

1. Mention different types energy band and their properties in the field of electronics.

Solⁿ: The range of energies possessed by an electron in a solid is known as energy band.

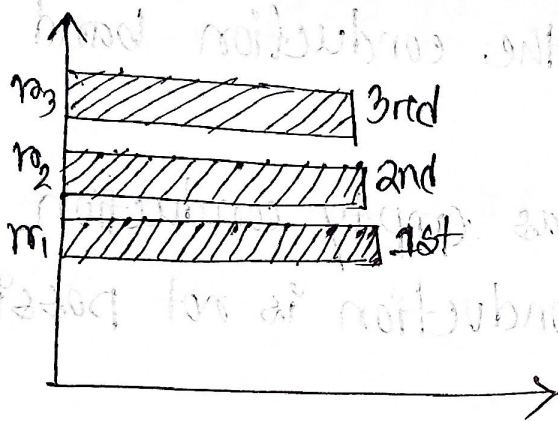


Fig: Energy Band

There are three type of energy band.

1. Valence band:

The range of energies possessed by valance ~~band~~ electrons is known as valance band.

The electrons in the outermost orbit of an atom are known as valance electron.

In a normal atom, valance band has the electrons of highest energy. This band may be ~~exactly~~ completely or partially filled.

In case of ~~inert~~ gases, the valance band is full where as

For other materials, it is only partially filled.

(ii) conduction Band: The range of energies possessed by conduction band electrons is known as conduction band.

All electrons in the conduction band are free electrons.

If a substance has empty conduction band, it means current conduction is not possible in that substance.

Generally, insulators have empty conduction band. On the other hand, it is partially filled for conductors.

(iii) Forbidden energy gap:

The separation between conduction band and valence band on the energy level diagram is known as forbidden energy gap.

No electron of a solid can stay in a forbidden energy gap.

The greater the energy gap, more tightly the valence electrons are bound to the nucleus.

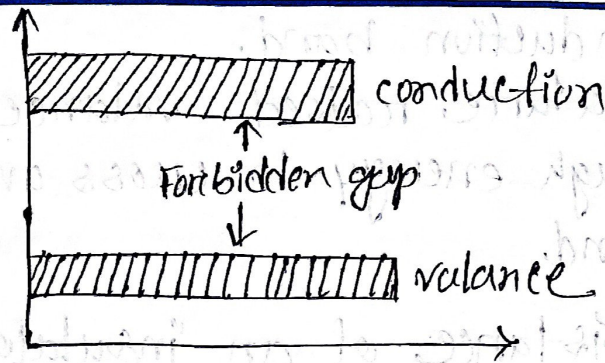


Fig: Energy Band

2. classify the solids into conductors, semiconductors & insulators based on band theory.

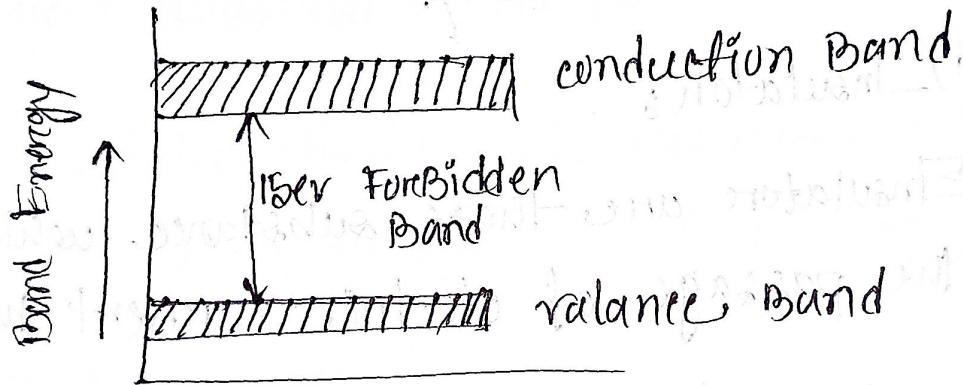
Solⁿ: (i) Insulator:

- Insulators are those substance which do not allow the passage of electric current through them.
- the valance band is full while the conduction band is empty.
- the energy gap between valance band and conduction bands is very large ($\approx 15 \text{ eV}$)
- Very high electric field is required to push the valance electrons to the conduction band.
- At room temperature, the valance ~~band~~ electrons of the insulators do not have enough energy to cross

over the conduction band. When temperature is raised, valence electrons may acquire enough energy to cross over to the conduction band.

→ The resistance of an insulator decreases with the increase in temperature.

→ An insulator has negative temperature coefficient of resistance.



(ii) Conductors:

→ conductors are those substance which easily allow the passage of electric current through them.

~~It~~ It is because there are a large number of free electrons available in a conductor.

→ In term of energy band,

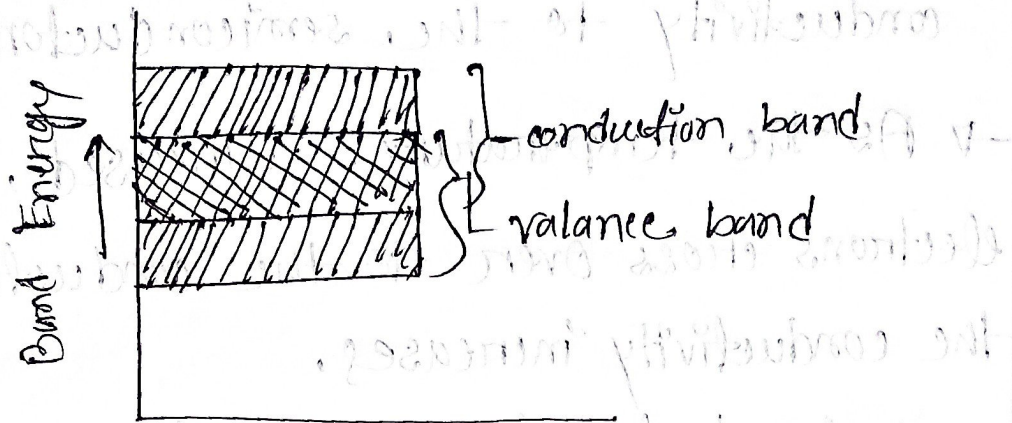
— the valance and conduction bands overlap

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each other.

- Due to this overlapping, a slight potential difference across a conductor causes the free electrons to constitute electric current.



(iii) Semiconductor:

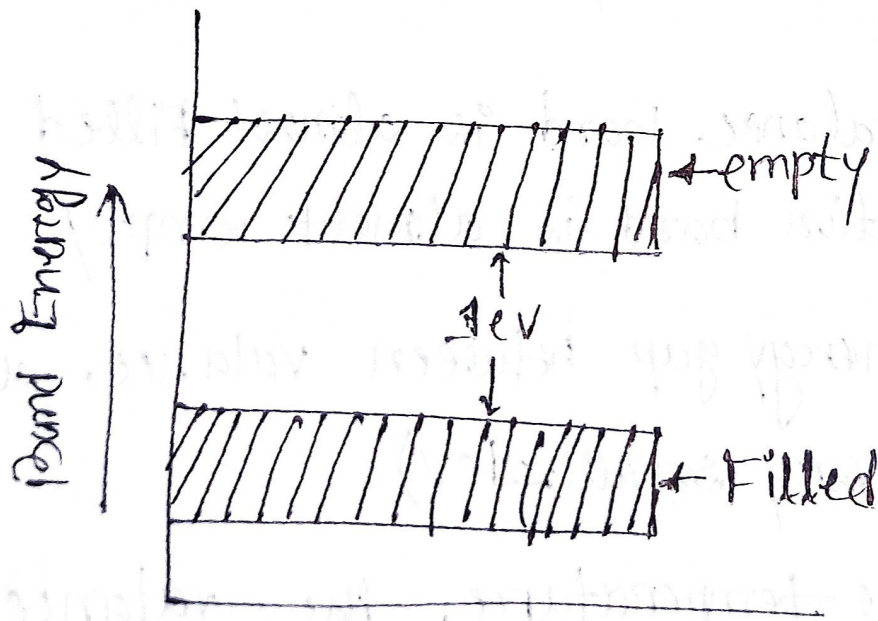
→ Semiconductors are those substances whose electrical conductivity lies in between conductors and insulators.

→ The valance band is almost filled & conduction band is almost empty.

→ The energy gap between valance and conduction bands is very small ($\approx 1\text{eV}$)

→ At low temperature, the valance band is completely full and conduction band is completely empty.

- Semiconductor behaves as an insulator at low temperatures.
 - At room temperature, some electrons cross over to the conduction band, imparting little conductivity to the semiconductor.
 - As the temperature increased, more valence electrons cross over to the conduction band and the conductivity increases.
 - Semiconductor increase with the rise in temperature.
- Semiconductor has negative temperature coefficient of resistance.



-1. Discuss the effect of temperature on semiconductors

Solⁿ: A semiconductor is a substance which has resistivity (10^4 to $0.5 \Omega m$) in between conductors and insulators.

properties:

1. resistivity is higher than conductors but lesser than an insulators.
2. Semiconductor has negative temperature co-efficient of resistance, the resistance of a semiconductor decrease with the increase in temperature and vice-versa.
3. Semiconductors act like insulators at zero temperature. On increasing the temperature, they work as conductors.
4. When a suitable metallic impurity is added to a semiconductor, its current conducting properties change appreciably.

temperature on Semiconductors;—

The electrical conductivity of a semiconductor changes appreciably with temperature variations.

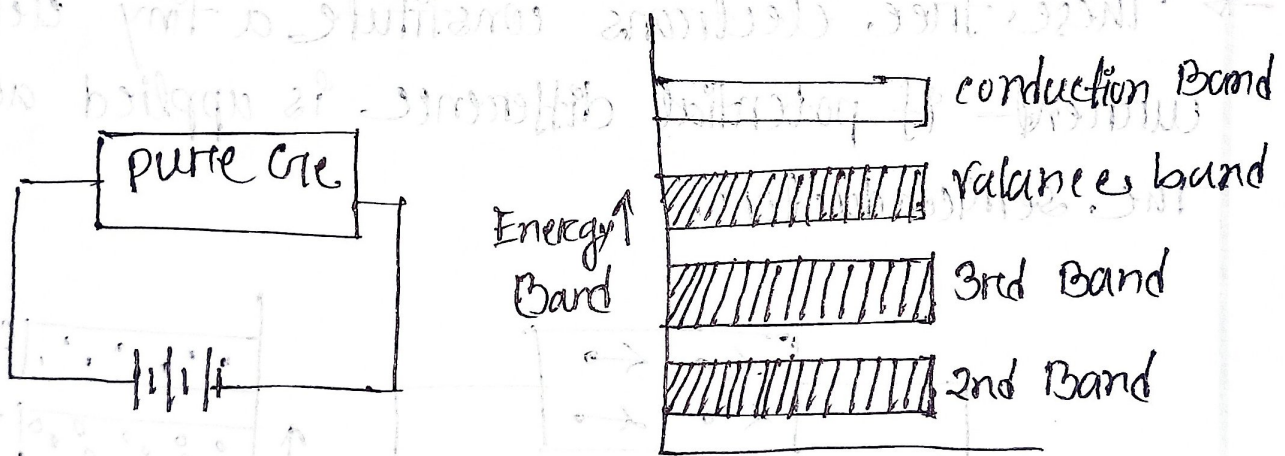
(i) At absolute zero:-

At absolute zero temperature, all the electrons are tightly held by the semiconductor atoms.

The inner orbit electrons are bound whereas the valence electrons are engaged in co-valent bonding.

At this temperature, the co-valent bonds are very strong and there are no free electrons.

The semiconductor crystal behaves as a perfect insulator.



(ii) Above absolute zero:-

In term of energy band,

— valance band is filled and large energy gap between valance band and conduction band.

— no valence electron can reach the conduction band to become free electron.

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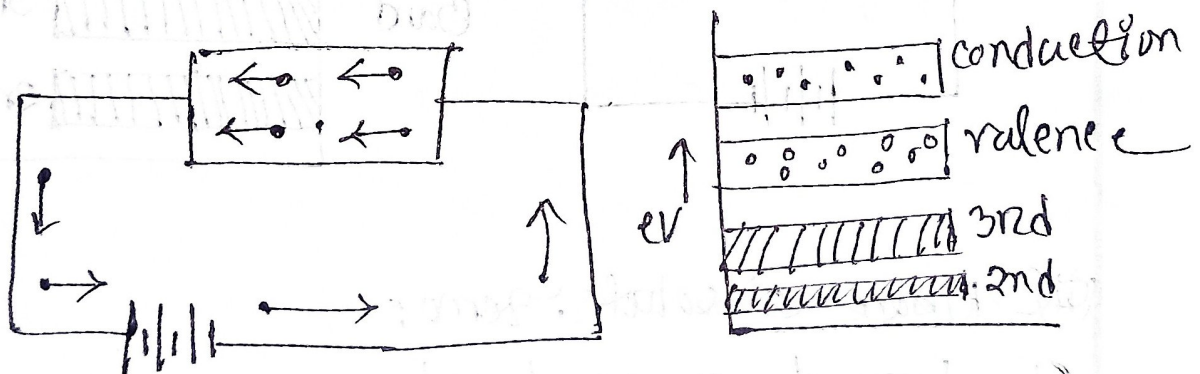
— due to non-availability of free electrons that a semiconductor behaves as an insulator.

(ii) Above absolute zero:

→ when the temperature is raised, some of the co-valent bonds in the semiconductor break due to the thermal energy supplied.

→ The breaking of bonds set those electron free which were engaged in the formation of these bonds.

→ These free electrons constitute a tiny electric current if potential difference is applied across the semiconductor.



→ The resistance of a semiconductor decreases with the increase in temperature.

→ It has negative temperature co-efficient of resistance.

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- In term of energy band,

- As the temperature raised, some of the valence ~~band~~ electrons acquire sufficient energy to enter into the conduction band and thus become free electrons.

- Under the influence of electric field, these free electrons will constitute electric current.

- Each time a valence electron enters into the conduction band, a hole is created in the valence band.

Q.2. What is intrinsic semiconductor and explain the formation of intrinsic semiconductors through doping?

Solⁿ: A semiconductor in an extremely pure form is known as an intrinsic semiconductor.

Properties:

1. An intrinsic semiconductor behaves like an insulator at $T=0K$.
2. It is a pure semiconductor.
3. Its characteristic is temperature-dependent.
4. Electrical conductivity is comparatively low.
5. The density of electrons is equal to the density of holes.

Extrinsic semiconductor is a type of semiconductor material that has been doped, with impurities to alter its electrical conductivity.

properties:

1. The density of electrons is not equal to the density of holes.
2. Electrical conductivity is high.
3. It's not pure, they contain impurity through doping, to achieve better electrical conductivity.
4. The conductivity not only depends on the temperature but also on the amount of impurity in the original ~~number~~ material of the semiconductor.

The process of adding impurities to a semiconductor is known as doping.

The purpose of adding impurity is to increase either the number of free electrons or holes in the semiconductor crystal.

Depending upon the type of impurity added, extrinsic semiconductors are classified into:

- (i) n-type semiconductor.
- (ii) p-type semiconductor.

Electrons are the majority carriers and holes are the minority carriers.

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n-type semiconductor: -

When a small amount of pentavalent impurity is added to a pure semiconductor, it is known as n-type semiconductor.

The addition of pentavalent impurity provides a large number of free electrons in the semiconductor crystal.

Example: Arsenic and Antimony

n-type semiconductors are known as donor impurities because they donate or provide free electrons to the semiconductor.

Formation of n-type semiconductor:

We know that,

Germanium atom has four valence electrons. When a small pentavalent impurity

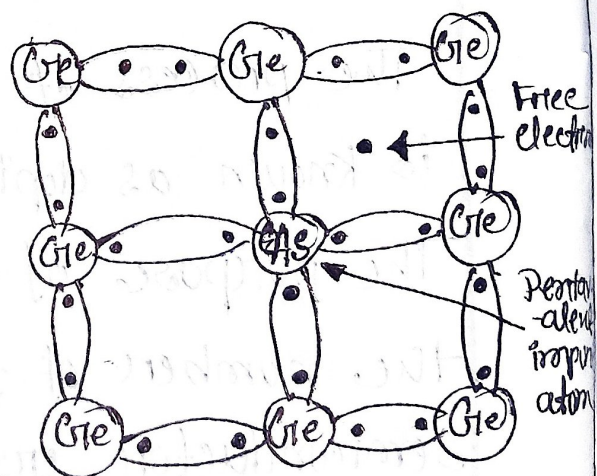
like Arsenic is added to

Ge crystal, a large number

of free electrons become available

in the crystal. Arsenic has five valence electrons.

An Arsenic atom fits in the Ge crystal in such



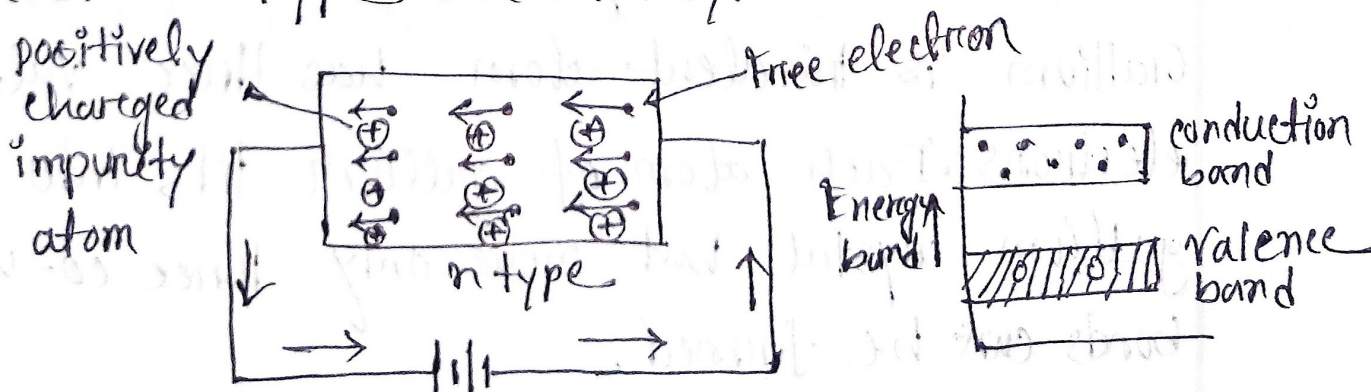
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a way that its four valence electrons form covalent bonds with germanium atoms. The fifth valence electron of arsenic find no place and is thus free electron created.

So, it is seen that each impurity atom gives one free electrons. Hence, the impurity atom is called donor atom. Besides due to thermal agitation some equal number of electrons ~~are~~ and holes are produced so n-type ~~semiconductor~~ semiconductor both electrons and holes are present. Positive holes play minor role and negative electrons play majority carriers in electric conduction.

conductivity: The current conduction in an n-type semiconductor is predominantly by free electrons negative charges and is called n-type or electron type conductivity.



P-type Semiconductors:-

When a small amount of trivalent impurity is added to a pure semiconductor, it is called P-type semiconductor.

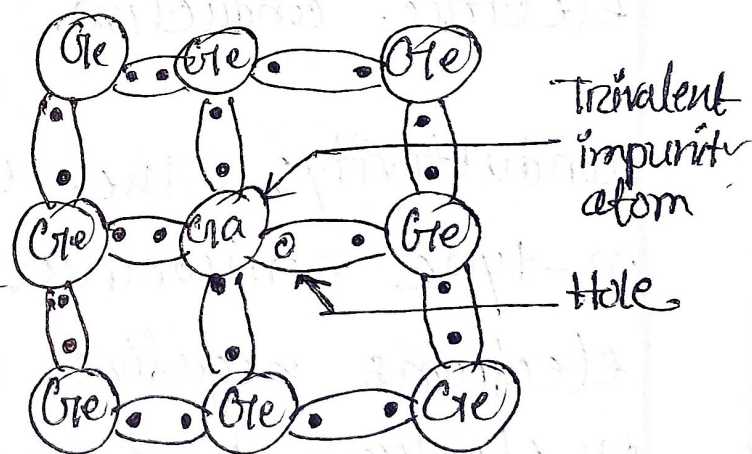
The addition of trivalent impurity provides a large number of holes in the semiconductor.

ex: Gallium & Indium

P-type semiconductor are known as acceptor impurities because the holes created can accept the electrons.

Formation of p-type semiconductor:

When a small amount of trivalent impurity like gallium is added to germanium crystal, there exists a large number of holes in the crystal.



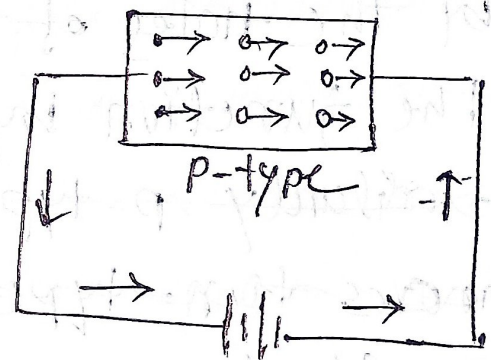
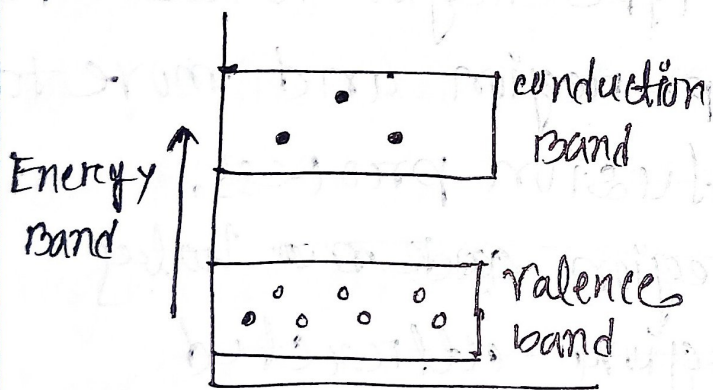
Gallium is trivalent atom has three valence electrons. Each atom of gallium fits into the germanium crystal but now only three co-valent bonds can be formed.

→ holes are the majority carriers and electrons are the minority carriers,

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so, it is seen, that the fourth electron of germanium atom ~~does~~ does not form any co-valent bond, since gallium has deficiency of atom. Due to this deficiency of electron a hole is created in gallium atom. gallium atom is called acceptor. In p-type semiconductor positive charges ~~electrons~~ play the main role of flow of current. Holes are majority carriers and electrons are minority carriers.



The current conduction in p-type semiconductor is pre dominantly by holes positive charges and is called p-type or hole-type ~~semiconductor~~ conductivity.

4] Formation of p-n Junction

When a p-type semiconductor is suitably joined to n-type semiconductor, the contact surface is called p-n junction.

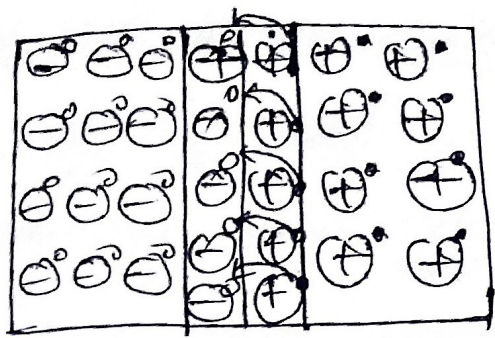
In p-n junction which is in p-type region has majority charge carrier holes and n-type region is electron.

In pn junction n-type region is ^{attracted} ~~connected~~ by the holes of the p-region and move to the junction by diffusion process.

~~Similarly p-type region and holes moves to n-type region attracted~~

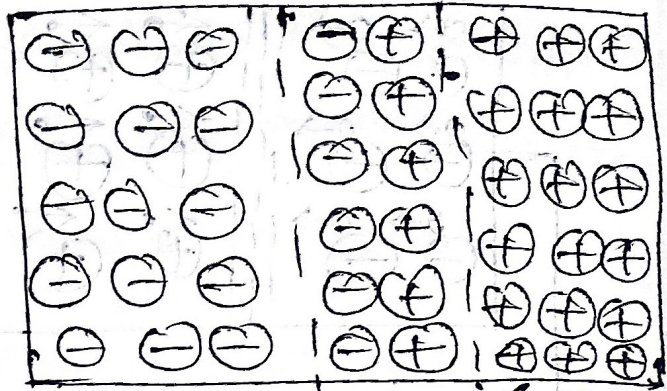
Similarly holes from p-type region move to the junction being attracted by the electron of n-type region.

In the pn junction both holes and electrons combine and become neutral.



p n

Diffusion process



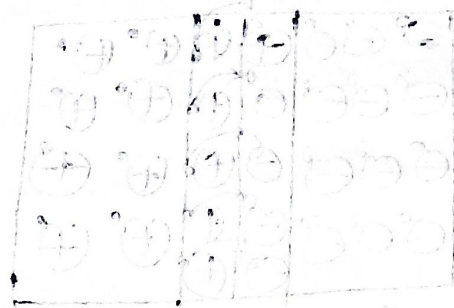
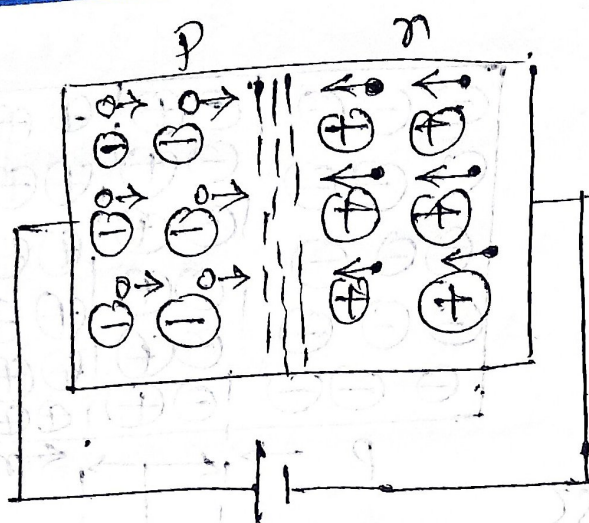
p n

Depletion region

Now, holes coming from p-region are repelled by positive ions & n-region repelled by negative ions. In this way a small depletion region produced. It is also known as junction barrier. The width of this region is from 10^{-6} m to 10^{-8} m.

There are two types of biasing condition in p-n junction:

1. Forward biasing: - when external d.c voltage in the junction is applied in such a way that ~~by reducing the potential barrier~~ it cancel the potential barrier, thus permitting current flow, it is called forward biasing.



(i) potential barrier is reduced and at some forward voltage (0.1 to 0.3) V, it is eliminated altogether.

(ii) The junction offers low resistance to current flow.

(iii) Current flows due to low resistance path.

(iv) The magnitude of current depends upon the applied forward voltage.

Half wave rectifier:—

A halfwave rectifier is defined as a type of rectifier that only allows one half cycle of an AC voltage to pass, blocking the other half cycle. It is called to convert AC voltage to DC voltage.

Circuit diagram:

A halfwave rectifier circuit consists of three main components as follow,

1. A diode
2. A transformer
3. A resistive load

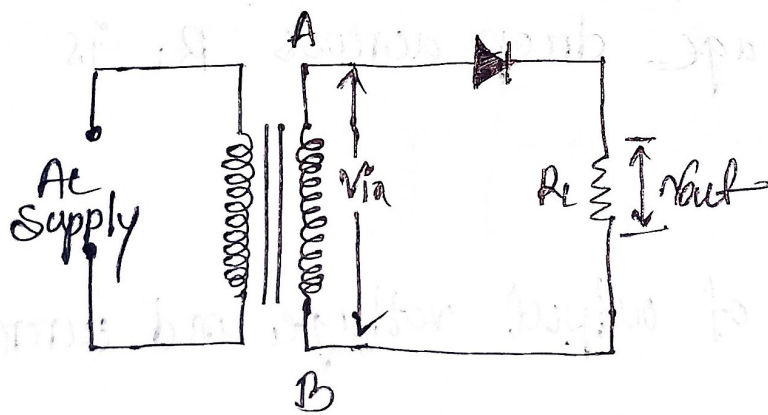
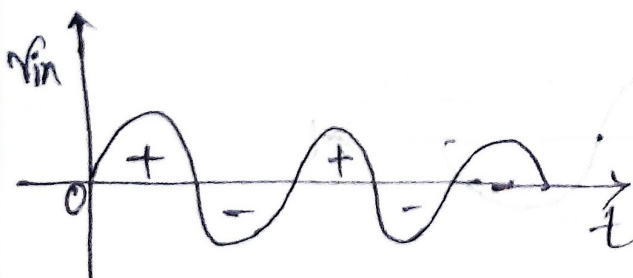
Input/output voltage diagram:

Fig: Input voltage



Fig: output voltage.

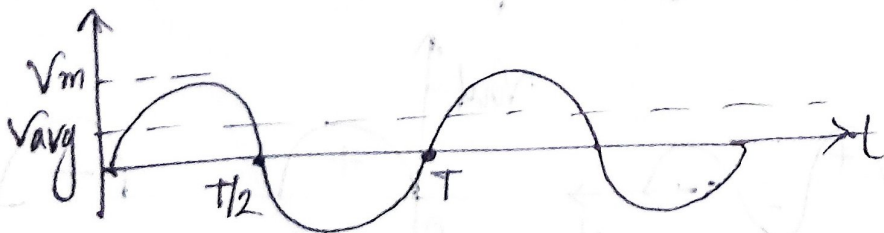
Working Principle:-

During the positive half cycle of input AC voltage, the diode D is forward-biased (ON) and conducts. while conducting, the current flows the load resistive and a dropped output voltage ' V_o ' across R_L is generated.

During the negative half cycle of input AC voltage, the diode is reverse-biased (OFF) and doesn't conduct. That's why there is no current flow through resistive load and there is no voltage drop across R_L is generated.

1. Average values of output voltage and current:-

a. Average voltage, V_{dc}



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$$V_{dc} = V_{avg} = \frac{1}{T} \int_0^T v(t) dt$$

$$= \frac{1}{T} \left[\int_0^{T/2} V_m \sin \omega t dt + 0 \right]$$

$$= \frac{1}{T} \int_0^{T/2} V_m \sin \omega t dt$$

$$= \frac{1}{T} \cdot V_m \int_0^{T/2} \sin \omega t dt$$

$$= \frac{1}{T} \cdot V_m \left[\frac{-\cos \omega t}{\omega} \right]_0^{T/2}$$

$$= \frac{V_m}{T \omega} \left[-\cos \omega t \right]_0^{T/2}$$

$$= \frac{V_m}{T \cdot \frac{2\pi}{T}} \left[-\cos \left(\frac{2\pi}{T} \cdot \frac{T}{2} \right) - (-\cos(0)) \right]$$

$$= \frac{V_m}{2\pi} \left(-\cos \pi + \cos 0 \right)$$

$$= \frac{V_m}{2\pi} (1 + 1)$$

$$= \frac{V_m}{\pi} = 0.318 \cdot V_m$$

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b. Average current I_{dc} ,

$$I = \frac{V}{R}$$

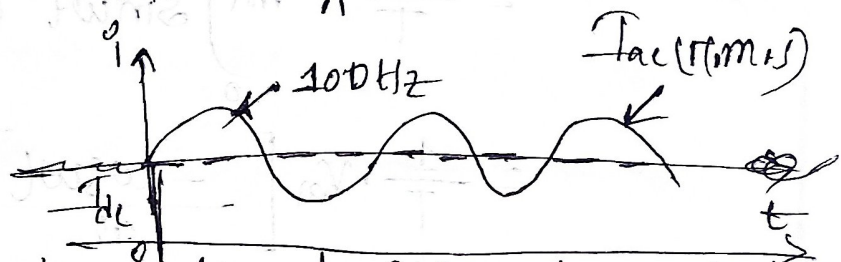
$$I_{dc} = \frac{V_{dc}}{R_L}$$

$$= \frac{V_m}{\pi} \times \frac{1}{R_L}$$

$$= 0.318 \frac{V_m}{R_L}$$

$$= 0.318 I_m = \frac{I_m}{\pi}$$

2. Ripple factor:



Ripple factor is the ratio of RMS values of the AC component of the output voltage to the DC component of the output voltage.

$$= \frac{V_{ac(rms)}}{V_{dc}} \quad \text{or } 38.6\%$$

$$\text{Ripple factor} = \frac{\text{rms value of ac component}}{\text{value of dc component}}$$

$$= \sqrt{\left(\frac{I_{rms}}{I_{dc}}\right)^2 - 1}$$

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$$I_{rms} = \frac{I_m}{2}$$

$$V_{rms} = \frac{V_m}{2}$$

For half-wave rectification,

$$I_{rms} = I_m/2 \quad \& \quad I_{dc} = I_m/\pi$$

$$\therefore \text{Ripple factor} = \sqrt{\left(\frac{I_m/2}{I_m/\pi}\right)^2 - 1} = \sqrt{\left(\frac{\pi}{2}\right)^2 - 1} = 1.21$$

4. Efficiency of half-wave rectifier:-

The ratio of d.c power output to the applied input a.c power is known as rectifier efficiency.

$$\text{Rectifier efficiency, } \eta = \frac{\text{d.c power output}}{\text{Input a.c power}}$$

Here,

$$\text{d.c power, } P_{dc} = I_{dc}^2 R_L = \left(\frac{I_m}{\pi}\right)^2 R_L$$

$$\text{AC power, } P_{ac} = I_{rms}^2 (r_f + R_L) = \left(\frac{I_m}{2}\right)^2 (r_f + R_L)$$

$$\therefore \eta = \frac{\left(I_m/\pi\right)^2 R_L}{\left(I_m/2\right)^2 R_L (r_f + R_L)}$$

$$= \frac{0.406 R_L}{r_f + R_L}$$

r_f = Diode resistance

R_L = Load resistance

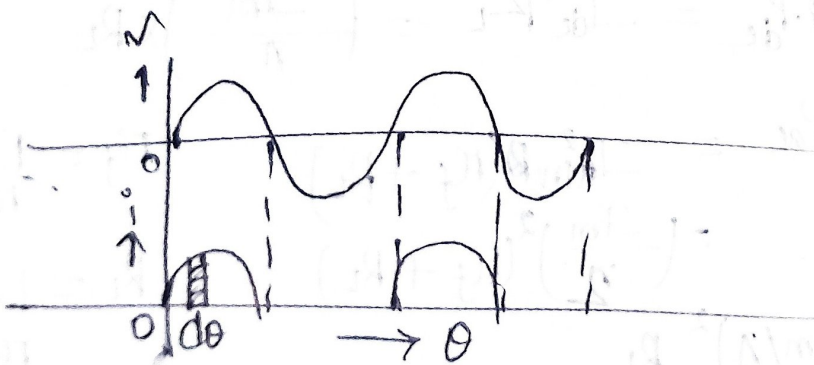
$$I_{rms} = \frac{I_m}{2}$$

Advantage of half wave rectifier:-

1. Affordable
2. Simple connections
3. Easy to use and number of components used are less.

Disadvantage:

1. Ripple production is more.
2. The a.c supply delivers power only half the time, therefore the output is low.
3. Utilization ~~is~~ of the transformer is low
4. The efficiency of rectification is low.



Full wave rectifier:-

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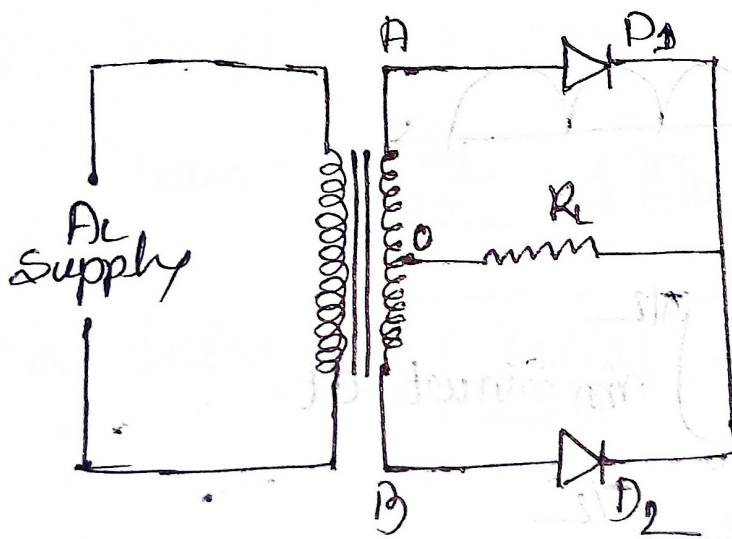
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A full wave rectifier is defined as a rectifier that convert the complete cycle of ac current into pulsating Dc.

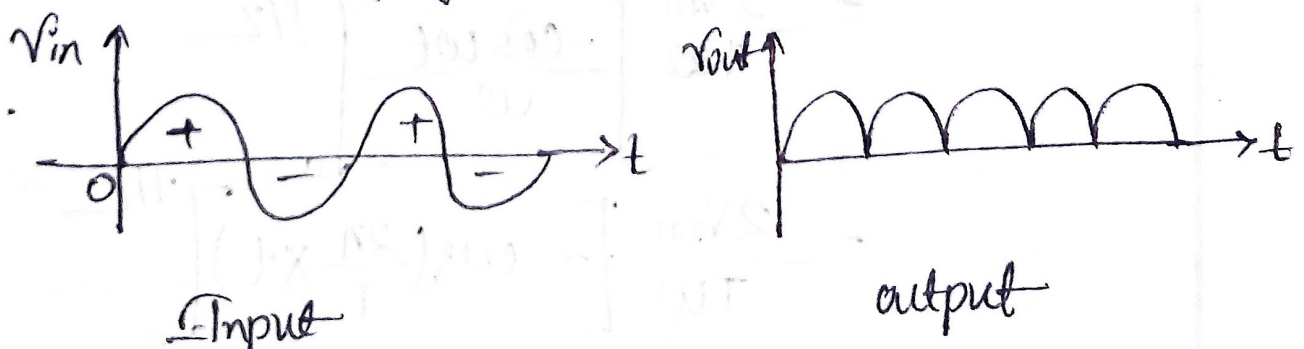
Centre-tap full wave rectifier:-
Circuit Diagram;

A full-wave rectifier consists of following components:

1. two diode
2. A transformer
3. A resistive load



Input/output voltage Diagram:-

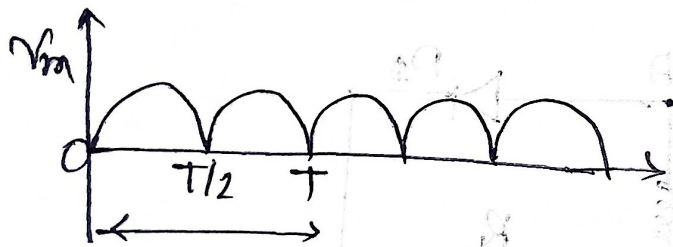


Working Principle:-

1. For positive half cycle D_1 is ON, D_2 is OFF. Dropped output voltage is generated across R_L .

2. For negative half cycle ~~Diode~~ D_2 is ON, D_1 is OFF, dropped output voltage is generated across R_L .

3. Average value of output voltage and current:-



$$\begin{aligned}
 V_{dc} = V_{avg} &= \frac{1}{\frac{T}{2}} \int_0^{\pi/2} V_m \sin \omega t \, dt \\
 &= \frac{2V_m}{T} \int_0^{\pi/2} \sin \omega t \, dt \\
 &= \frac{2V_m}{T\omega} \left[\frac{-\cos \omega t}{\omega} \right]_0^{\pi/2} \\
 &= \frac{2V_m}{T\omega} \left[-\cos\left(\frac{2\pi}{T} \times t\right) \right]_0^{\pi/2}
 \end{aligned}$$

$$I_{rms} = \frac{V_m}{\sqrt{2}}$$

$$V_{rms} = \frac{I_m}{\sqrt{2}}$$

$$= \frac{2V_m}{T \times \frac{2\pi}{T}} \left[-\cos\left(\frac{2\pi}{T} \times \frac{T}{2}\right) - (-\cos 0) \right]$$

$$= \frac{V_m}{\pi} (1+1)$$

$$= \frac{2V_m}{\pi}$$

current, $I_{dc} = \frac{V_{dc}}{R_L}$

$$= \frac{2V_m}{\pi} \times \frac{1}{R_L} = \frac{2}{\pi} \cdot \frac{V_m}{R_L} = \frac{2}{\pi} I_m$$

2. Ripple factor:-

$$I_{rms} = \frac{I_m}{\sqrt{2}} \quad \& \quad I_{dc} = \frac{2I_m}{\pi}$$

$$\text{Ripple factor} = \sqrt{\left(\frac{I_m/\sqrt{2}}{2I_m/\pi}\right)^2 - 1} = 0.48$$

3. Efficiency of Full-wave rectifier:

$$\eta = \frac{P_{dc}}{P_{ac}}$$

dc power output, $P_{dc} = \left(\frac{2I_m}{\pi}\right)^2 \times R_L$

ac power output, $P_{ac} = \left(\frac{I_m}{\sqrt{2}}\right)^2 (r_g + R_L)$

$$= \frac{(2Im/\pi)^2 R_L}{\left(\frac{Im}{\sqrt{2}}\right)^2 (r_f + R_L)}$$

$$= \frac{8}{\pi^2} \times \frac{R_L}{(r_f + R_L)}$$

$$= \frac{0.812 R_L}{r_f + R_L} = \frac{0.812}{1 + \frac{r_f}{R_L}}$$

The efficiency will be maximum if r_f is negligible as compared to R_L .

$\therefore$ Maximum efficiency = 81.2%.

Advantage:-

1. The ripple frequency is two times the input frequency.
2. Efficiency is higher.
3. Ripple factor is less.
4. Higher output voltage.

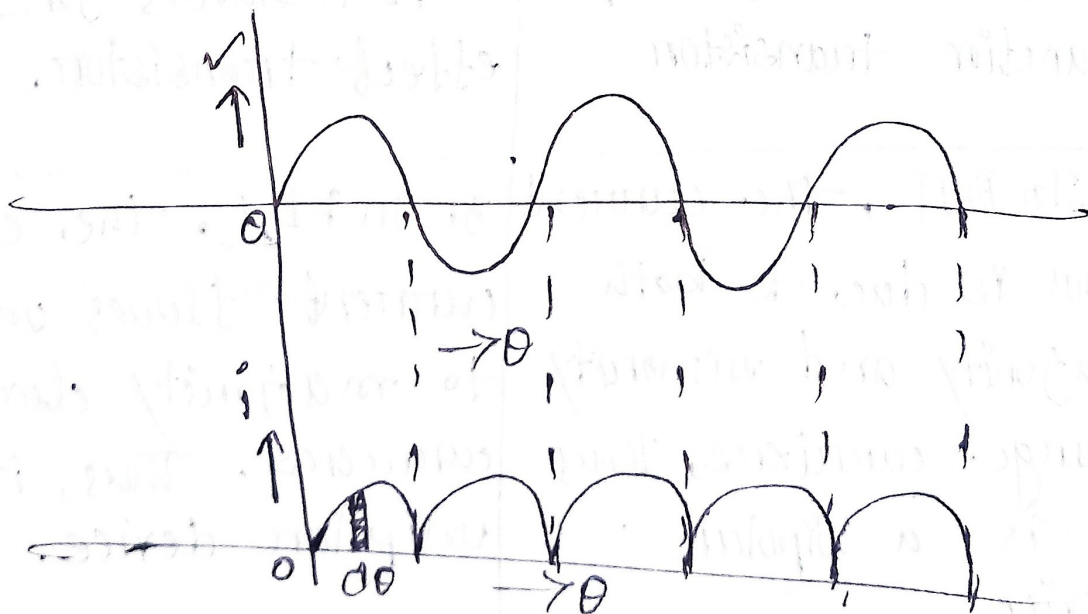
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5. Higher ~~temperature~~ transformer utilization factor.
6. Utilize both halves of the AC waveform.

Disadvantage:

1. The diodes used must have high peak inverse voltage.
2. It is difficult to locate the central tap on the secondary winding.
3. The d.c. output is small as each diode utilises only one-half of the transformer secondary voltages.



1. Bring out the difference between FET & BJT transistor, which is more preferred?

Sol: Differences between BJT & FET is given below,

BJT	FET
1. A bipolar junction transistor (BJT) is a current controlled device, output characteristics of the device are controlled by base current and not by base voltage.	A Field effect transistor (FET), the output characteristics are controlled by input voltage and not by input current.
2. BJT stands for bipolar junction transistor	2. FET stands for field effect transistor.
3. In BJT, the current flow is due to both majority and minority charge carriers, thus it is a bipolar device.	3. In FET, the electric current flows only due to majority charge carriers. Thus, it is a unipolar device.
4. BJT is a current controlled device	4. FET is a voltage controlled device.

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5. BJT has positive temperature coefficient

5. FET has negative temperature ~~coefficient~~ coefficient.

6. The switching speed of BJT is low

6. FET ~~is~~ relatively has higher switching speed.

7. BJT is susceptible to radiation.

7. FET is relatively immune to radiation.

FET is more preferable.

Q7 JFET

JFET stands for Junction field effect transistor.

A junction field effect transistor is a three terminal semiconductor device in which current conduction is by one type of carrier electrons or holes.

construction:

A JFET consists of a p-type or n-type silicon bar containing two pn junctions.

The bar forms the conducting channel for the charge carriers.

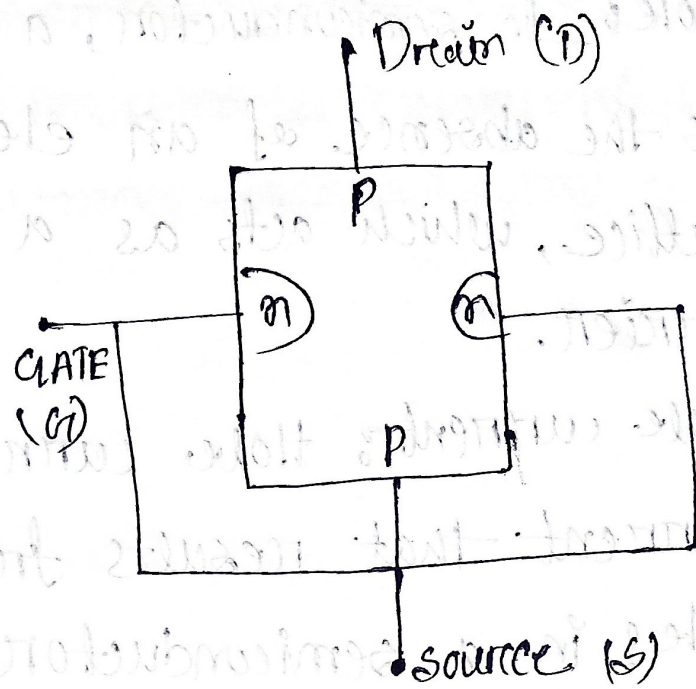
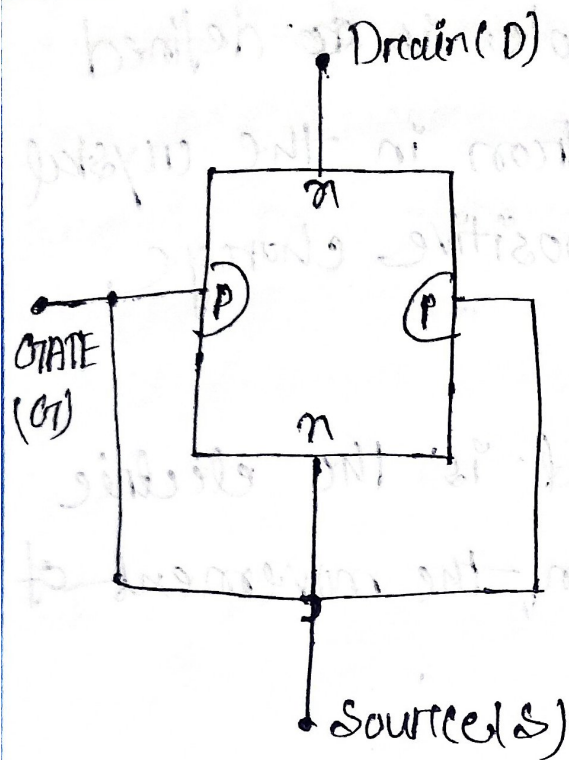
If the bar is of n-type, it is called n-channel JFET and if the bar is of p-type, it is called a p-channel JFET.

Two pn junction forming diodes are connected internally and a common terminal called gate is taken out. Other terminals are source and drain taken out from the bar.

Thus a JFET has essentially three terminals gate (G), source (S) & drain (D).

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p-channel JFET

n-channel JFET

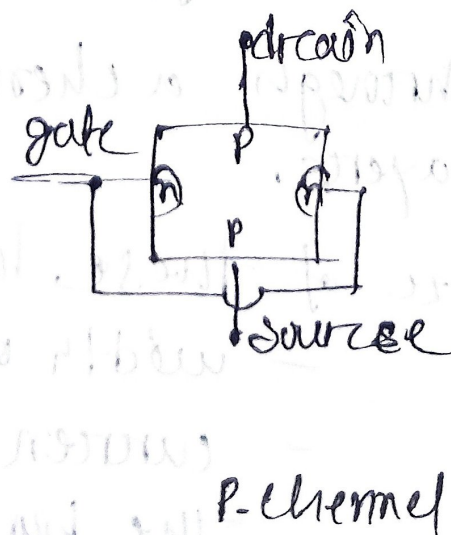
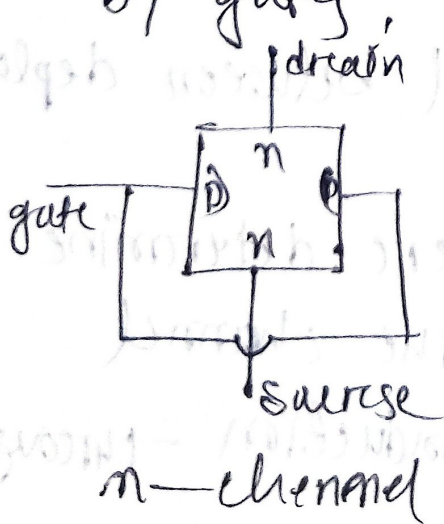


JFET:-

A junction field effect transistor is a three-terminal semiconductor device in which current conduction is by one type of carrier electrons or holes.

construction:-

- consists of a p-type or n-type silicon bar containing two pn junction at the sides.
- the bar form conducting channel for the charge carrier.
- If the bar is n-type then n-channel or if the bar is p-type then p-channel JFET.
- JFET has essentially three terminal source, gate, drain.
- two pn junction diodes are connected by gates.



Principle & working of JFET

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Working

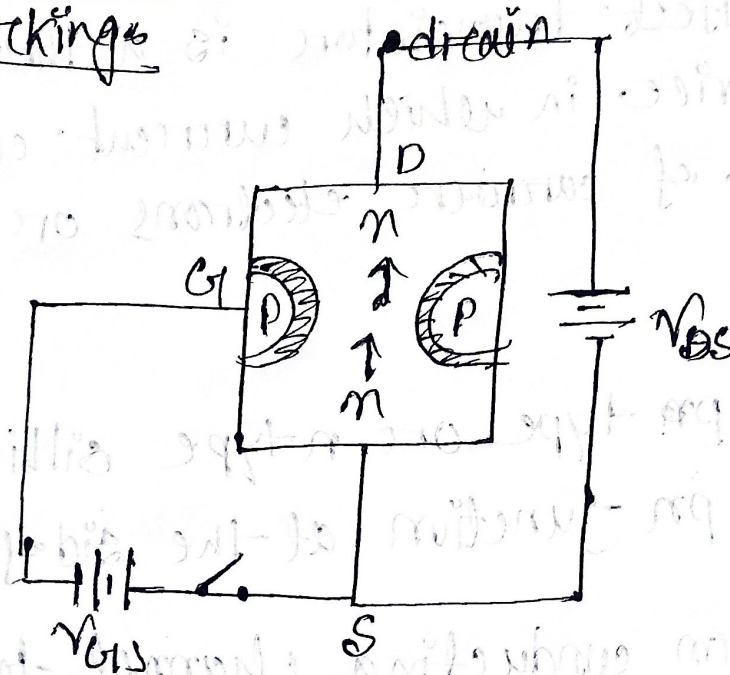


Fig: (i)

When a voltage V_{DS} is applied between drain & source

- voltage V_G on the gate is zero
- two side depletion layers established,
- electron flow from source to drain through a channel between depletion layers.
- size of these layers determine
 - width of the channel
 - current conduction through the bar.

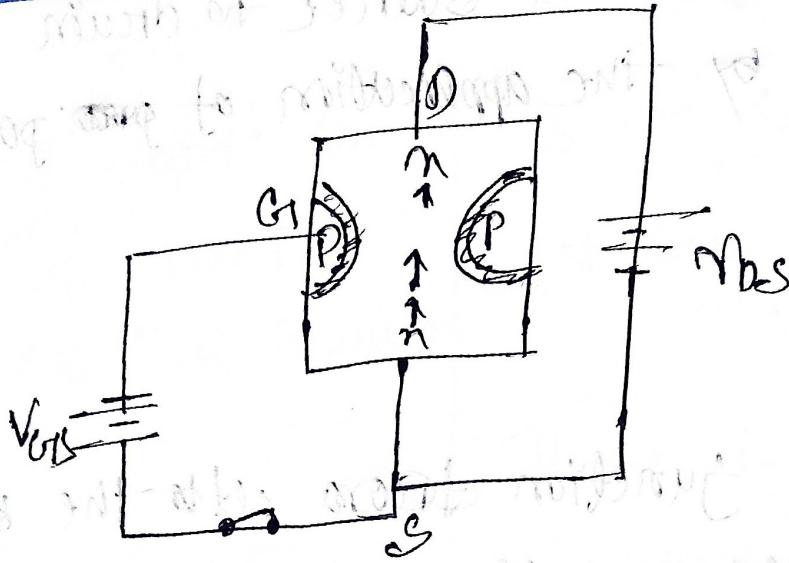


Fig: (ii)

when a reverse voltage V_{DS} is applied ~~recd~~ between sources & gate. —

— the width of the depletion layers is increased.

— this reduce of depletion layer of conducting ~~bar~~ channel; ~~so the resistance~~ the ~~resistance~~ of n type bar is also increase.

— consequently, the current from source to drain is decreased.

On the other side,

→ If reverse voltage on the gate is decrease the width of depletion layers also decrease.

increase — width of conducting channel &
Source to drain current.

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→ the current from source to drain can be controlled by the application of ~~gate~~ potential on the gate.



Principle:

→ two pn junction ~~from~~ ~~at~~ the sides form two depletion layer.

→ current conducting through the channel.

→ the width of depletion layer & resistance controlled by input voltage (V_{GS})

→ when the ^{reverse} ~~input~~ voltage become greater,

— the width of depletion layer increased.

→ the narrower will be the conducting channel.

→ narrower channel.

— ~~become~~ means — greater resistance

— source & drain current decrease.

This process will be happen reverse when V_{GS} ~~decrease~~ ^{decreases}

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JFET

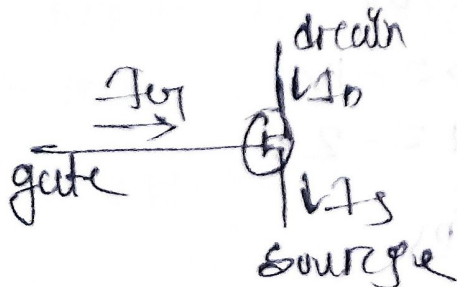
JFET stands for Junction Field Effect Transistor.

There is only one type of carrier, holes in p-type & electron in n-type channel.

It is called unipolar transistor.

JFET is reverse biased.

The device has high input impedance.



BJT Bipolar Transistor

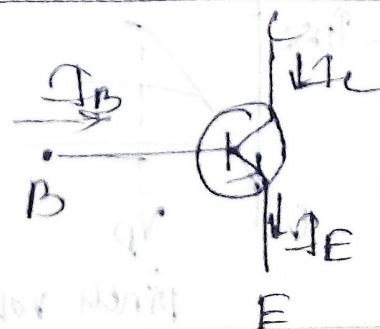
BJT is stands for Bipolar Junction Transistor.

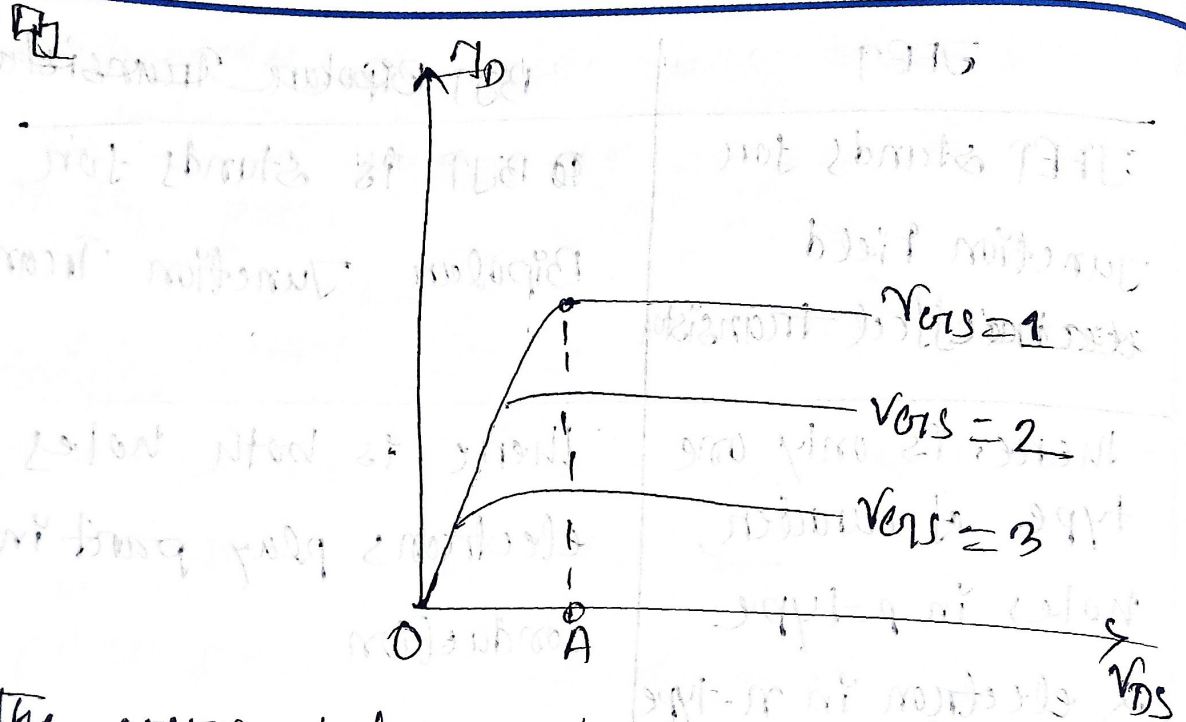
There is both holes & electrons play part in conduction.

Sometimes called bipolar transistor.

BJT is forward biased.

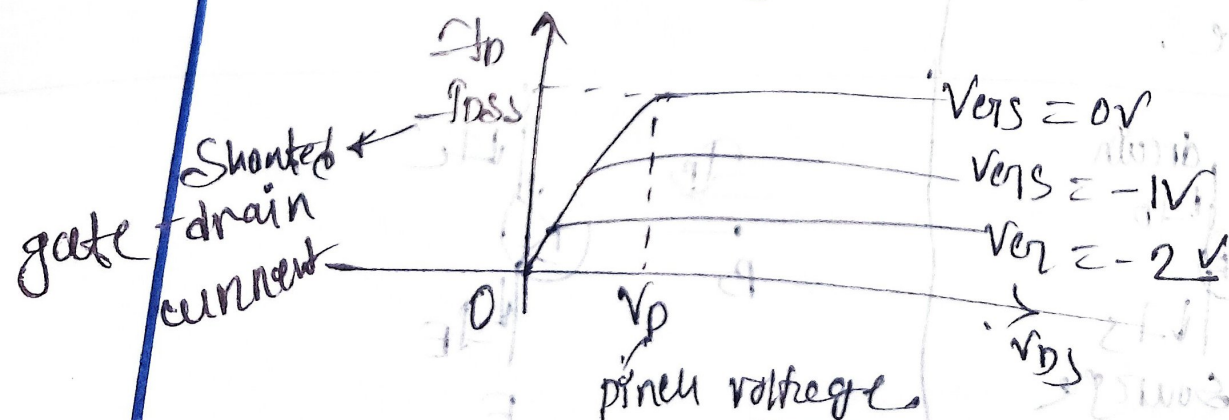
The device has low input impedance.





The curve between drain current (I_D) and drain source voltage (V_{DS}) of a JFET at constant gate-source voltage (V_{GS}) is known as output characteristics of JFET.

Pinch off voltage: It is the minimum drain source voltage, ~~at~~ at which the drain current becomes constant.



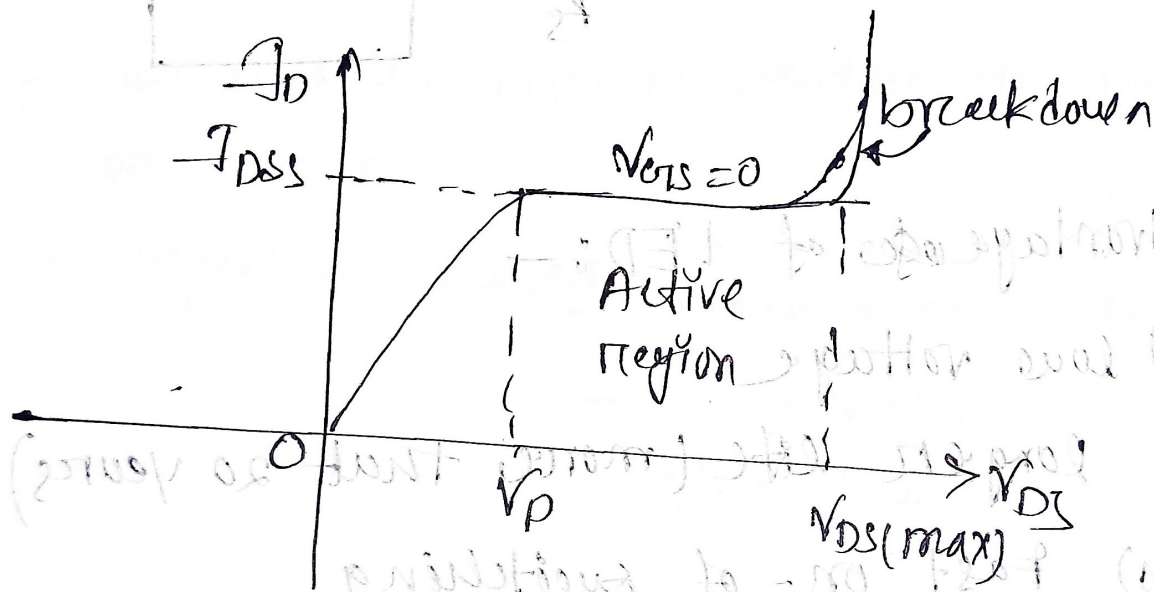
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shorted - gate drain current:-

— It is drain current with source short-circuited to gate & drain voltage equal to pinch off voltage.

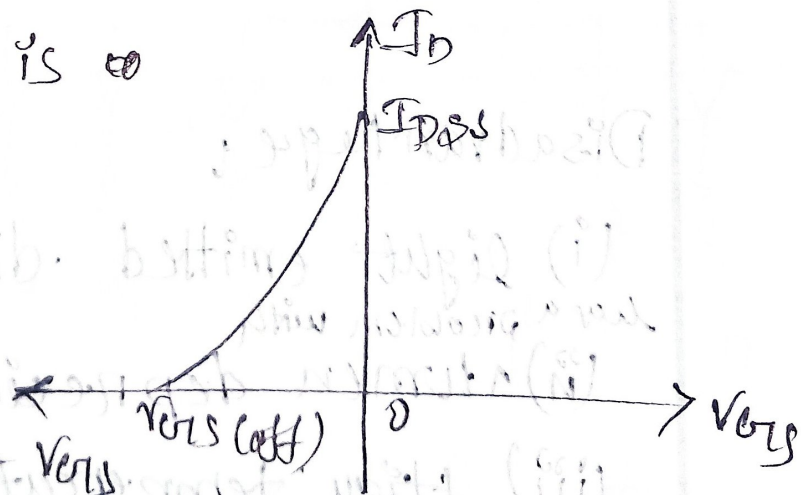
— It is sometimes called zero-bias current



gate-source cut off voltage (V_{GS}):-

where the channel is completely cut off & the drain current become zero, it is

known as gate-source cut off voltage.



LED:

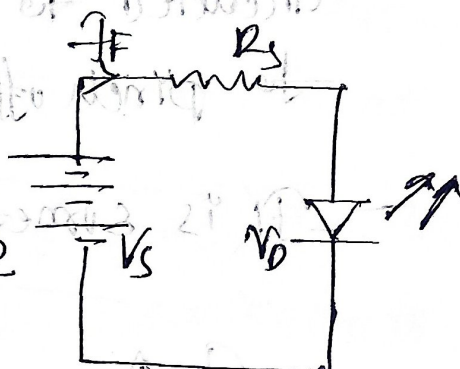
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⇒ A light emitting diode is a diode that gives off visible light when forward biased.

across
voltage $V_s = V_D$

circuit current, $I_f = \frac{V_s - V_D}{R_s}$



Advantages of LED: -

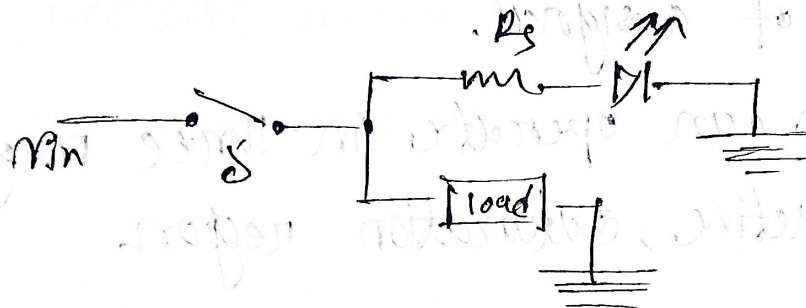
- (i) low voltage
- (ii) longer life (more than 20 years)
- (iii) Fast on-off switching
- (iv) converting electricity into visible light.

Disadvantages:

- (i) light emitted directly
has a problem with
- (ii) lumen depreciation
- (iii) High temperatures may damage LED
- (iv) produce light every direction

Application of LEDs:-

(i) As a power indicator:



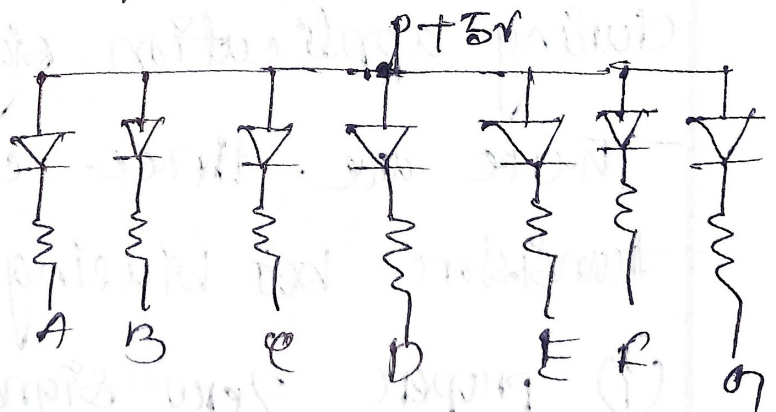
= can used to indicate whether the power is on or not,

— when S is closed — power apply in load

— current flows through the LED.

(ii) Seven-segment display:-

$\begin{matrix} P \\ \hline A \ B \\ \hline E \ C \\ \hline D \end{matrix}$



(iii) Sensors,

(iv) Infrared LEDs in remote controls,

Biasing: —

Transistor biasing is defined as the proper flow of zero signal collector emitter voltage during the passage of a signal.

Transistor can operate in three regions namely cut off, active, saturation region.

The basic purpose of transistor biasing is to keep —

- the emitter - junction properly forward biased

- the collector - base junction properly reverse biased.

during application signal.

There are three condition to fulfill transistor biasing.

- (i) proper zero signal collector current
- (ii) proper base - emitter voltage at any instant
- (iii) proper collector - emitter voltage at any instant.

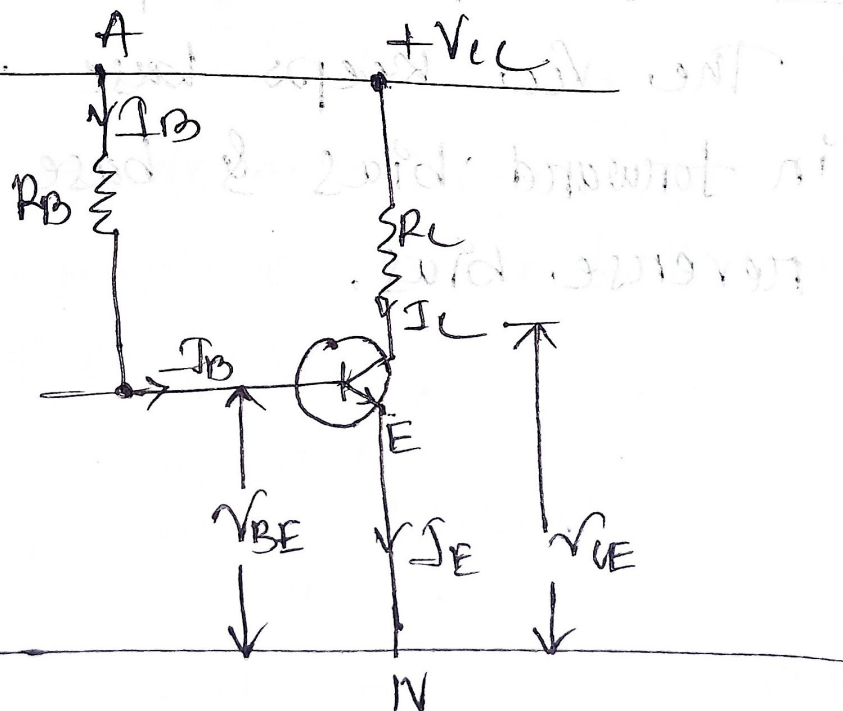
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The most commonly used methods of obtaining transistor biasing from one supply (V_{CC}):

- (i) Base resistor method
- (ii) Emitter bias method
- (iii) Biasing with collector-feedback resistor
- (iv) Voltage divider bias.

(i) Base resistor method:



In this method,

- It is a transistor biasing method
- that determine the zero signal base

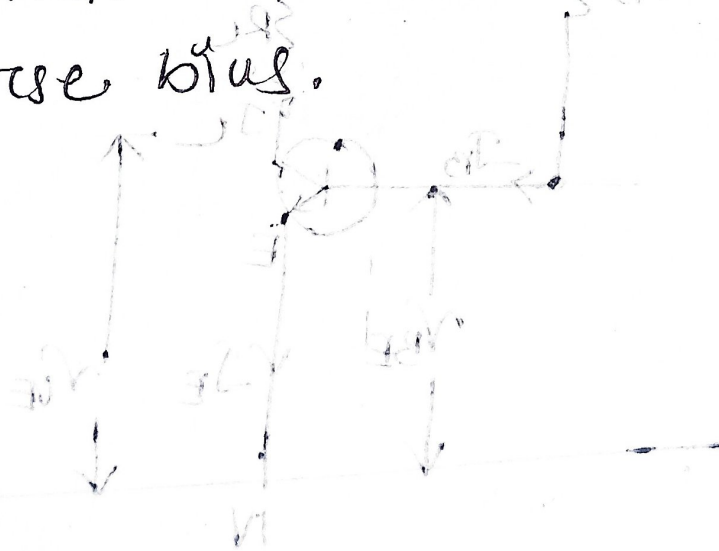
current by the collector base voltage (V_{CB})

(1) A resistor R_B of high resistance is connected in base.

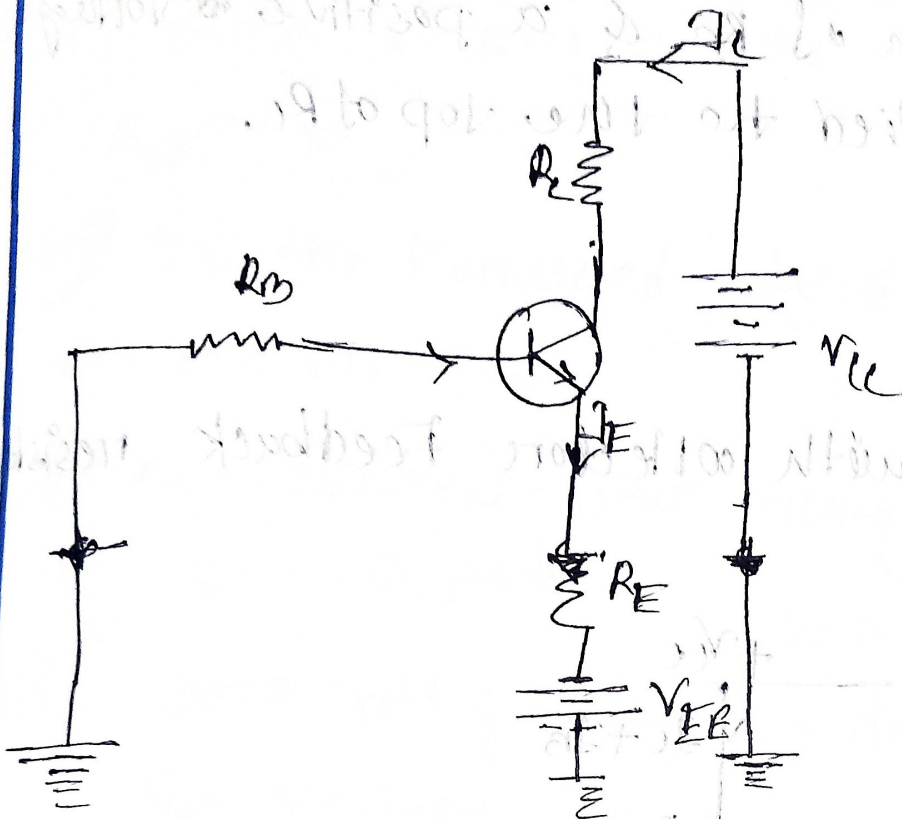
→ The high resistance R_B is connected between supply V_{CC} & base terminal.

→ The required zero signal base current I_B is provided by V_{CC} .

→ The V_{CC} keeps base-emitter junction in forward bias & base-collector in reverse bias.



(ii) Emitter bias method:—



It is a transistor biasing method that uses positive & negative power supplies to create a stable bias.

(i) It uses separate dc voltage source.

— one positive, $+V_{CC}$ and one negative, $-V_{EE}$.

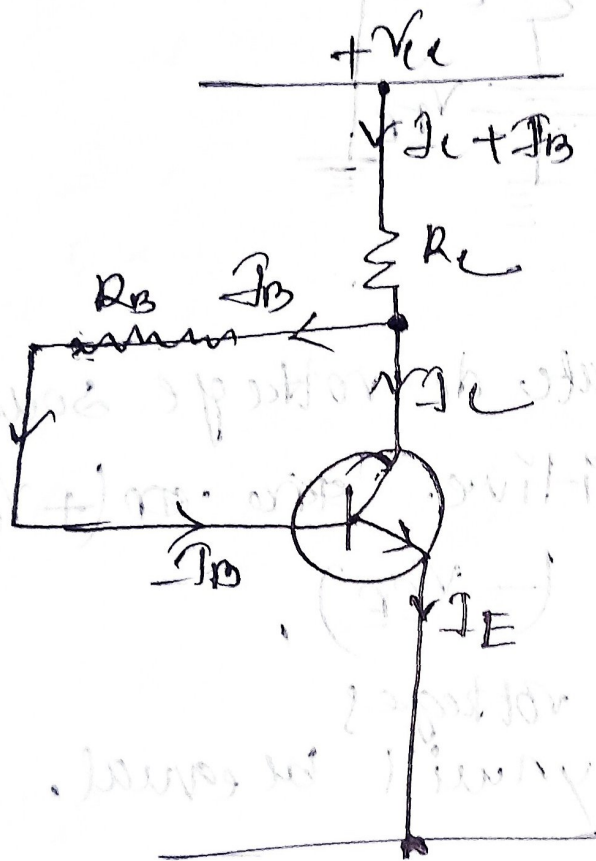
(ii) ^{voltages} two supply will be equal.

(iii) The resistor R_E has been added from emitter to the ground. terminal of the fixed bias circuit.

This is done to improve the stability of the circuit.

→ negative supply voltage $-V_{EE}$ is applied on the bottom of R_E & a positive voltage of $+V_{CC}$ applied to the top of R_C .

(iii) Biasing with collector Feedback resistor.



(i) R_B resistor is connected to the base and the other end is connected to the collector.

(ii) The required zero voltage ~~to~~ signal base current is determined by the collector-base voltage

V_{CB} .

(iii) V_{CB} is Forward biased the base-emitter junction.

(iv) base current flows through ~~I_{CB}~~ R_B .

$-I_B$

base current (I_B)

Zero voltage signal is determined by the V_{CB} voltage, not by V_{CE} voltage.

Hole: In semiconductor, a hole is defined as the absence of an electron in the crystal lattice, which acts as a positive charge carrier.

Hole current: Hole current is the electric current that results from the movement of holes in a semiconductor.

~~Hole~~

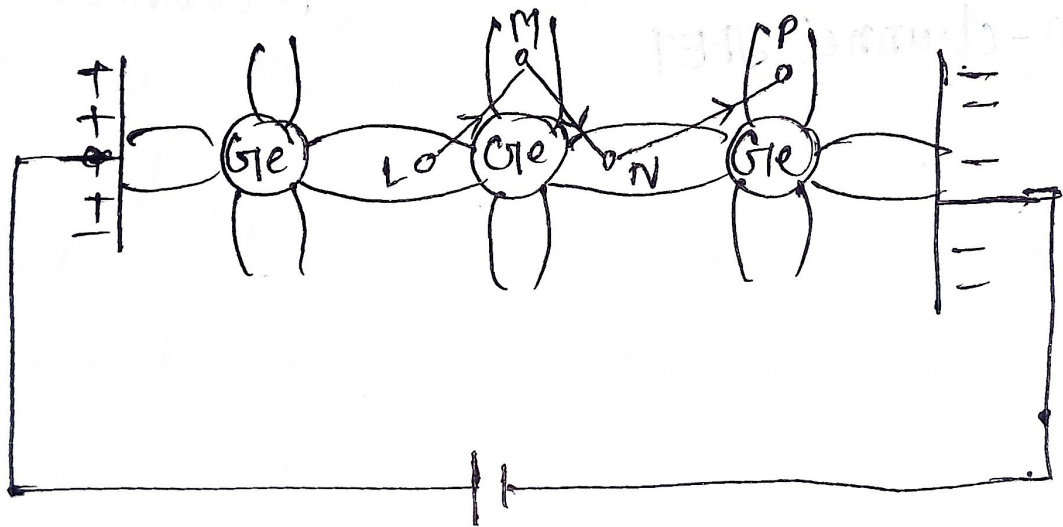


Fig: Movement of holes

Holes are the absence of electrons in a semiconductor, and they act as positive charge carriers.

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☐ A Free electron in a semiconductor is an electron that has broken free from a covalent bond and is now able to move around and conduct electricity.

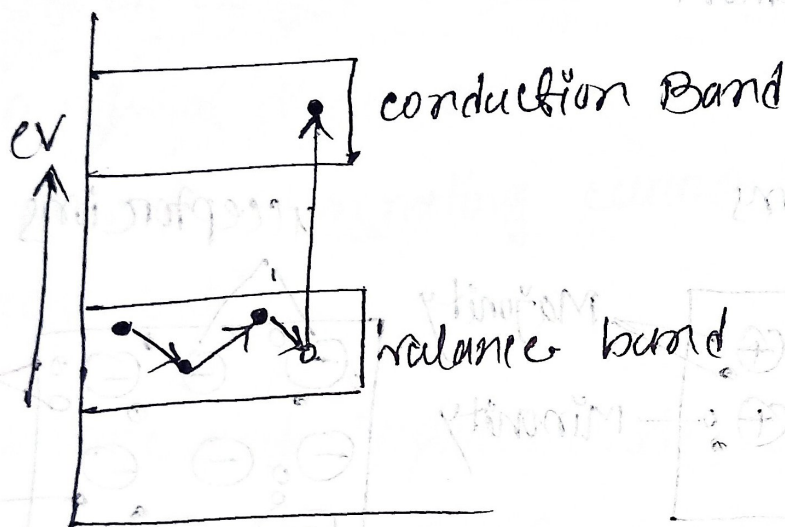


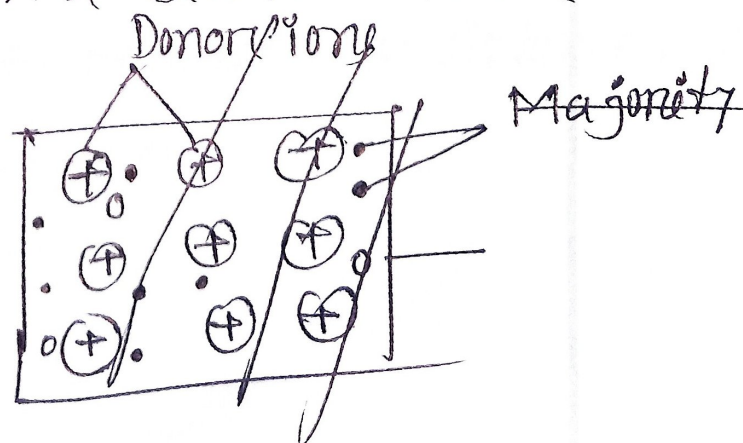
Fig: energy band diagram of holes.

Majority carriers:

The type of charge carriers that is present in greater concentration in a semiconductor material.

n-type: Electron

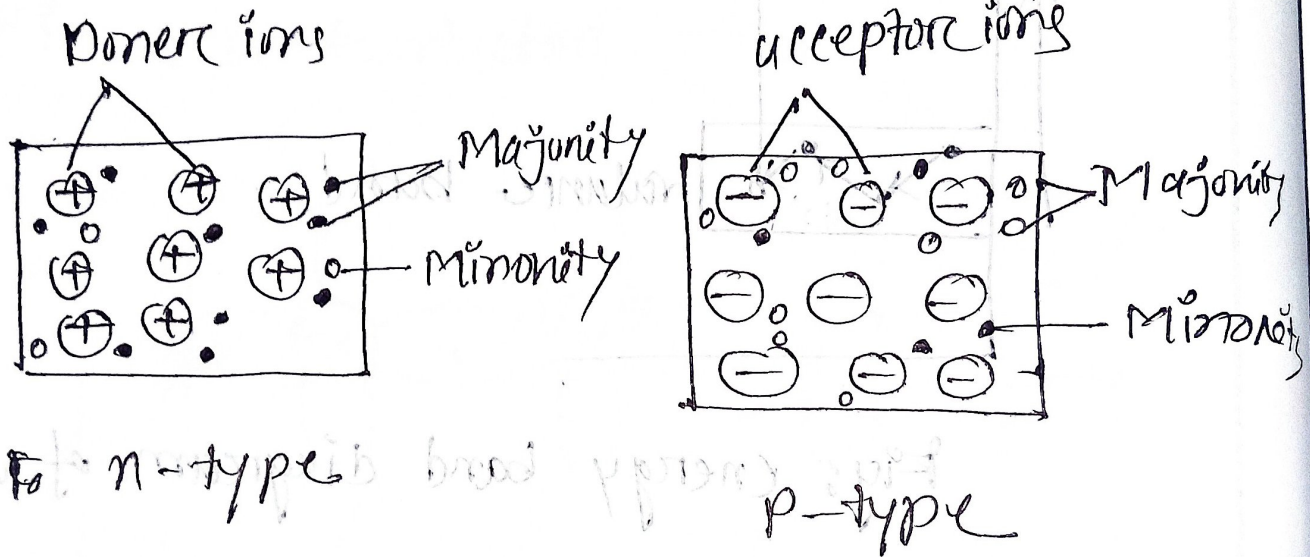
p-type: Hole



Minority carrier: The type of charge carrier that is present in lesser concentration in a semiconductor material.

n-type: Hole

p-type: Electron



→ A Pn-junction is known as a semi-conductor or crystal diode.

→ A crystal diode has two terminals.

← Forward



~~→ If arrowhead is connected~~

→ A crystal diode can be used as a rectifier to convert alternating current (AC) to direct current (DC).

→ Resistance of crystal diode:—

Forward biased diode conducts ~~can~~ current easily whereas reverse biased diode conducts no ~~can~~ current.

(i) Forward ~~biased~~ resistance: The resistance offered by the diode to forward bias is known as forward resistance.

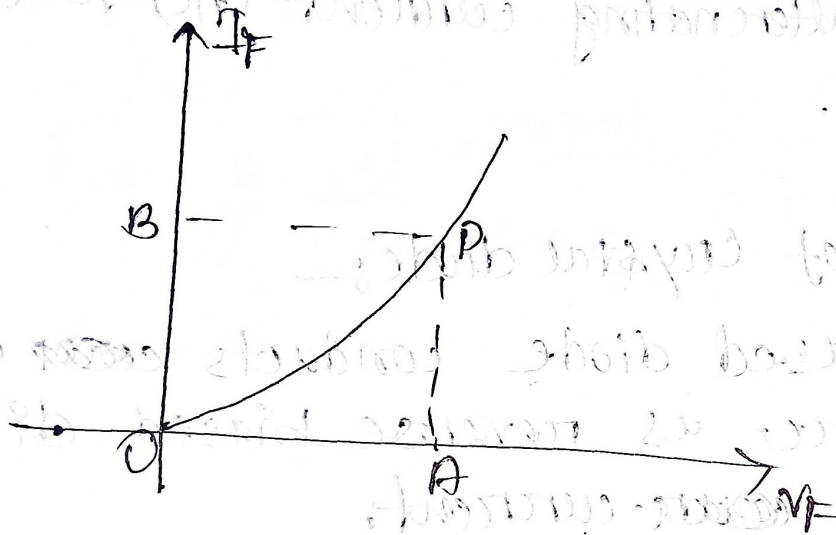
There are two type of forward resistance.

(i) A.C forward resistance.

(ii) D.C forward resistance.

(i) D.C forward resistance: The resistance offered by the diode to forward bias is. It is the opposition offered by diode to forward the direct current.

It is measured by the ratio of d.c voltage across the diode to the resulting d.c current through it.



Here,

Forward voltage is OA

Forward current is OB

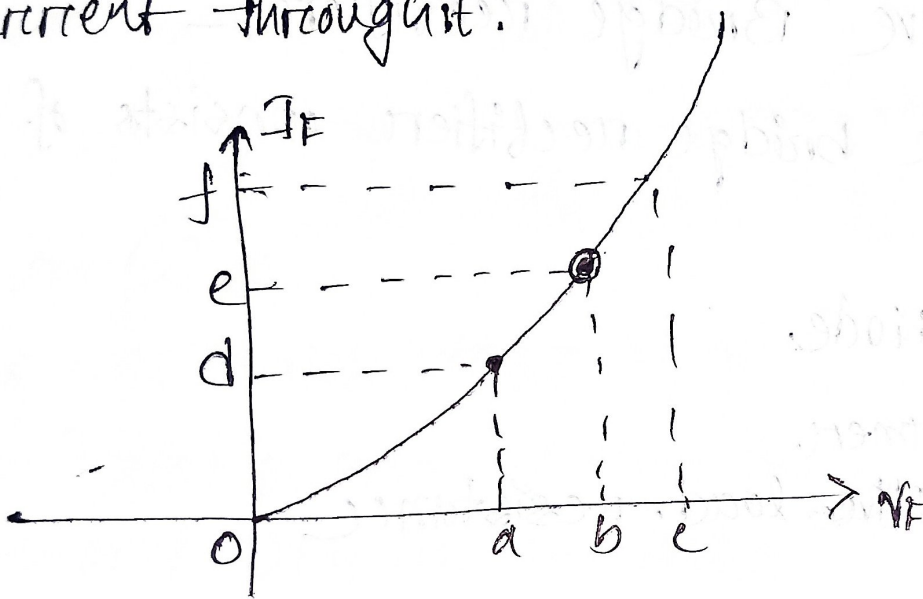
$$\text{d.c forward resistance } R_f = \frac{OA}{OB}$$

Subject:

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(ii) AC forward resistance: It is the opposition offered by the diode to the changing forward current.

It is measured by the ratio of change in voltage across diode to the resulting change in current through it.



$$\therefore \text{ac forward resistance } r_{af} = \frac{\text{change in voltage across diode}}{\text{corresponding change in current through diode}}$$

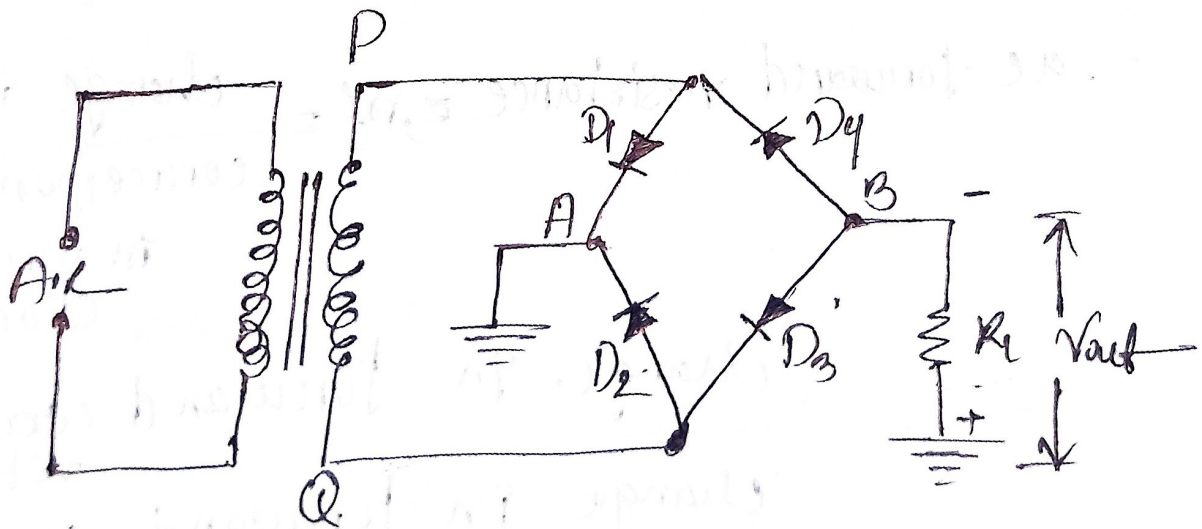
$$= \frac{\text{change in forward current}}{\text{change in forward voltage}}$$

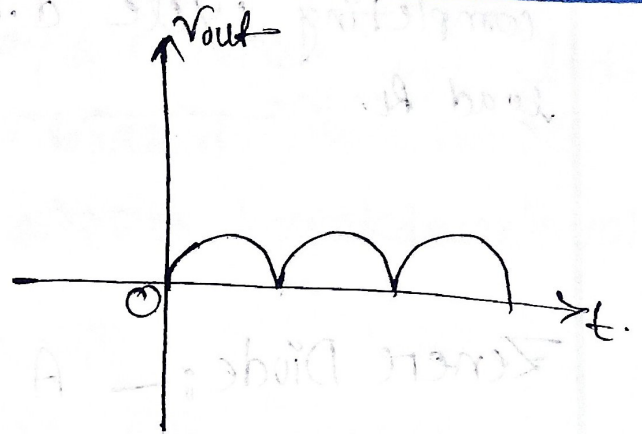
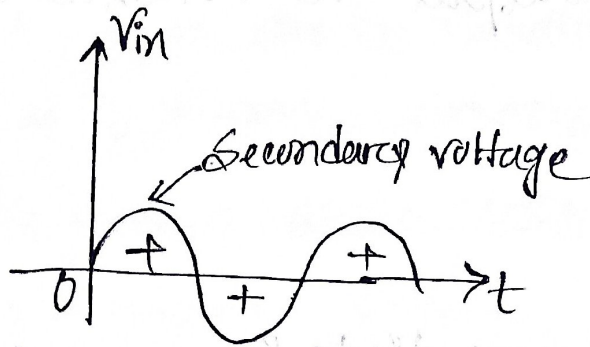
$$= \frac{oc - oa}{of - od} = \frac{ce}{df}$$

(ii) Reverse resistance: The resistance offered by the diode to the reverse bias is known as reverse resistance.

Q (ii) Full-wave Bridge rectifier:-
a full-wave bridge rectifier consists of following components.

- (i) Four diode.
- (ii) One transformer.
- (iii) A resistive load resistance





1. During positive half-cycle —

(i) P of secondary voltage is positive & @ end Q winding becomes negative.

→ This makes diode D_1 & D_3 forward bias & D_2 & D_4 are reverse biased.

→ only D_1 & D_3 conduct

→ D_1 & D_3 will be in series through the load R_L .

~~(ii)~~

(2) During negative half cycle of secondary voltage: —

(i) End P becomes negative & @ end Q positive.

This makes diodes D_2 & D_4 forward &

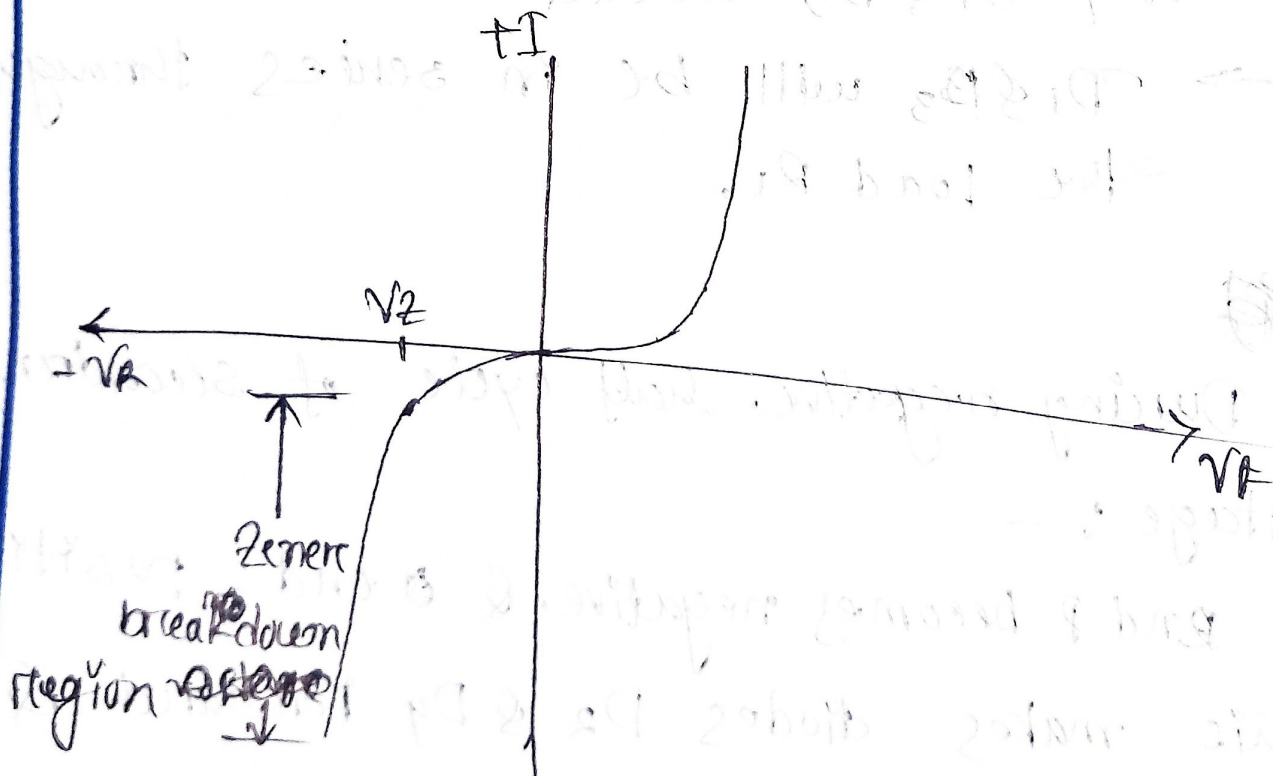
D_1 & D_3 are reverse biased.

Therefore D_2 & D_4 conduct, ~~series~~

completing cycle d.c output is obtained across load R_L .

Zener Diode: — A zener diode is a special type of diode that is designed to operate in the reverse breakdown region.

The break down voltage is sometimes called Zener voltage and the sudden increase in current is known as Zener current.

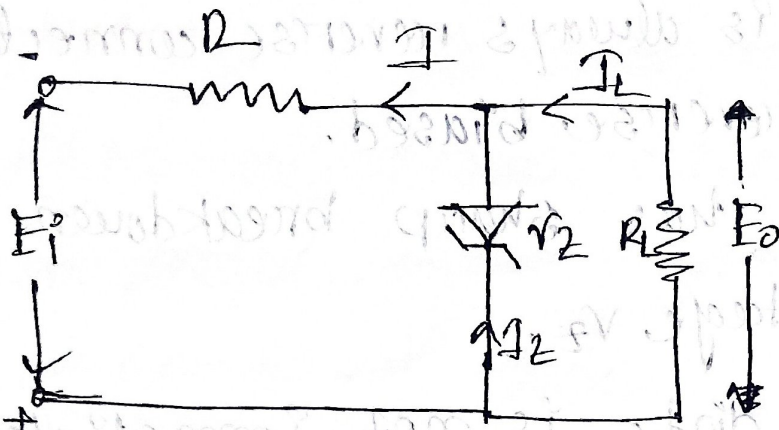


- A Zener diode is always reverse connected. It is always reverse biased.
- A Zener diode has sharp breakdown voltage called Zener voltage V_Z .
- The Zener diode is not immediately burnt just because it has entered the breakdown region.
- When Forward biased, its characteristics are just those of ordinary diode.

Q. Zener diode as voltage regulator:—

A Zener diode can be used as voltage regulator to provide a constant voltage from a source whose voltage may vary over sufficient range.

A Zener diode is commonly used as a voltage regulator to maintain constant output voltage despite variation in input voltage or load condition.



- ① when the ^{input} ~~output~~ voltage is higher than the Zener voltage (V_Z), the diode starts conducting and keeps the output voltage steady at V_Z .
- ② The extra voltage is absorbed by the resistor.
- ③ If the input voltage is lower than V_Z the diode stops working & the output decreases.

Zener