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Unit = III

P.N Junction

Important Energy bands :-

1.> Valance band :- The electrons in the outmost orbit of an atom are known as valance electron under normal condition of the Atom valance band contains the e⁻ of heigest energy. This band may be filled completely or partially.

2.> Conduction gap :- In some of the material for example :- matels the valance e⁻ are attached to the nucleus can be reattached very easily. These e⁻ are known as free e⁻ and a responsible for the conduction of current.

3.> forbidden energy gap :- The energy gap b/w the valance band and conduction band is known as forbidden energy gap.

HOL :- A vacancy left in the valance ba because of lifting of electron from valance band to conduction band is call HOL.

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Hol current :- The movement of Hol (+vely charged vacancy in the valence band) from +ve terminal of the supply to the -ve terminal to semi conductor constitute Hol current.

Intrensive semi conductor :- An extremely pure semicondu-ctor is called intrensive semi conductor.

Extensive semi conductor :- An extremely impure semi conductor is called extensive semi conductor.

Drift current :- The flow of current in the semi conductor constituted by the drift of free e⁻ available in the conduc-tion band and holes available in valance band which are form due to external energ-y. (Heat supply to them is known as drift current)

Dopping :- It is a process by which an impurity is added in semi conduc is known as dopping. Depending upon the type of impurity adding expensic s conductor may be classified into 2 types
1) N-type 2) P-type

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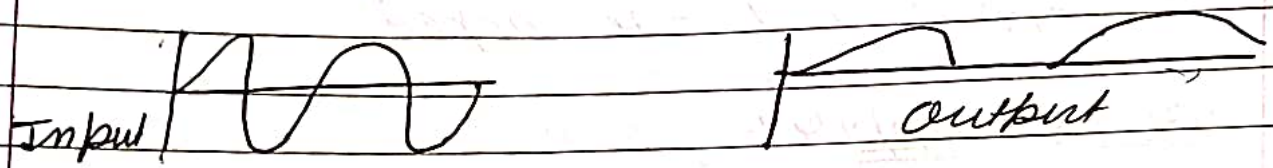
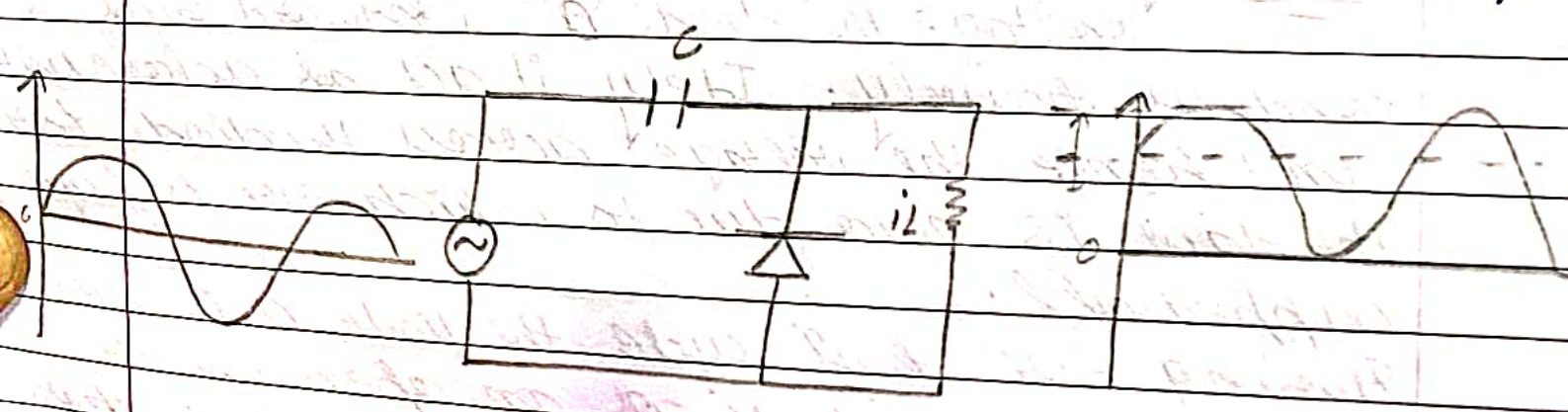
the circuit behaves as voltage dibides which the output in taken across R_1

Some time it is required to remove the -ve half cycle of the input signal in that case the direction of the polacity of the diode can be is the change such type of clipper is known as -ve clipper.



⇒ Clamper :- A circuit which shift either +ve or -ve peak of the signal dc level is known as clamping circuit or clamper.

Positive clamper :- A circuit which shift the signal in the +ve side in such a way that the -ve peak of the signal falls on the zero level is called +ve clamper



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N-type semiconductor:-

When a small amount of pantovalent impurity is added to a pure semiconductor providing a large no of free e⁻ in it is known as N-type semiconductor

P type semiconductor:- when a small amount of trivalent impurity is added to a pure semiconductor providing a large number of holes is known as p type semiconductor.

Hence, in N-Type semiconductor e⁻ are majority where as holes are minority carriers.

⟹ PN JUNCTION:-

When a P-type semiconductor is joint to an N-type semiconductor the contact surface is known as PN Junction

Formation of PN Junction:-

An PN Junction is fabricated by special technic known as alloying and defusion methon an alloyed junction is made from an N-type slice of semiconductor (germanium of, silicon by melting a pallet of trivalent indium place on the slice this is done by heating the system to about 500° centigrate. The indium is absorb into the germanium

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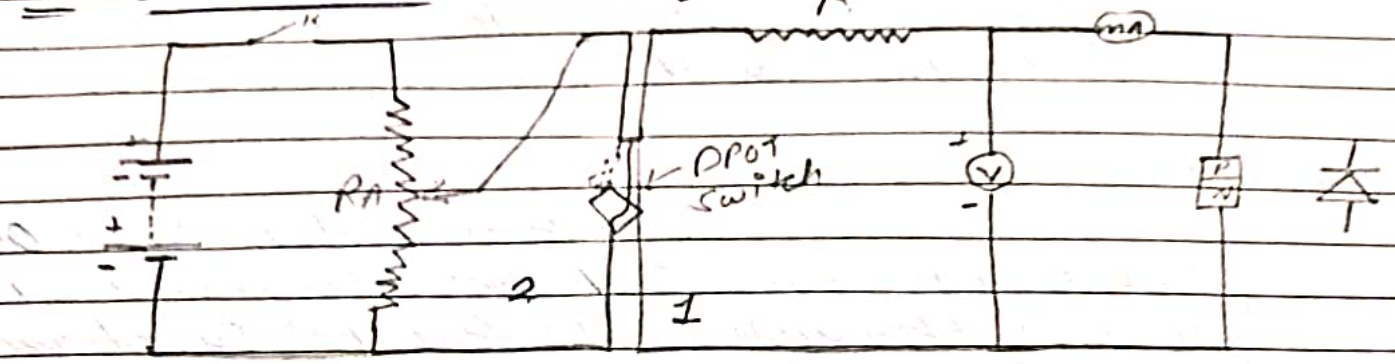
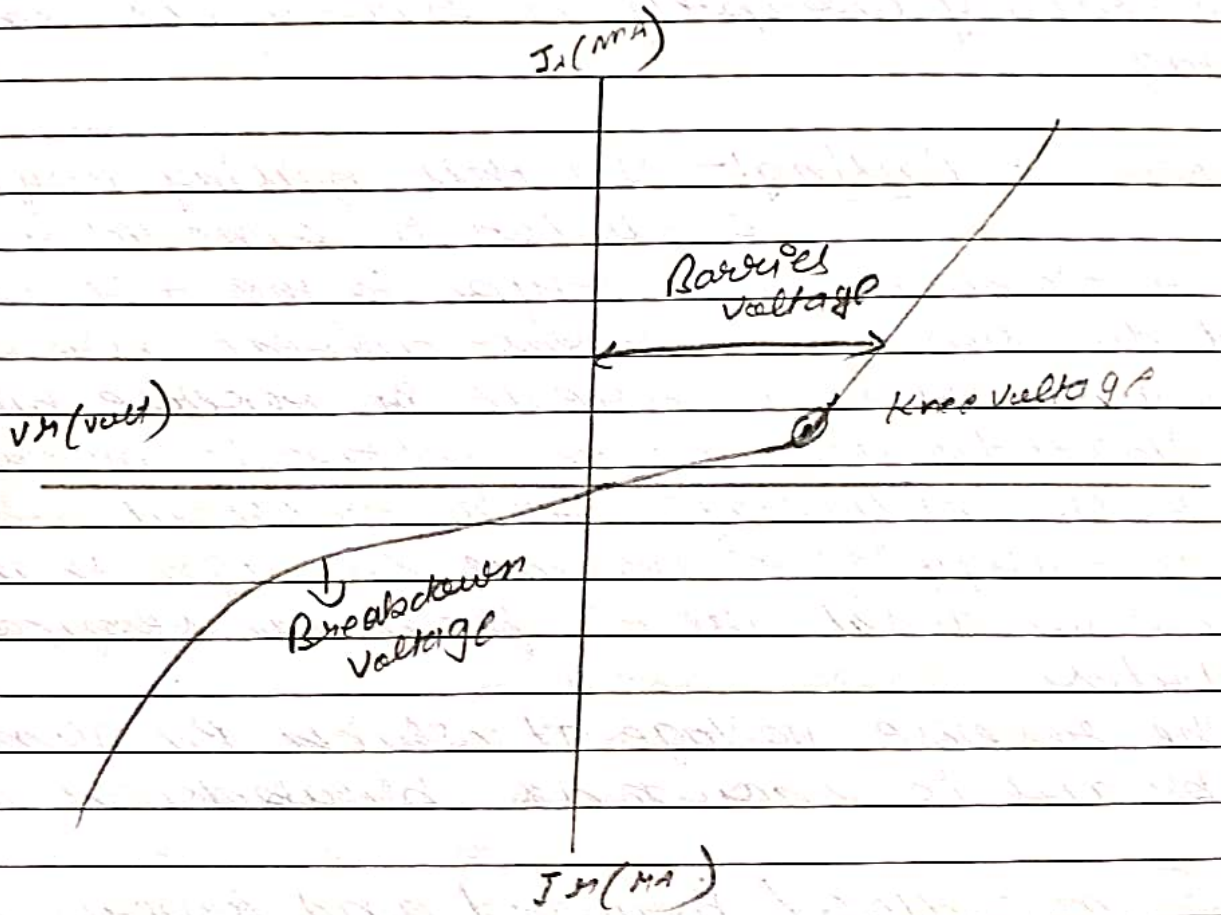
In this mechanism electric field existing in the depletion layer is sufficiently high the velocity of carrers crossing the depletion layer increases. The carrers collide with the crystal atoms and create e⁻ hole pairs. As the pair of e⁻ is created in the mid of the high field they quickly seperate and a train high velocity to cause further pair generation through more collisions. It is a continuous process and as it across the breakdown voltage the field become so large that the chain of collision can give rise to an almost infinit current with very slight additional increasing voltage.

It take place in a very thin junction that is when both sides of the junction are heavily dopped and the depletion layer is narrow. In the breakdown electric field becomes high and with only a small applied reverse bias voltage mechanism breakdown take place.

of silicon to produce a P region and hence a PN Junction is form.

VI Characteristics of PN Junction :—





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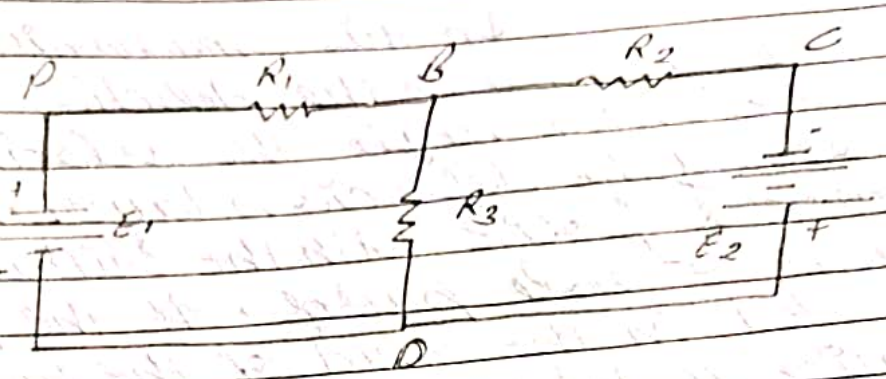
Networks Anal:-

Act



Active Element:- The element which supply energy to the circuit is called active element. E1 & E2 are active elements.

Passive element:- The element which recieves energy is called passive element (resistor, inductor, and capacitor) In fig=1 R1, R2, R3 are the passive elements.

NOD:- A nod is a point in the networks where two or more circuit element are join.

Junction:- A junction is a point in the networks where 3 or more circuit elements are join infact it is a point where current is divided (B & D).

Branch:- The part of a networks which lies b/w two junction point is called branch.

Forward Raising :-

When Key (K) is closed and double through switch is on position 1 the PN Junction is forward Bias as P-type semi conductor is connected to the +ve terminal and N-type to the -ve terminal of the supply

Knee voltage :-

The forward voltage (0.3 volt for germanium, 0.7V for silicon). At which the current through diode for PN Junction start increasing abruptly is known as knee voltage.

Reverse Raising :- In this raising P-type semi conductor is connected to the -ve terminal and N-type to the +ve terminal of the supply. The reverse current increases slightly with the increase in reverse bias supply voltage. In the reverse voltage is increase consistently a stage reach out when kinetic energy of e^- become so high that they known about the e^- from the semiconductor dodes.
The reverse voltage at which PN Junction break is known as breakdown voltage.

☆ Summary of Forward and Reverse Raising :-

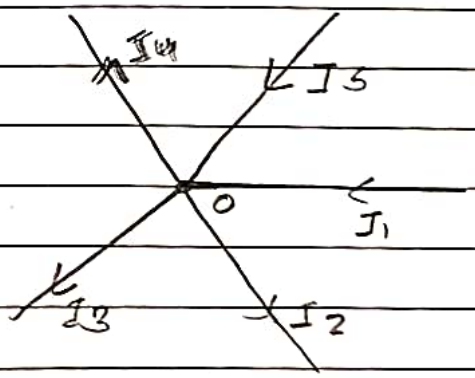
From the above discussion it may be noted that :.

Loop :- The cross path of a network is called loop. ABDA , BCD

Mesh :- The most elementary form of a loop which cannot the further divided is called mesh.

Kirchoff's law :-

First law :- This law relate the current flowing to the circuit is known as kirchoff current law (KCL). This law state that the algebric sum of all the current meeting at a point or junction is zero.



In this incoming current in fig 2 is taken as + ve and outgoing current is taken as -

$$I_1 + I_5 + I_3 + I_4 + I_2$$

1.) At zero external voltage no current flow the circuit or diode.

2.) At forward biast the current increases slig-gishly till the barrier voltage is achieved

3.) After knee voltage the forward current rises avrubbly.

4.) The forward current is limited by series resistance are.

5.) In reverse bias the reverse current increases slightly with the increasing voltage. For silicon diods the maxi. value of reverse current is is 1 mA. However for germanium this value is 100 mA

Effect of temp. on the conductivity of semiconductor diode :-

→ At absolute zero :- temp. all the electrons of semiconductors are held t packed in the atoms. The inner orbit e are bound to nucleus whereas the valan electrons are bound by the forces of c bonds. therfore at this temperature no e^- is available in the semiconductor. the semiconductor crystal behaves ti be perfect insulater.

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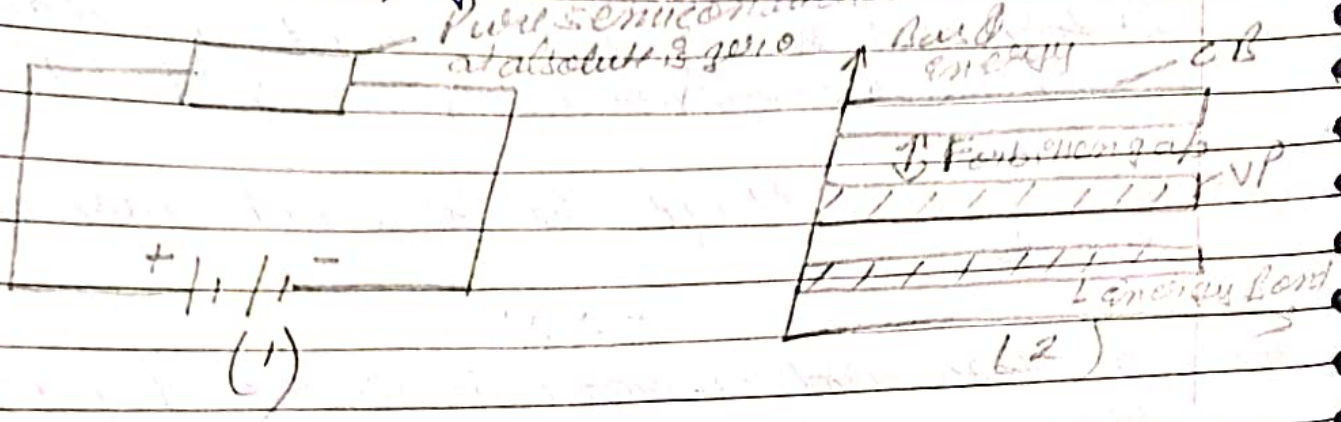
Know if some potential difference applied across the semiconductor as shown in fig-1



The behaviour of a semiconductor at absolute zero temp. can be explain with the help of energy band as shown in fig 2. The valance band at absolute zero temp. is completely filled whereas the conduction band is totly empty moreover no valance e can reach the conduction band to become free since no energy is supply to the semiconductor crystal and they cannot cross the forbitten energy gap. Hence the semiconductor (SC) behaves as an insulater due to empty conduction band.

→ Above absolute zero :- When the temp. of semiconductor it raised the sum of its covelent bond breaks due to the thermal energy supplied to it. The breaking of bonds set those free which are angaged in the formation of

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these bond Hence at higher temp a few
free e⁻ exist the semiconductor and they are no
longer behave as insulator (SC)

When temp. of SC is increased the heat
energy supply to it we left some of the
balance e⁻ to the conduction band. the
higher the temp. the greater the no. of valan
e⁻ burst up to the conduction band and lar
-ge the current and it can conduct.

Transitor :- It is a semicondu
device consist of two PN
Junction formed by merging either P type
or N-type semiconductor & a pair of
opposite type is known as transitor. The
are two types of transitor NPN & PNP

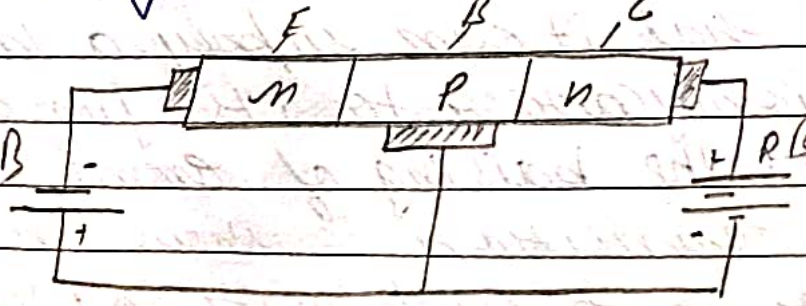
NPN Transitor :- A transitor in which tw
blocks of N-type semiconductor
are saperated by thin layer of P-type semicon
-ductor is known as transitor.

1> **Ammeter :-** It supplies a large no. of majo
carrier and is called ammeter. It
is always Forward biased with respect to
base so that it can supply a large numb
of majority carrier to its junction with
the base. The baising of ammiter based junc
of NPN Transition is shown in fig 1. Sin
ammiter is to supply or inject a large a

majority carrier into the base it is heavely doped but moderat in size.

Collecter :- It main function is to collect the measure function of the majority carrier supplied by the ammeter is called collecter. This junction is always reverse baise and its main function is to remove majority carrier from the junction with the base. The collecter is moderatey drop but large in size so that it can collect most of the majority carrers of ammeter.

Base :- The middle section which form two PN Junction b/w ammeter and collector is called base. The base forms two circuit one in put circuit with ammeter and the other output circuit with the collector The base ammeter junction is forward baise providing low resistance for the ammeter The base collector junction is reversed baise offering high resistance path the the collector circuit the base is lightly doped and very thin so that it can pass on most of the majority carrer supplied by the ammeter to the collector.



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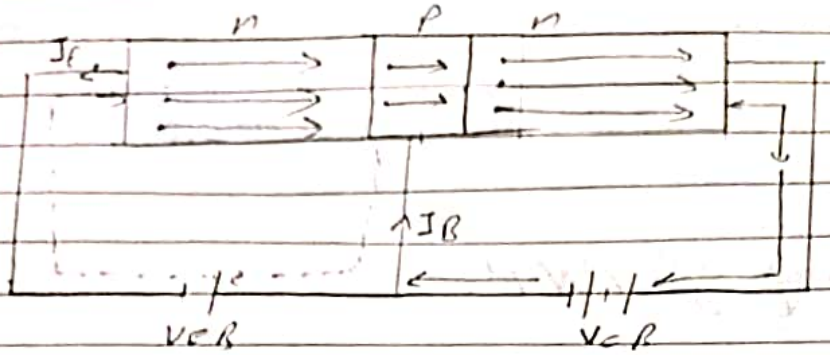
Working of an NPN Transistor:-



NPN Transistor is shown in fig one. The emitter base junction is forward baised while collector base junction is reversed baise. The forward baise voltage V_{EB} in quite small where as reversed baised voltage V_{CB} is high.

At the emitted baise junction is forward baise a large no of e^- (majority carriers), in the emmited n type region are pushed towards the base due to which emitted current I_E flows. When these e^- enters the P-type material (base) they try to combine with the holes. Since the base is lightly doped and very thin only a few e^- only combine with the holes constitude the base current I_B (only 5%). The remaining e the ~~free~~ diffuse across the thin base region and reach the connector space charge laye These e^- then come under the influence of +vely biased ~~and~~ n region and are attracted or collected by the collector which helps

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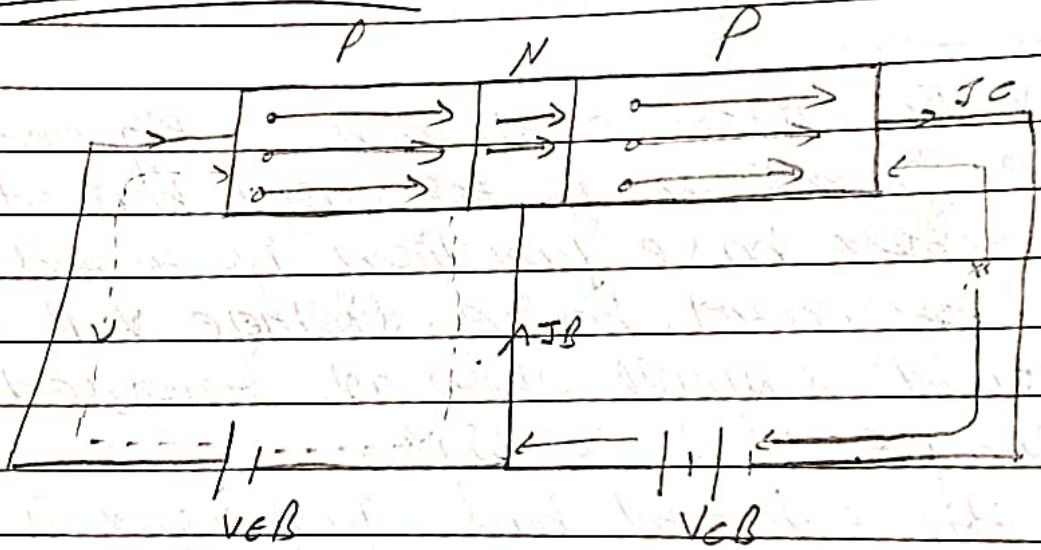
the flow of current that is I_C. Hence it is observed that the almost entire amm -ber current flows in the collector circuit.

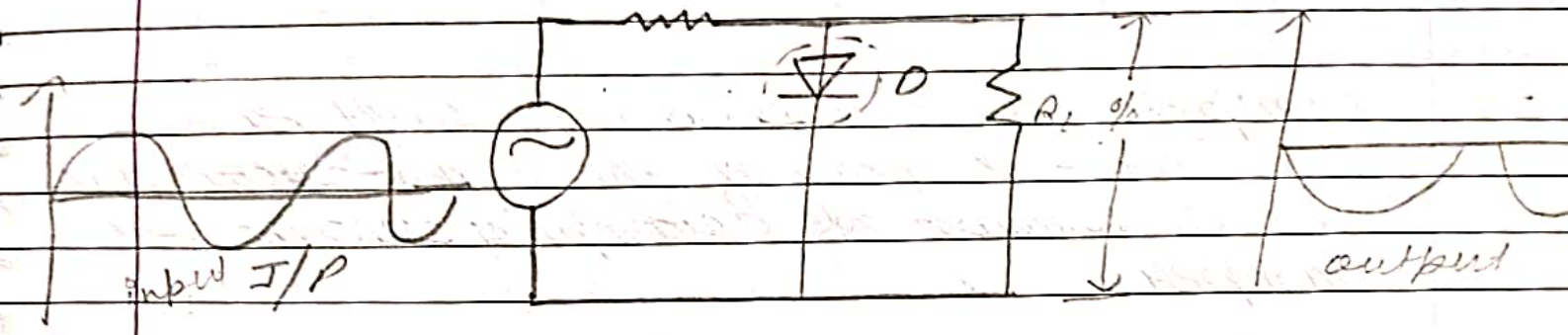
$$I_E = I_C + I_B$$

Working of PNP :-



Clipper :- It is a circuit use to change the shape of an input voltage wave by clipping or removing a portion of it is called clipper circuit. It is also known as clipper / limiter or slicer. A clipper has the ability to remove singles voltage above or below a sapacified level and hence change the wave shape of input signal. Based on it they are of two types +ve clipper and -ve clipper

Positive clipper :-



A circuit which remove +ve half cycle of the signal (input voltage) is called +ve clipper

Working :- During +ve half cycle of input voltage the diode 'D' is forward bias and conducts heavily. Ideally it act as a close switch and hence the voltage across the diode for the law is zero due to which +ve half cycle clipped off.
During -ve half cycle the diode D is reverse bias and behave as an open switch. The current flow through R1 and R which connected in series. In this condition