P-type Semiconductor:

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

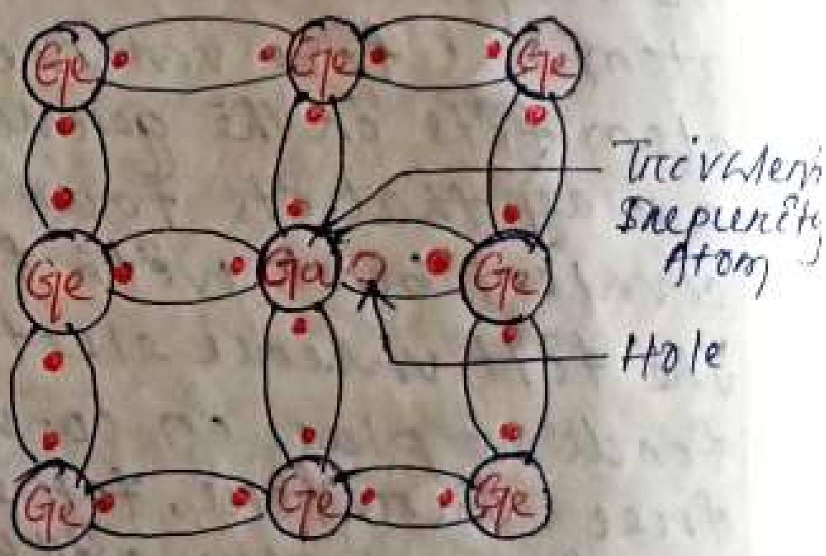
→ The addition of trivalent impurity provides a large number of holes in the semiconductor.

→ Examples of trivalent impurities are:

- Gallium (Ga) (At. No - 31)
- Indium (In) (At. No. 49)

Description:

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



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

→ In the fourth co-valent bond, only germanium atom contributes one valence electron while gallium has no valence electron to contributes. So fourth bond is incomplete; being short of one electron.

→ This missing electron is called a hole.

→ Therefore, for each gallium atom added, one hole is created.

→ The current conduction in p-type semiconductor is by holes. i.e Positive charges.

* Accepton Impurities :

Such Impurities which produce p-type Semiconductor are known as acceptor impurities.

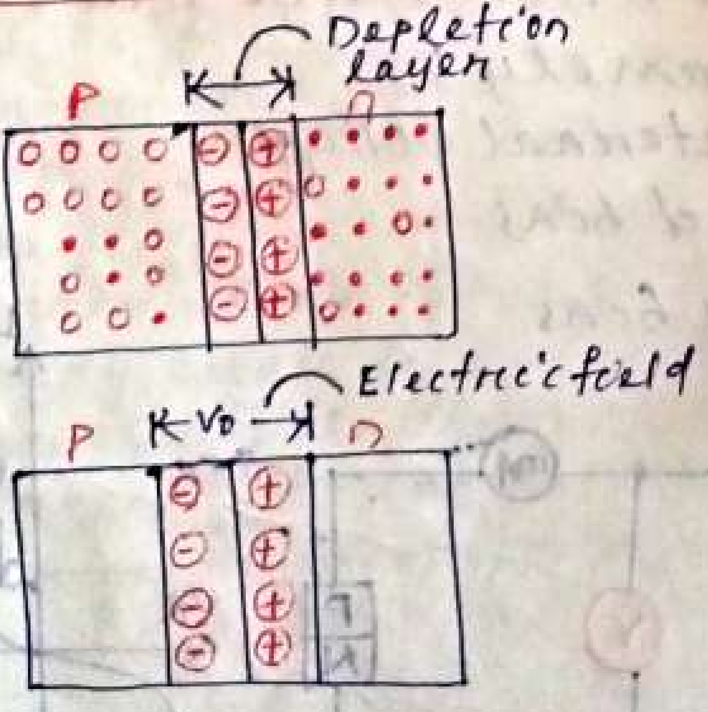
Majority and Minority carriers :

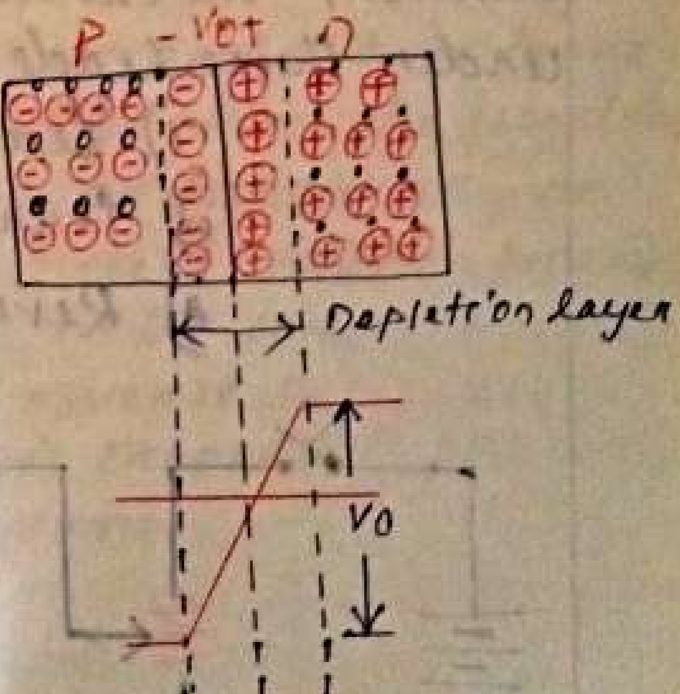
In case of n-type semiconductor, the free electrons are the majority carriers and holes are the minority carriers where as in case of p-type semiconductor, the holes are the majority carriers and the free electrons are the minority carriers.

PN junction :

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

Properties of pn junction :





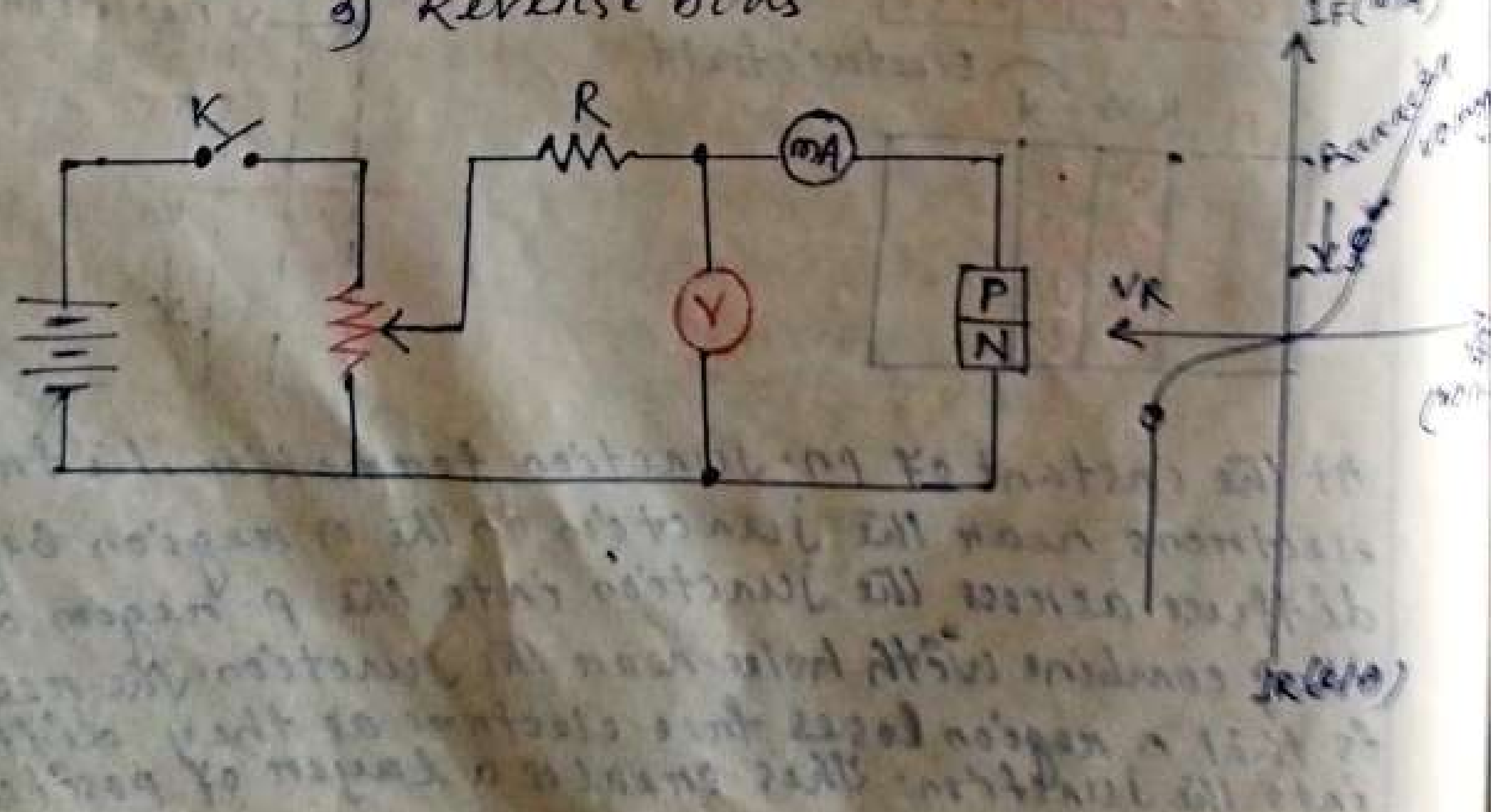
At the instant of pn-junction formation, the free electrons near the junction in the n region begin to diffuse across the junction into the p-region where they combine with holes near the junction. The result is that n region loses free electrons as they diffuse into the junction. This creates a layer of positive near the junction. The P region loses holes as the electrons and holes combine. The result is that there is a layer of negative charges near the junction. 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. The positive and negative charges set up an electric field. The electric field is a barrier to the free electrons in the n-region. This is called barrier potential (V_0). The barrier potential for silicon, $V_0 = 0.7V$.

Germanium (V_0) = 0.3 V

V~I characteristics of pn junction :

V-I characteristics of a pn junction is the curve between voltage across the junction and the circuit current. The characteristics can be studied under three heads; namely:

1) Zero external voltage.
2) Forward bias
3) Reverse bias



Zero external voltage:

When the external voltage is zero, i.e, circuit is open at K, the potential barrier at the junction does not permit current flow. Therefore, the circuit current is zero.

Forward bias:

With forward bias to the junction i.e p-type connected to positive terminal and n-type connected to negative terminal, the potential barrier is reduced. At some forward voltage, the potential barrier is eliminated and current starts flowing in the circuit. From now onwards, the current increases with increase in forward voltage.

Reverse bias:

With reverse bias to the pn junction i.e. p-type connected to negative terminal and n-type connected to positive terminal. Therefore the junction resistance becomes very high and practically no current flows through the circuit. But in practice a very small current flows in the circuit with reverse bias. This is called reverse saturation current. ~~If reverse voltage is increased, the kinetic energy of electrons may become~~

Important term:

Break down voltage:

It is the minimum reverse voltage at which pn junction breaks down with sudden rise in reverse current.

ELECTRONIC CIRCUIT

RECTIFIER :

→ A rectifier is a circuit which is used to convert a.c voltage into the pulsating d.c voltage

→ A rectifier circuit uses one or more diode

Uses of Rectifier :

→ Soldering Iron circuit
→ Pulse generator circuits
→ Signal demodulation circuits
} Half wave Rectifier

→ Mobile phones, laptops.
→ LCD, LED TVs.
→ Radios, Audio amplifiers
} Full wave Rectifier

Types of Rectifiers :

There are two types of rectifiers :

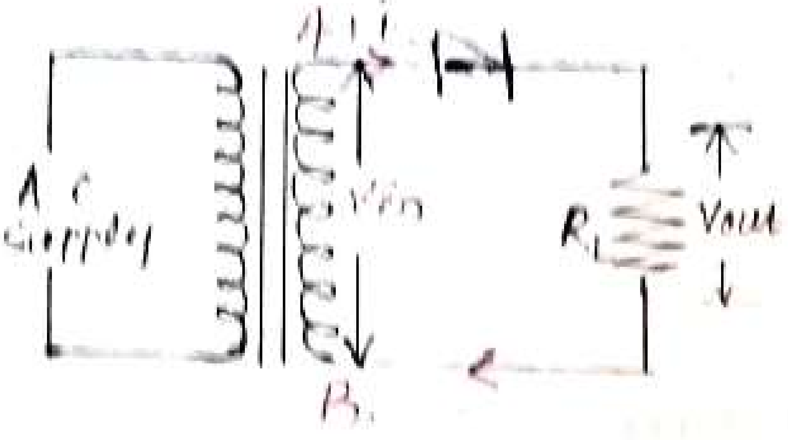
1) Half wave Rectifier
2) Full wave Rectifier

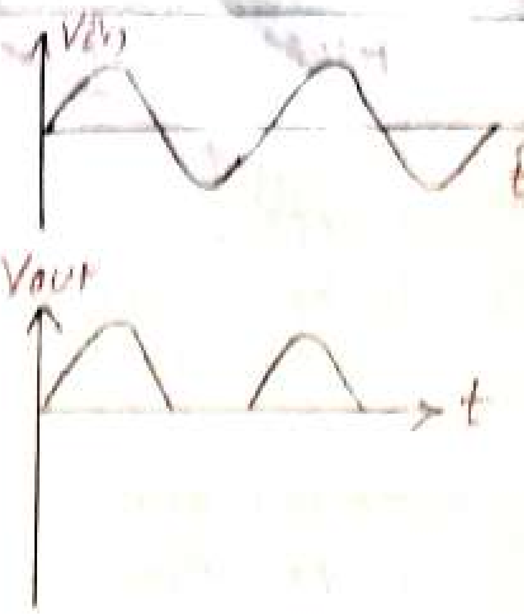
Half-wave Rectifier :

→ In Half-wave rectification, the rectifier conducts current only during the positive half-cycles of input a.c supply.

→ The negative half-cycles of a.c supply are suppressed i.e. during negative half-cycles, no current is conducted and hence no voltage appears across the load.

→ Therefore, current always flows in one direction through the load through after every half-cycle.





Circuit details :

→ The a.c supply to be rectified is applied in series with diode and load resistance R_L.

→ The use of transformer permits to setup or step down the a.c voltage as the situation demands.

→ The transformer isolates the rectifier circuit from power line and thus reduces the risk of electric shock

Operation :

→ The a.c voltage across the secondary winding AB changes polarities after every half-cycle

→ During the positive half-cycle of input a.c voltage, end A becomes positive w.r.t end B

→ This makes diode forward biased and hence it conducts current.

→ During the negative half-cycle, end A is negative w.r.t end B.

→ Under this condition the diode is reverse biased and it conducts no current.

→ Therefore, current flows through the diode during positive half-cycles of input a.c voltage only.

→ Hence d.c output is obtained across R_L. Current flows through R_L always in the same direction.

Disadvantages :

→ The pulsating current in the load contains alternating component whose basic frequency is equal to the supply frequency.

→ The a.c supply delivers power only half the time.

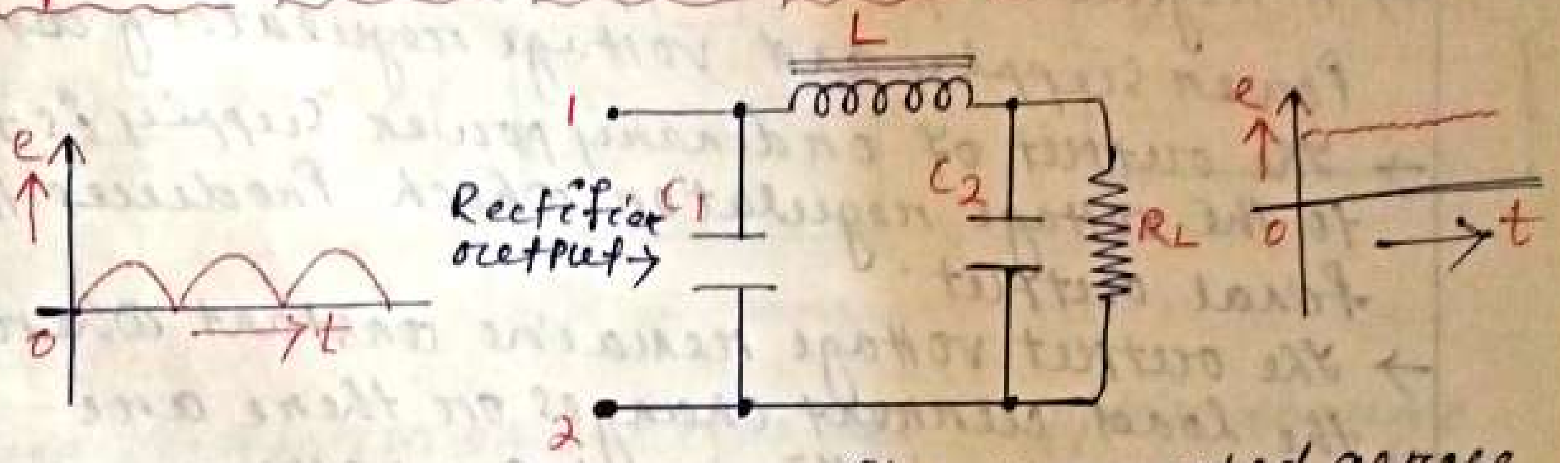
d.c component and the remaining part of a.c component which has managed to the pass through the choke.

→ Now the low reactance of filter capacitor by passes the a.c component but prevents the d.c component to flow through it.

→ Therefore, only d.c component reaches the load.

→ In this way, the filter circuit has filtered out the a.c component from the rectifier output, allowing d.c component to reach the load.

Capacitor Input filter or π filter:



→ It consists of a filter capacitor C_1 connected across the rectifier output, a choke L in series and another filter capacitor C2 connected across the load.

→ The pulsating output from the rectifier is applied across the input terminals of the filter.

→ The filter capacitor C_1 offers low reactance to a.c component of rectifier output while it offers infinite reactance to the d.c component.

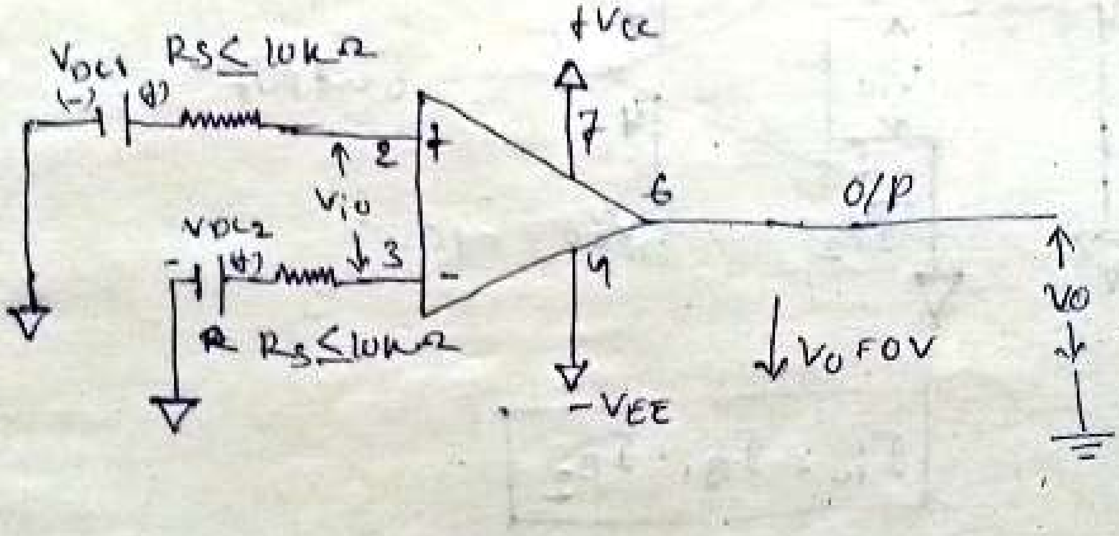
→ The choke L offers high reactance to the a.c component but it offers almost zero reactance to the d.c component. Therefore, it allows the d.c component to flow through it, while the unbypassed a.c component is blocked.

→ The filter capacitor C2 bypasses the a.c component which the choke has failed to block. Therefore only d.c component appears across the load ~~and~~.

Electrical specification of op-amp

(i) Input offset voltage - (Imp)

Input offset voltage is the voltage that must be applied between the two input terminals of op-amp to null the output.



$V_{io} = (V_{dc_1} - V_{dc_2})$

- Maximum value of V_{io} = 6 mv dc
- smaller the value better the i/p terminal are match.

2.2.17

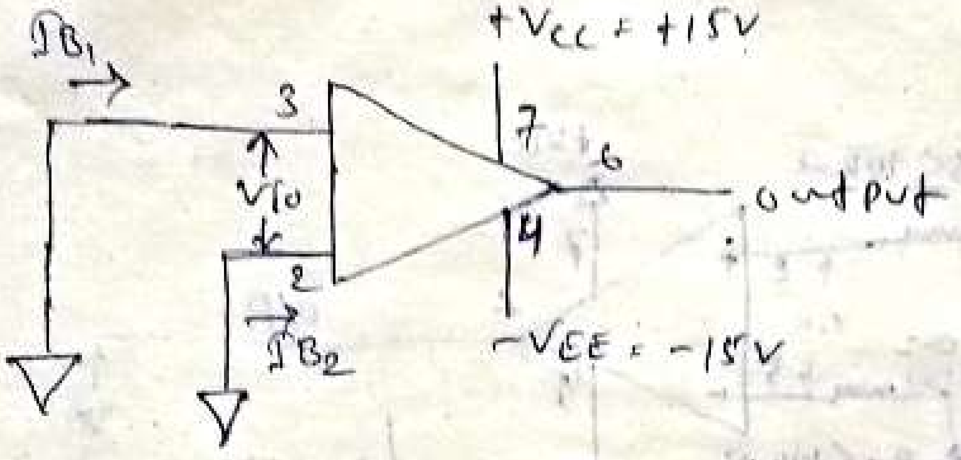
- The input offset voltage is denoted as V_{io}. It may be positive or negative, so it's absolute value
- is given in data sheet.

- The smaller the input offset voltage V_{io} the better the input terminals are matched.

- For a 741C the maximum value for V_{io} is 6mV

Input offset current (I_{io})

The algebraic difference between the currents into the inverting and non inverting terminals is referred to as input offset current I_{io}.



$$I_{io} = I_{B1} - I_{B2}$$

where I_{B1} - Current at non inverting terminal

I_{B2} - Current at inverting terminal

The smaller the input offset current the better matching between two input terminals is achieved.

→ The 741C as a maximum I_{io} value of 200nA

→ The precision of 741C op-amp has a maximum I_{io} value of 6nA.

Block diagram of feedback circuit

An op-amp that uses feed back is called feed-back amplifier.

- A feedback amplifier is also called as close loop amplifier because the feedback forms a closeed loop between input and output

- A closed loop amplifier generally consists of two parts
  - (i) Op-amp
  - (ii) Feed back circuit

- Depending upon the feedback of voltage or current to the input, four configuration are normally used.
  - (i) ~~current~~ voltage series feedback
  - (ii) voltage shunt feedback
  - (iii) Current series feedback
  - (iv) current shunt feedback

(i)