.
- If the forward current falls below the level of the holding current I_H, then depletion region begins to develop around J_2 and device goes into the forward blocking region.
- When SCR is turned ON from OFF state, the resulting forward current is called latching current I_L.The latching current is slightly higher than the holding current.

5.14.3.2 Reverse characteristics

- If the anode to cathode voltage is reversed, then the device enters into the reverse blocking region. The current is negligibly small and practically neglected.
- If the reverse voltage is increased, similar to the diode, at a particular value avalanche breakdown occurs and a large current flows through the device. This is called reverse breakdown voltage V_{BR}.

5.14.4 Specifications of SCR

1. Forward breakover voltage (V_{BO}):

- It is the voltage above which the SCR enters the conduction region (ON state). The forward breakdown voltage is dependent on the gate bias.

2. Holding current (I_H):

- It is that value of current below which the SCR switches from the conduction state (ON state) to the forward blocking state.

3. Latching current (I_L):

- This is the minimum current flowing from anode to cathode when SCR goes from OFF to ON state and remains in ON state even after gate bias is removed.
- It is greater than, but very close to holding current.

4. Reverse breakdown voltage (V_{BR}):

- It is the reverse voltage (Anode-negative and cathode-positive) above which the reverse breakdown occurs, breaking J_1 and J_3 junctions.

- Therefore, the forward breakover voltage V_{BO} is greater than the reverse breakover voltage V_{BR}.

5. Minimum gate trigger current (I_{GTmin}):

- The minimum value of gate current which can trigger SCR is defined as $I_{GTmin.}$

6. Maximum gate current (I_{GTmax}):

- It is the peak value of gate current which must not be exceeded to avoid damage to the SCR.

5.14.5 Merits of SCR

- Very small amount of gate drive is required.
- SCRs with high voltage and current ratings are available.
- On state losses of SCR are less.

5.14.6 Demerits of SCR

- Gate has no control, once SCR is turned on.
- External circuits are required for turning it off.
- Operating frequencies are low.
- Additional protection circuits are required.

5.14.7 Applications of SCR

- Switching
- Power (AC & DC) control
- Over-voltage protection
- Battery charging regulator.

5.15Unijunction Transistor (UJT)

- A Unijunction transistor (UJT) is a device which does not belong to thyristor family but is used to turn ON SCRs.
- It is a three terminal device namely Emitter (E), Base1 (B_1) and base2 (B_2).

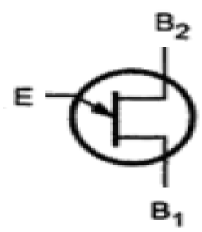


Fig. 5.29 Symbol of UJT

5.15.1 Equivalent Circuit of UJT

- The Fig. 5.30 (a) shows the basic structure of UJT while the Fig. 5.30 (b) shows the equivalent circuit of UJT.

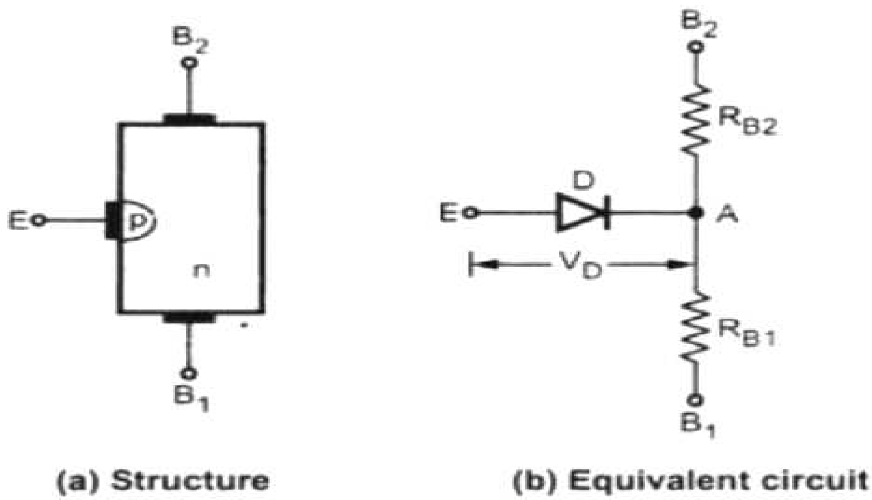


Fig. 5.30 Equivalent Circuit of UJT

- The internal resistances of the two bases are represented as R_{B1} and R_{B2}.
- In the actual construction, the terminal E is closer to B_2 as compared to B_1.
- Hence resistance R_{B1} is more than the resistance R_{B2}.
- The p-n junction is represented by a normal diode with V_D as the drop across it.
- When the emitter diode is not conducting then the resistance between the two bases B_1 and B_2 is called interbase resistance denoted as R_{BB} and its value ranges between 4 KΩ and 12 KΩ.

$$R_{BB}=R_{B1}+R_{B2}$$

5.15.2 Intrinsic Standoff Ratio (η)

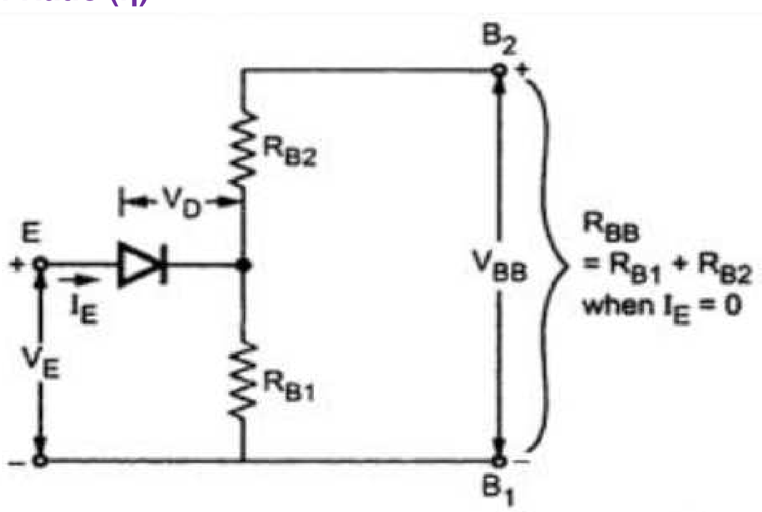


Fig. 5.31 Intrinsic Standoff Ratio

Then the voltage drop across R_{B1} can be obtained by using potential divider rule.

$$V_{RB1} = \frac{R_{B1} V_{BB}}{R_{B1} + R_{B2}} = \eta V_{BB} \quad \text{... when } I_E = 0$$

Then $$\eta = \text{Intrinsic stand off ratio} = \left.\frac{R_{B1}}{R_{B1} + R_{B2}}\right|_{I_E=0}$$

$$\eta = \left.\frac{R_{B1}}{R_{BB}}\right|_{I_E=0}$$

- The typical range of η is from 0.5 to 0.8.

5.15.3 Principle of Operation

- The supply V_{BB} is applied between B_2 and B_1, while the variable emitter voltage V_E is applied across the emitter terminals.
- This arrangement is shown in the Fig. 5.32.
- Let us see the effect of change in V_E. The potential of A is decided by η and is equal to ηV_{BB}.

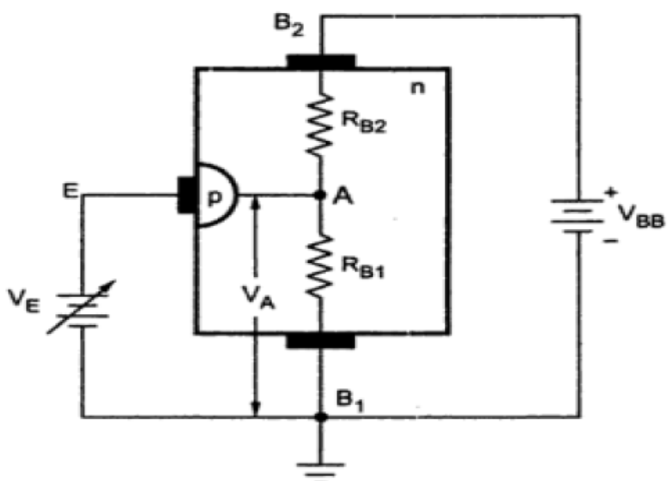


Fig. 5.32 Operation of UJT

Case 1: $V_E < V_A$

- As long as V_E is less than V_A,the p-n junction is reverse biased.
- Hence emitter current I_E will not flow. Thus UJT is said to be OFF.

Case2: VE> V_P

- The diode drop V_D is generally between 0.3 to 0.7 V. Hence we can write,

$$V_P = V_A + V_D = \eta V_{BB} + V_D$$

- When V_E becomes equal to or greater than V_P the p-n junction becomes forward biased and current I_E flows. The UJT is said to be ON.

5.15.4 Characteristics of UJT

- The graph of emitter current against emitter voltage plotted for a particular value of V_{BB} is called the characteristics of UJT.
- For a particular fixed value of V_{BB} such characteristics is shown in the Fig. 5.33.

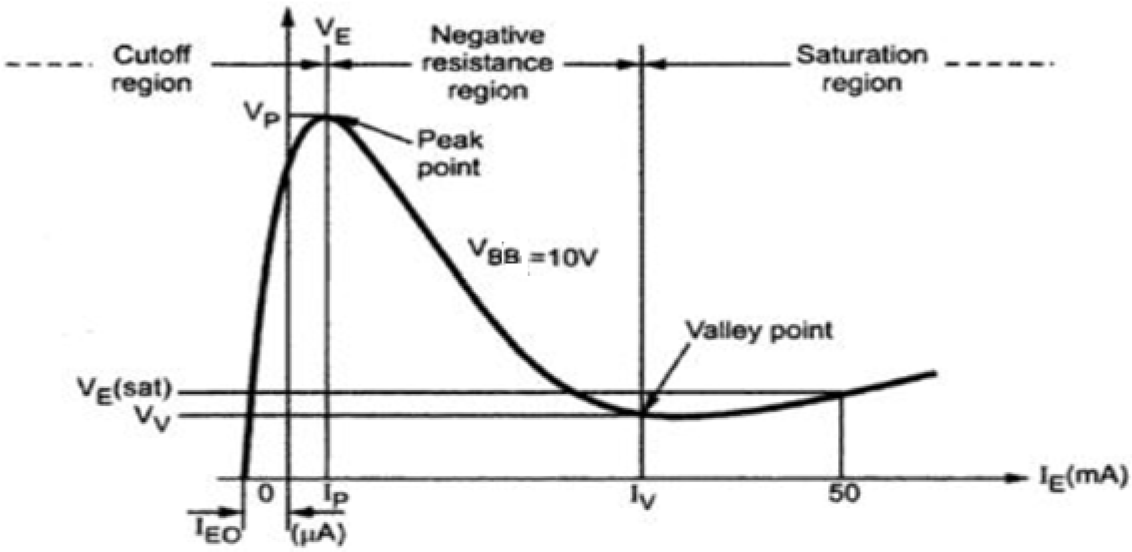


Fig. 5.33 Characteristics of UJT

The characteristics can be divided into three main regions which are,

1. Cut off region:

- The emitter voltage V_E is less than V_P and the p-n junction is reverse biased.
- A small amount of reverse saturation current I_{EO} flows through the device, which is negligibly small of the order of μA.
- This condition remains till the peak point.

2. Negative resistance region:

- When the emitter voltage V_E becomes equal to V_P the p-n junction becomes forward biased and I_E starts flowing.
- The voltage across the device decreases in this region, though the current through the device increases.
- Hence the region is called negative resistance region.
- This decreases the resistance R_{B1}.
- This region is stable and used in many applications.
- This region continues till valley point.

3. Saturation region:

- Increase in I_E further valley point current I_V drives the device in the saturation region.
- The voltage corresponding to valley point is called valley point voltage denoted as V_V.
- In this region, further decrease in voltage does not take place.
- The characteristic is similar to that of a semiconductor diode, in this region.

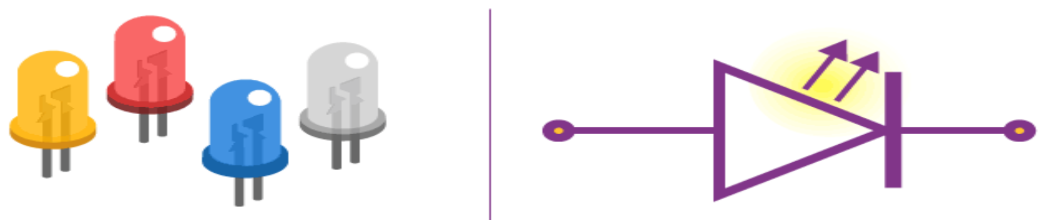
As the V_{BB} increases, the potential V_P corresponding to peak point will increase.

5.15.5 Applications of UJT

- Triggering of SCR
- SawtoothWave Generators
- Relaxation Oscillator

Light-Emitting Diode (LED)

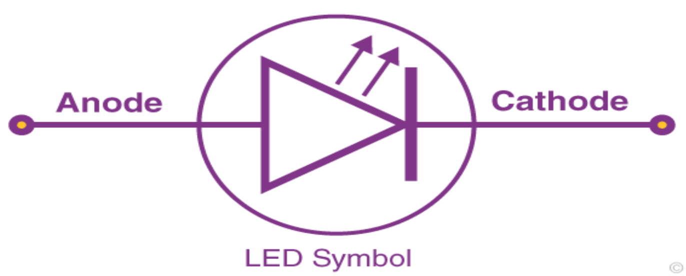
A light-emitting diode (LED) is a semiconductor device that emits light when an electric current flows through it. When current passes through an LED, the electrons recombine with holes emitting light in the process. LEDs allow the current to flow in the forward direction and blocks the current in the reverse direction.



Light-emitting diodes are heavily doped p-n junctions. Based on the semiconductor material used and the amount of doping, an LED will emit coloured light at a particular spectral wavelength when forward biased.

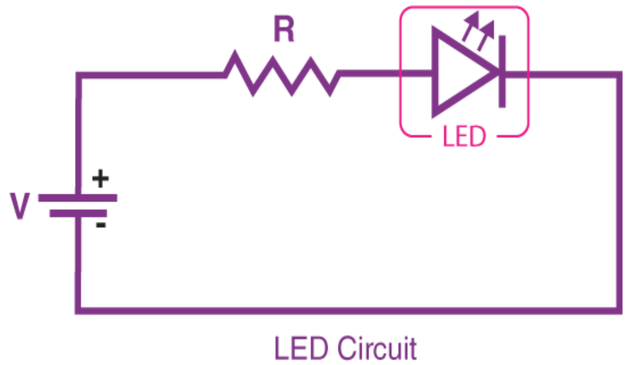
LED Symbol

The LED symbol is the standard symbol for a diode, with the addition of two small arrows denoting the emission of light.



Simple LED Circuit

The figure below shows a simple LED circuit.

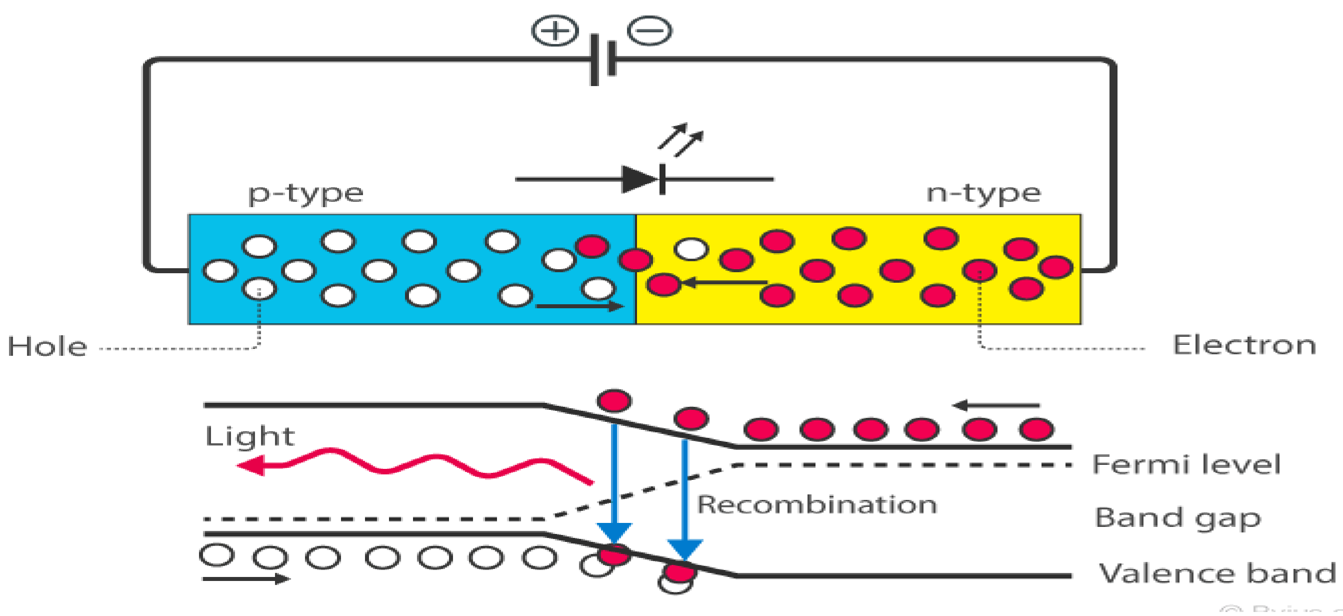


The circuit consists of an LED, a voltage supply and a resistor to regulate the current and voltage.

<u>LED Working Principle</u>

The LED Light Emitting Diode works like a regular diode. It allows the flow of current in the forward direction (forward biased) and blocks the current in the reverse direction (reverse biased). The LEDs can emit light when it is in the forward bias condition.

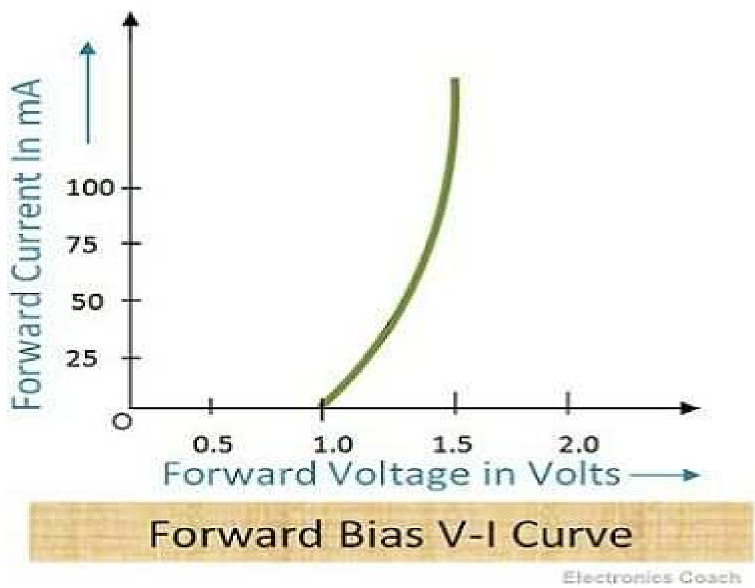
When an LED is forward biased, then the free electrons from the N-type region gain enough energy to cross the junction and recombine with the holes in the P-type region. Initially, free electrons from the N-type region are in the conduction band but as they cross over into the P-type region, they release energy and fall into a hole in the valence band. As a result, this energy released in the form of light. But, normal silicon diode is released energy in the form of heat.



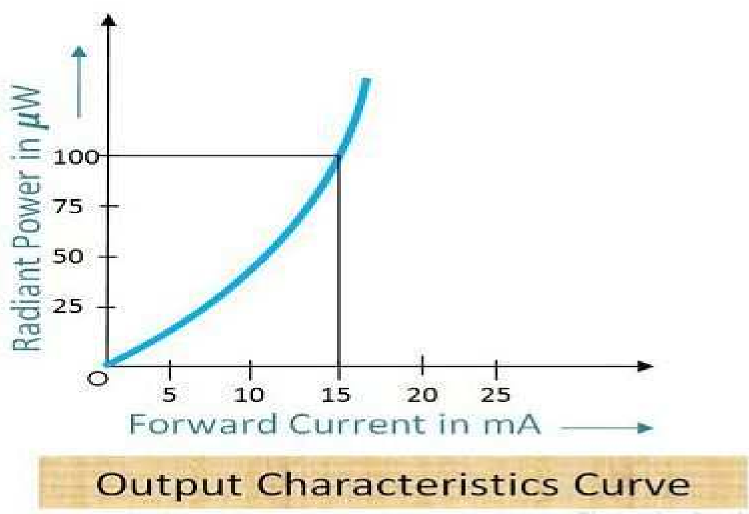
In light-emitting diodes, the energy is released in the form of photons. We call this phenomenon electroluminescence. Electroluminescence is an optical phenomenon, and electrical phenomenon where a material emits light in response to an electric current passed through it. As the forward voltage increases, the intensity of the light increases and reaches a maximum.

Volt-Ampere Characteristics of LEDs

The characteristics curve of the LED shows that the forward bias of **1 V** is sufficient to increase the current exponentially.



The output characteristics curve shows that radiant power of LED is directly proportional the forward current in LED.



The colour of an LED

The colour of an LED is determined by the material used in the semiconducting element. The two primary materials used in LEDs are aluminium gallium indium phosphide alloys and indium gallium nitride alloys. Aluminium alloys are used to obtain red, orange and yellow light, and indium alloys are used to get green, blue and white light. Slight changes in the composition of these alloys change the colour of the emitted light.

Uses of LED

LEDs find applications in various fields, including optical communication, alarm and security systems, remote-controlled operations, robotics, etc. It finds usage in many areas because of its long-lasting capability, low power requirements, swift response time, and fast switching capabilities. Below are a few standards LED uses:

- Used for TV back-lighting
- Used in displays
- Used in Automotives
- LEDs used in the dimming of lights

Advantages of LEDs over Incandescent Power Lamps

Some advantages of LEDs over Incandescent Power Lamps are:

- LEDs consume less power, and they require low operational voltage.
- No warm-up time is needed for LEDs.
- The emitted light is monochromatic.
- They exhibit long life and ruggedness.