* CH #17 * 05 Dec 2017

:Electronics:

The study of the Behaviour of ēs in electric Circuits.

① Semiconductors:-

$\rho \sim 10^{-4}\ \Omega m \rightarrow$ Conductors

$\rho \sim 10^{8}\ \Omega \cdot m \rightarrow$ Insulators

$\rho \sim 10^{4}\ \Omega m \rightarrow$ S.Cs. (Semiconductors)

-: PERIODIC TABLE :-

(I) Metals → Conductors (Free ēs)

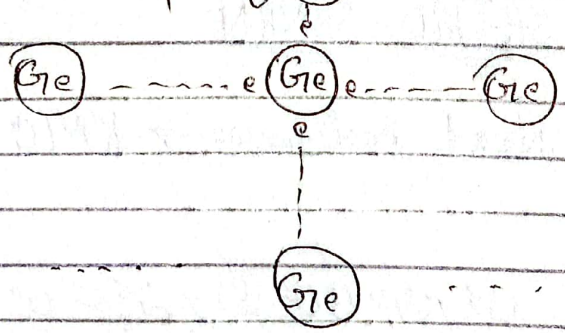
(II) Non-Metals → Insulator (No free ēs)

(III) Metalloid (Ge, Si) → Semi-Conductors.

Pure

Intrinsic and Extransic Semiconductors
(N-type and P-type Semiconductors)

* pure Semiconductors are Called Intrinsic Semiconductors.
* Bond energy of Germinium (Ge) = 0.72eV
* Bond energy of Silicon (Si) = 1.09eV

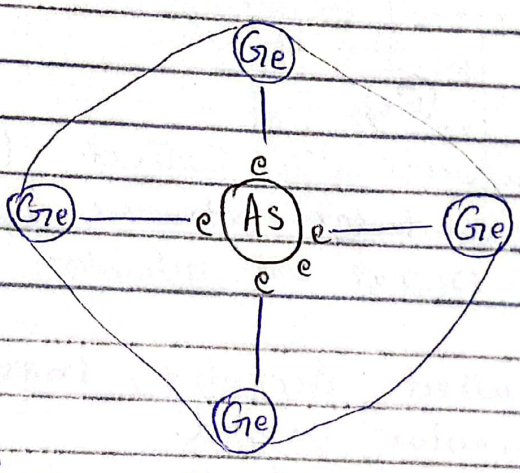


* In Intrinsic Semiconductors ēs and Holes are responsible for Conduction.

* The conduction effect of Semiconductor is less, so we add Impurites to them.

* When Impurites are added or doping is done, the conduction level of Semi conductor Increases and the Semiconductor is called Extransic Semiconductor.

Extransic Semiconductors are of two types:-



* Impure Semiconductor OR Extransic Semiconductor OR Doped semiconductor.

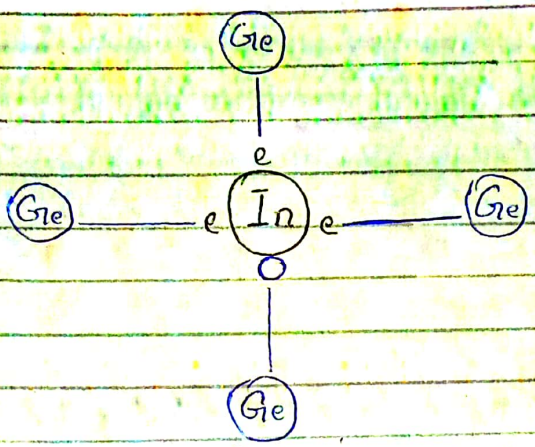
* The Arsenic (As) is called Donar Impurity or Donor Dopant.

* In this Case when:
  * One bond is broken, one hole and two ēs are freed. So on.

* In these types materials, the ēs are in Majority, So mainly conduction

occure due to ēs.
Such Materials are Called N-type materials.

* Overall charge = Zero:



This Material is Called Impure Semiconductor / Extransic Semiconductor / Doped semiconductor

* (In) is Called Acceptor Impurity or Acceptor Dopant.

In these materials:
When one Bond is broKen one ēlectron and two holes are Created and so on.

* In these materials the Conduction occure mainly due to Holes therefore these materials are Called P-type Materials.

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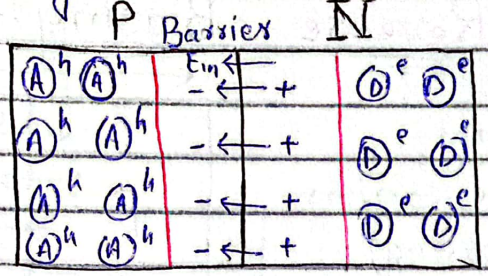
PN-junction or Semiconducting Diod:-

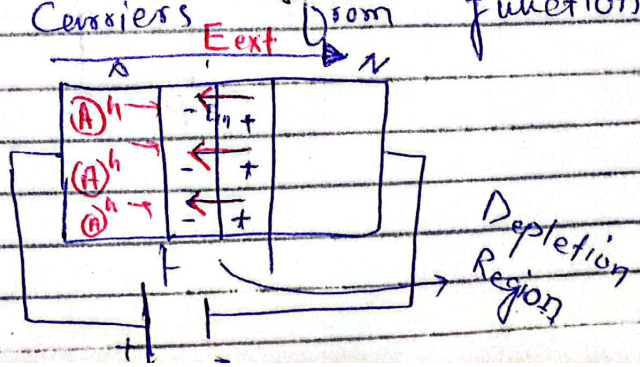
When a P-type material is pressed with N-type material under A particular fabrication process is called PN-junction or Semi-conducting diode.



1. At begaining a small current is passes which is called diffusion current.

2. When a Barrier potential is developed the current stops.

1. Forward Biasing → (to pass charge from junction)



* In case of forward Biasing the thickness of Depletion reigon Decreases. I.e Current passes Increases.

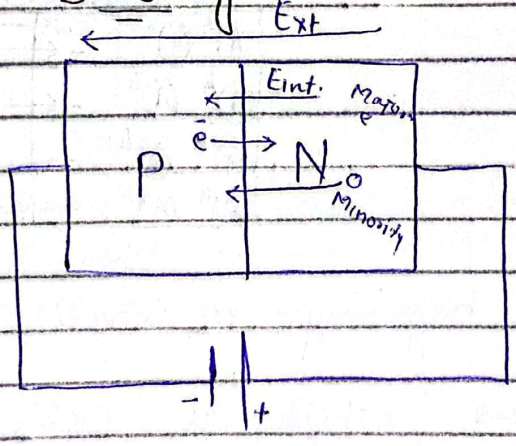
Diode

Two ↓

Holes → passage → Path

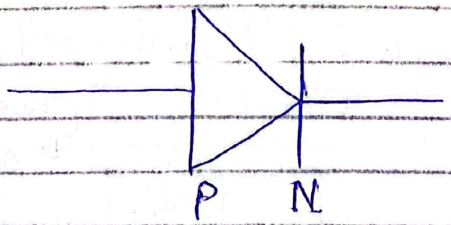
2. Reverse Biasing :-

(Minority charge carriers are passing)
(Try to Understand)

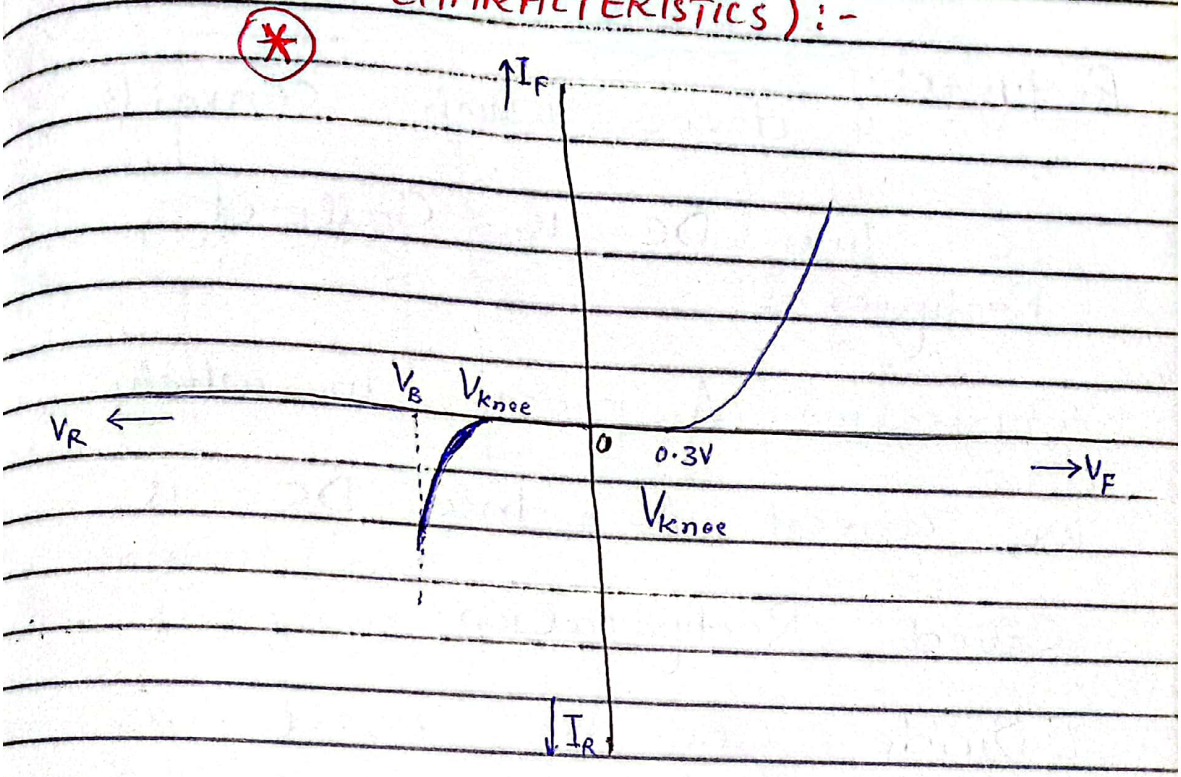


* In this Case the Barrier will Increases and Hence Current flow decreases.

Electronic Symbol for Diode :-



CHARACTERISTICS OF Diode (I-V CHARACTERISTICS):-



* The Barrier potential of Ge Diode = 0.3V

* The Barrier potential of Si Diode =

1. Avalanch Break Down:- (V_B)

Maximum es and holes are moving in their respective direction.

* At Avalanch Break Down the Current become maximum and Break Down take place...

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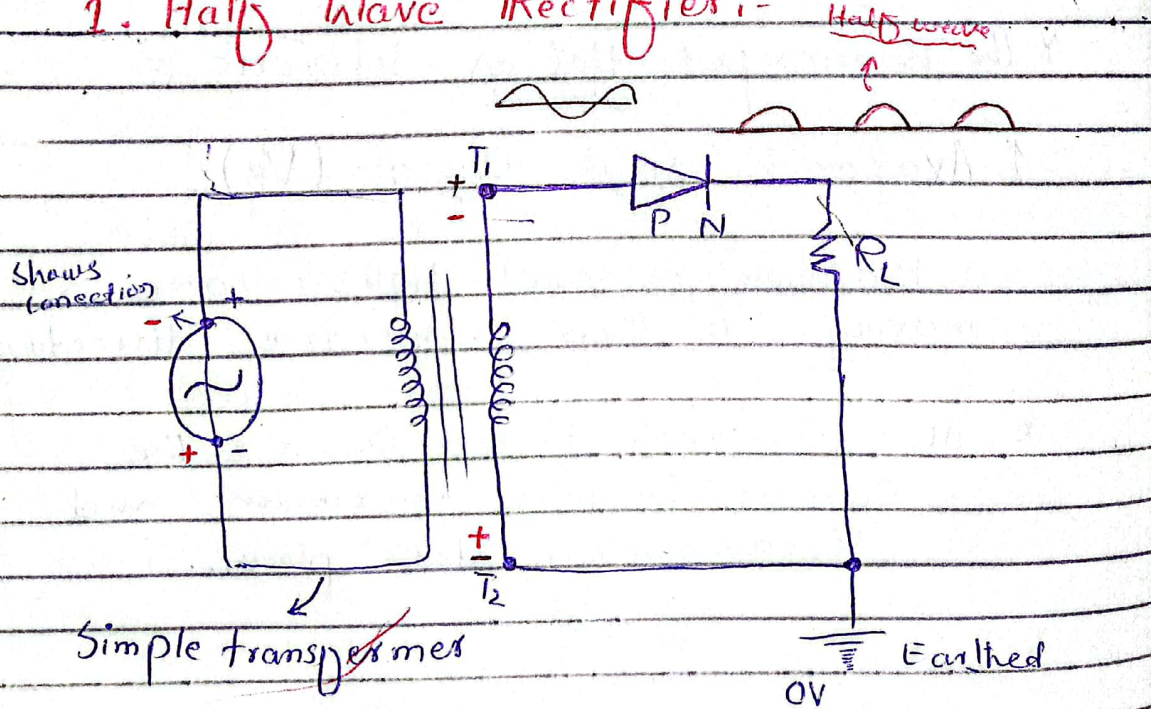
Diode As a Rectifier:-

Rectifier:- A device which converts AC into DC is Called Rectifier.

Rectification: A proces in which we convert AC into DC is Called Rectification.

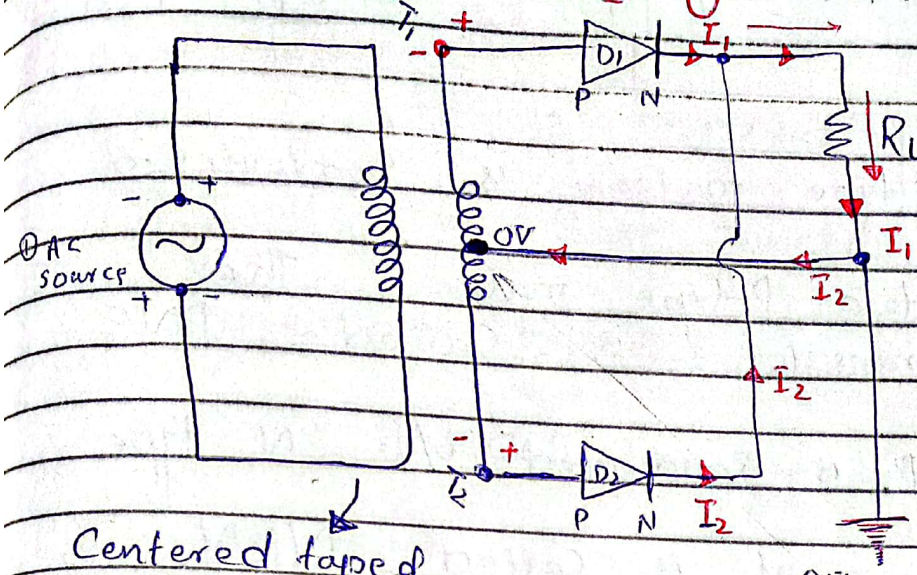
* Diode can be used as a rectifier.

1. Half Wave Rectifier:-

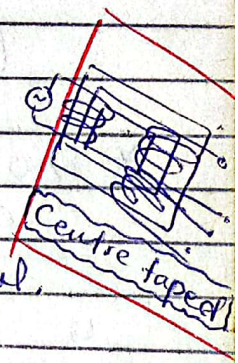


Centre tap design

2. Full Wave Rectifier :-



Centered taped transpermer



* oV ⇒ Ground or Comon potential.

* Centred taped transpermer is used in full wave rectifier to complete the circuit.

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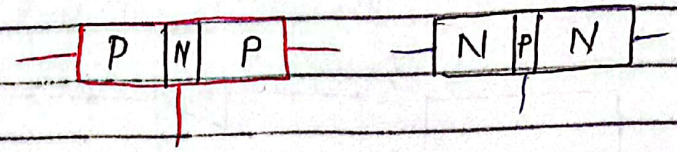
Exam Quest

Transistor :-

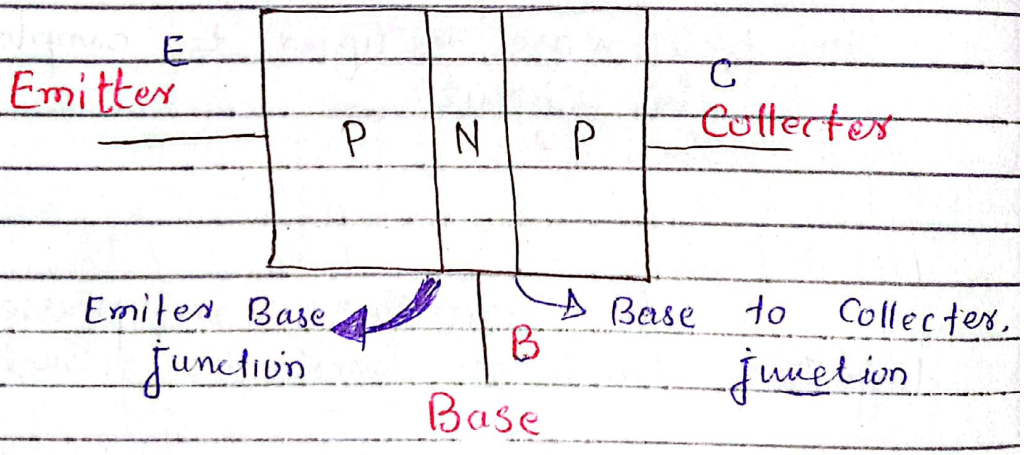
When diodes are pressed togather back to back in such away that the centre portion is made thinner, the divice porm is called Transistor.



* if N type material is Sandwitched b/w two P-type material then transistor is called PNP.

* if P is sandwiched b/w N-type then it is called NPN.

* Diode is a two terminal Semi-conducting device. While a transistor is three terminal Semi-conducting device...



1. Emitter :- The side which is highly/ Heavily Dopped.

2. Base :- Central part. It is very

Lightly Doped.

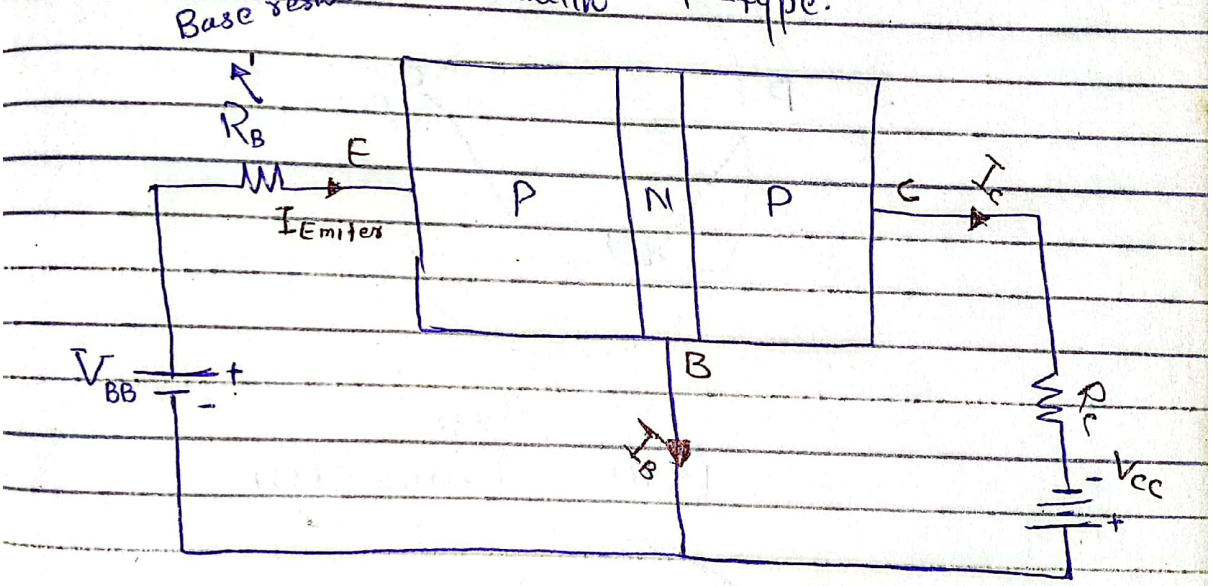
3. Collector:-

It is moderatily dopped.

* Emiter to Base junction is forward Biase

* Base to Collector junction is reversed Biase.

* A resistor (R_B) is conected with P-type.



V_{BB} → Forward biasing battery

In Transistor:-

$V_{cc} > V_{BB}$

According to KCL

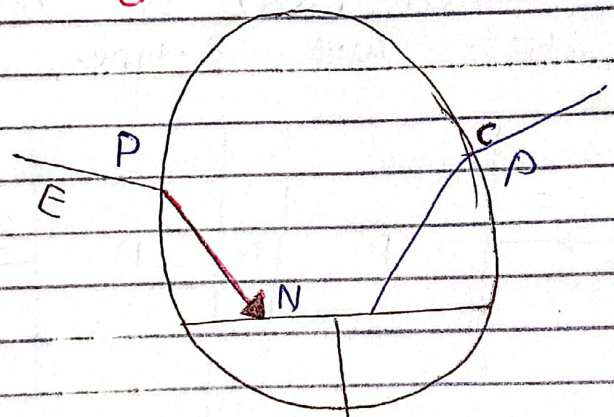
$I_E = I_B + I_c$ → Basic equation for Transistor.

Transister Can be attached in a circuit in 3 ways:

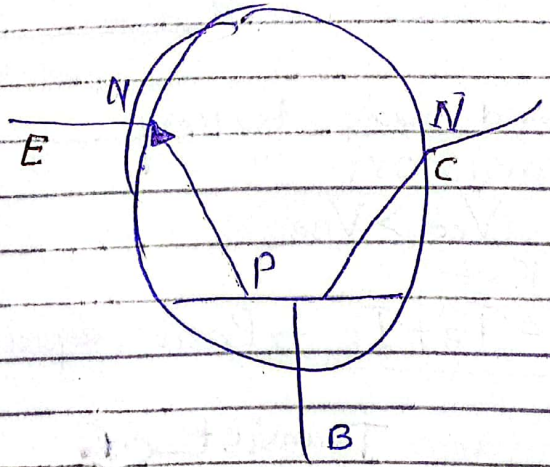
(I) COMON BASE CONIFIGURATION :-

Configuration of a transistor in a circuit ~~which~~ Such that Base is comon in Both Input and output sides.

Symbol for Transistor :-



PNP Transistor



NPN transistor

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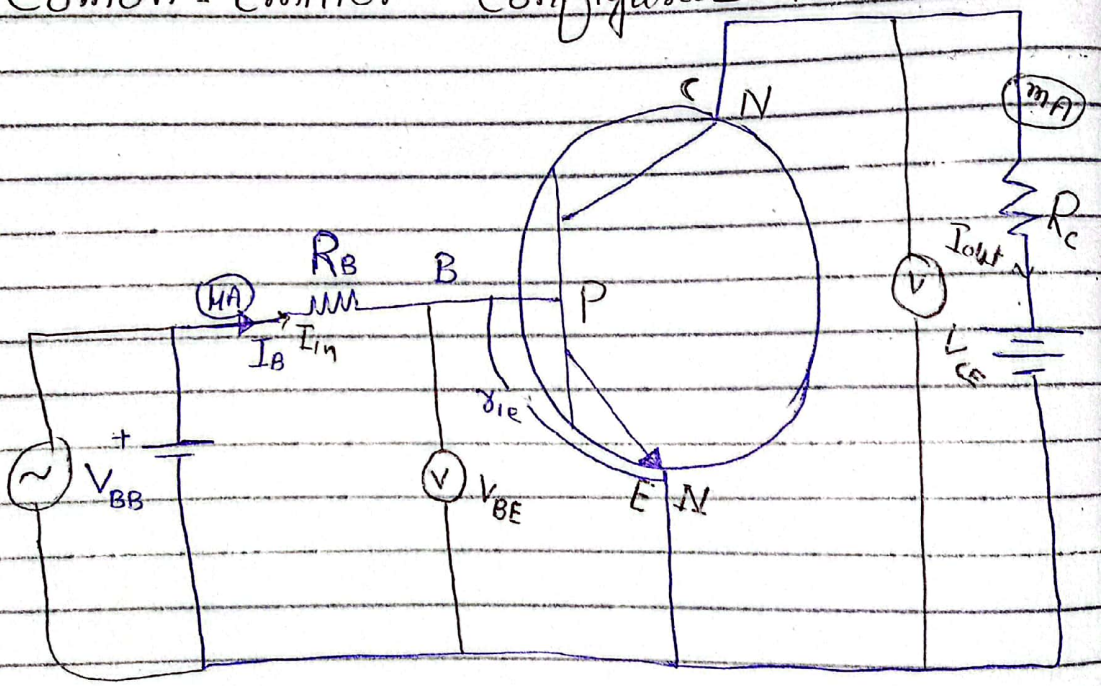
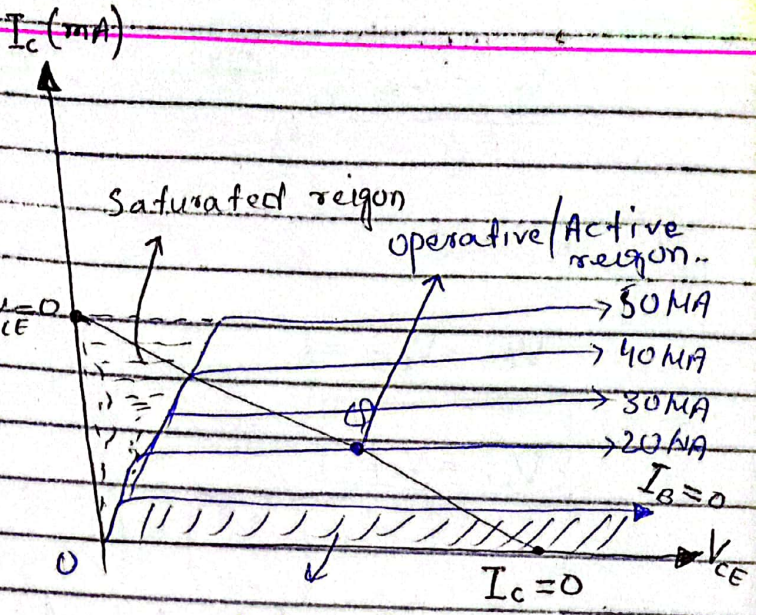
Comon - Emitter Configuration :-



Output Characteristics :-

$I_C \longrightarrow V_{CE}$ (I_B = constant).



* In cut off reigon transistor act as open switch.
* Saturated reigon → ot act like on Switch.

* Q is operative / Active reigon

In this reigon transistor Act as Amplifier.

$$V_{cc} = V_c + V_{CE}$$

$$V_{cc} = I_c R_c + V_{CE}$$

$$I_c = \frac{V_{cc} - V_{CE}}{R_c}$$

$$V_{CE} = 0$$

$$I_c = \frac{V_{CE}}{R_c} \quad (\text{Max})$$

$$I_c = 0$$

$$\frac{V_{cc} - V_{CE}}{R_c} = 0$$

$$R_c \neq 0$$

So

$$V_{cc} - V_{CE} = 0$$

$$\boxed{V_{cc} = V_{CE}}$$

Transistor As An Amplifier:-

A device which convert low AC Signals into High AC Signals.

β = Amplification factor:

$$\beta = \frac{\Delta I_c}{\Delta I_B} \quad \text{---(1)}$$

$$\Delta I_B = I_{in}$$

$$\Delta I_c = I_{out}$$

$$\beta = \frac{I_{out}}{I_{in}} \quad \text{---(2)}$$

$$V_{out} = I_{out} R_c$$

$$I_{out} = \frac{V_{out}}{R_c} \quad \text{---(3)}$$

$I_{in} = \frac{V_{in}}{\gamma_{ie}}$ — (4)

γ_{ie} → Resistance of NPN

put eq (3) and (4) in (2)

$$\beta = \left(\frac{V_{out}}{R_c}\right) \div \left(\frac{V_{in}}{\gamma_{ie}}\right)$$

$$\beta = \left(\frac{V_{out}}{R_c}\right) \times \left(\frac{\gamma_{ie}}{V_{in}}\right)$$

$$\beta = \left(\frac{V_{out}}{V_{in}}\right)\left(\frac{\gamma_{ie}}{R_c}\right)$$

If $R_c > \gamma_{ie}$

Then $V_{out} > V_{in}$

When Vout is greater then Vin, this is Called voltage Amplifiers....

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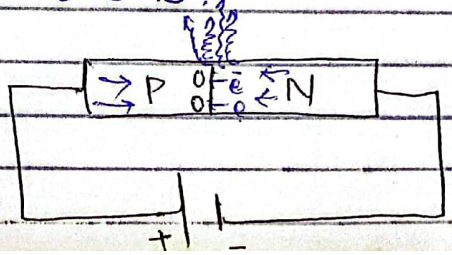
Types of Diode:-

1. LED (Light emitting diode)

A diode which converts electrical energy into Light energy is Called LED.

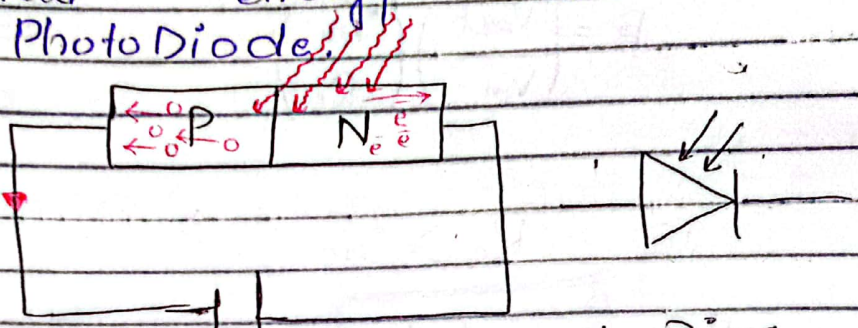


* LED is Forward Bias.

Symbol for LED:-

2. PhotoDiode:-

A diode which Convert Light energy into electrical energy is Called PhotoDiode.

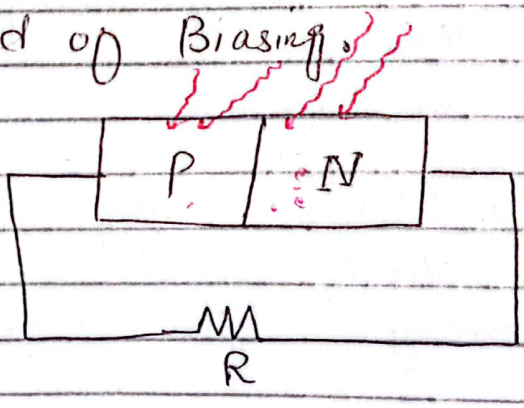


* PhotoDiode is reversed Bias.

3. Photovoltaic Cell:-

It is a Source of voltage or emf.

* No need of Biasing.



Relation b/w α and β :-

$$\beta = \frac{I_C}{I_B} \quad \text{---(i)}$$

$$\alpha = \frac{I_C}{I_E} \quad \text{---(ii)}$$

$\therefore$

$$I_E = I_B + I_C$$

$$I_B = I_E - I_C \quad \text{---(iii)}$$

$$\beta = \frac{I_C}{I_E - I_C} \quad \text{---(iv)}$$

÷ing the num and denominator of eq (iv) by I_E :

$$\beta = \frac{\left(\frac{I_C}{I_E}\right)}{\frac{(I_E - I_C)}{I_E}}$$

$$\beta = \frac{\left(\frac{I_C}{I_E}\right)}{\frac{I_E}{I_E} - \frac{I_C}{I_E}}$$

$$\beta = \frac{\left(\frac{I_C}{I_E}\right)}{\left(1 - \frac{I_C}{I_E}\right)} \quad \text{---(v)}$$

put eq (ii) in (v)

$$\beta = \frac{\alpha}{1-\alpha}$$

$$\alpha = \frac{\beta}{1+\beta}$$

Saturated region = ON Switch
Cut off region = OFF Switch

Digital Electronics :-

A System which can be described in two Quantized or discrete stafes is Called Digital electronics.

Low	High
OFF	ON
open	closed
False	True
0	1

* 0, 1 are Called Binary or Bolean numbers.