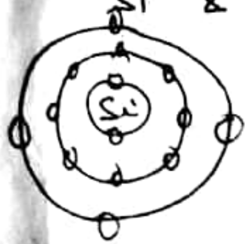
Semiconductor UNIT-V

(1) Atom, orbits, $2n^2$, Free electrons, Bound electron

Si & Ge (14) Si = 2, 8, 4

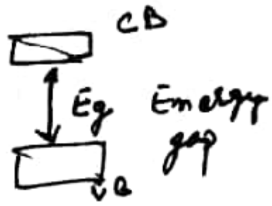



(32) Ge = 2, 8, 18, 4

33 As = 2, 8, 18, 5

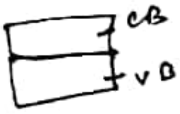
Energy level

Insulators - A solid is said to be an insulator if no current exists within it when a potential difference applied across it. Some electrons in the solid must move to an higher energy level.




like Diamond is an insulator

Metal

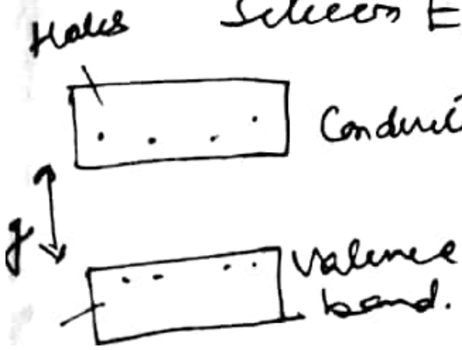



The highest occupied energy level falls some where near the middle of an energy band. If potential difference is applied across it, a current can exist because there are plenty of vacant levels nearby higher energies into which $e^-$ can jump.

Semi conductor :-

The band structure is just like insulator. The main difference is that the semiconductor has a much smaller Energy Gap Eg between highest band and bottom band.

Silicon Eg = 1.1ev Eg (diamond) = 5.5ev insulator




in Semiconductor, $e^-$ can jump from VB to CB due thermal agitation.

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# ENEGY BAND

Condution Band

$E_G$

3rd (Valency Band.

2nd

Ist

Enery level of e⁻ in Ist, 2nd band are very lower. These are very closer to eachother

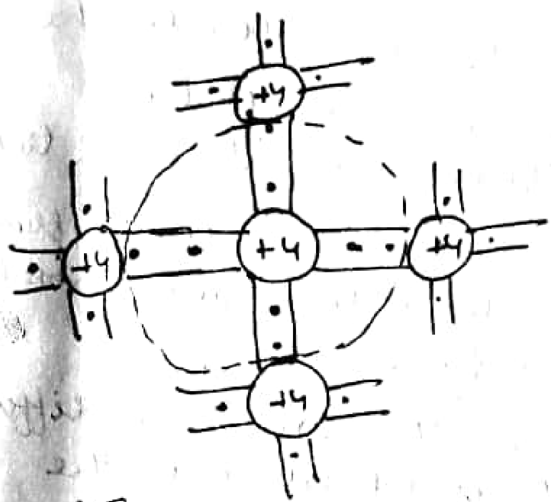
valency band has the $e^-$ as per the valency of the metal. यह जरूरी नहीं की VB में 8 e- होते

condution Band is also compeleising many energy level. If we provide energy to the $e^-$ of valency Band, these $e^-$ will move upto condunction band. provided that this energy is equevlant to the $E_G$.

# Doped Semiconductors

Introduce a small number of suitable replacement atoms (impurities) into semiconductor. This is doping.

There are two types of semiconductors n & p



$Ge = 2, 8, 18, 4 = 32$

$Si = 2, 8, 4 = 16$

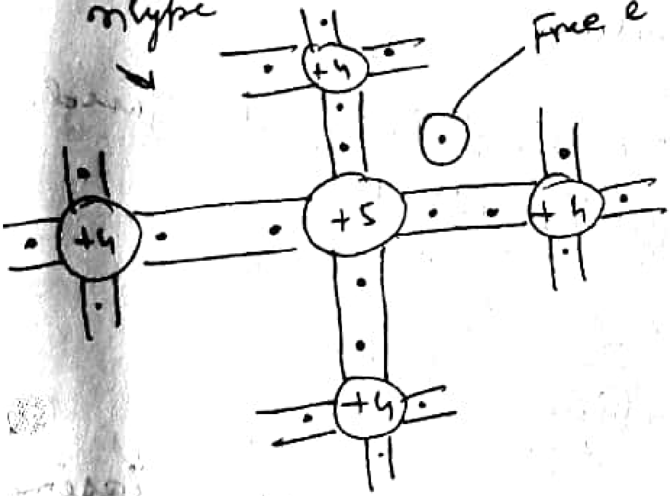
'Covalent bonding' सह संयोजी बंध

(i) Intrinsic → due to only temp

(ii) Extrinsic

n type ^ p type

n type

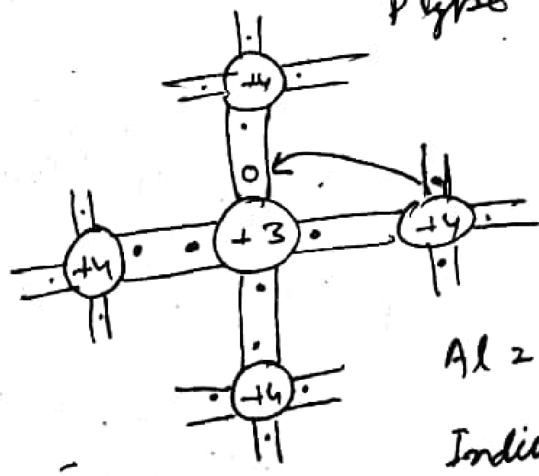


Free $\bar{e}$ (donor impurity)

By mixing phosphorus / As • (Valence = 5)

Antimony

p type



Drifting of hole

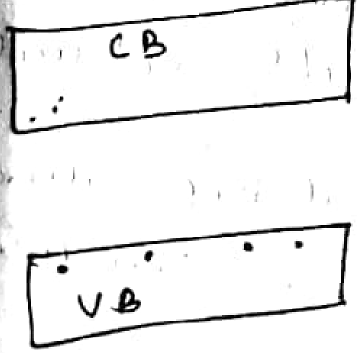
Al = 3 / Indium / Boran, गैलियम

Acceptor impurity)

p stands for +ive.

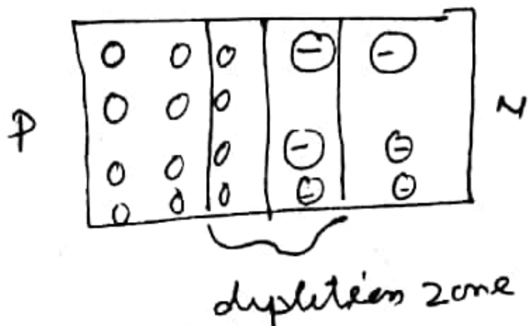
n type n stands for -ive

Se



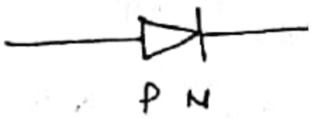
## P-N Junction

It is a single semiconductor crystal that has been selectively doped so that one part is n type and the adjacent part is p type material.

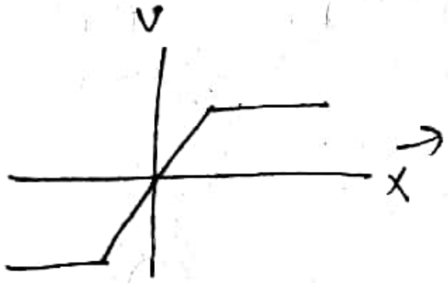



$e^-$ that are close to the Junction plane tend to diffuse across it from R to L.

Holes on p side close to plane will tend to diffuse across the plane from L → R.




~~Th~~ due to this process a diffusion current is observed in the junction

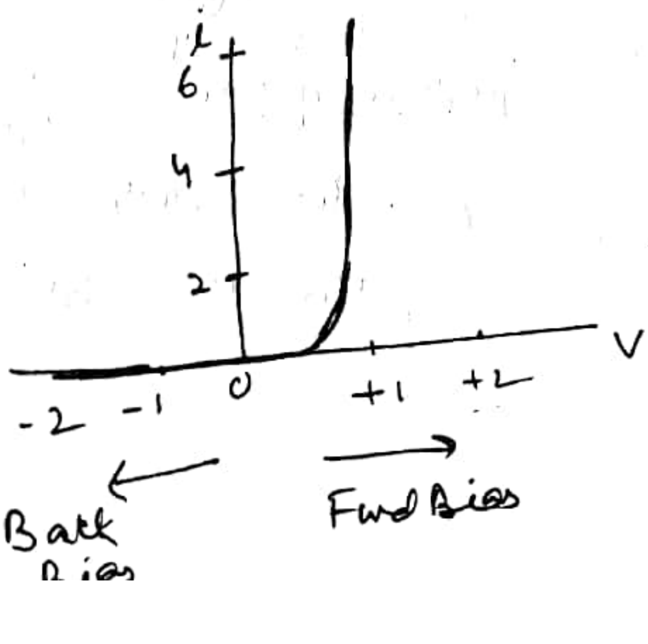



→ Till electron & holes get diffused.

diffusion current

## Biasing of P-n Junction

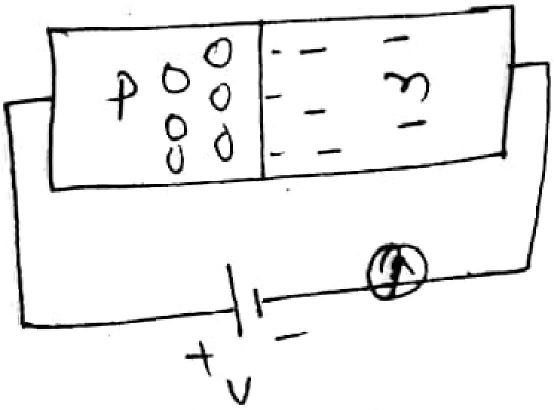
(1) Forward Biasing (11) Reverse Biasing



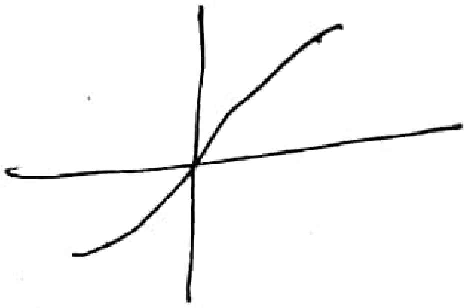

When Fwd Bias, Junction is highly conducted and Back Bias Junction is non conducted

## FWD Beias (Forward)

Narrow depletion zone

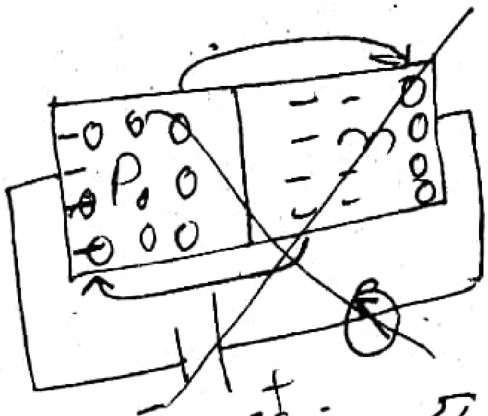


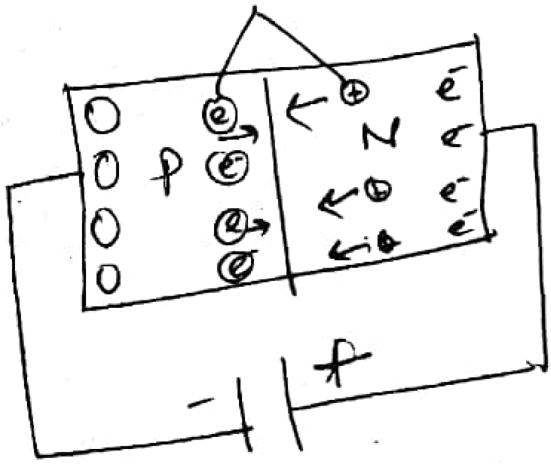

जैसे $e^-$ n से पार करके p में जाते है तुरन्त Battery से नये $e^-$ n में पहुँच जाते है और तार में current Flow होता है।



## Reverse (Back) Beias

Minority carrier




majority carrier दूर खींचे चले जाते है। अतः depletion layer की चौड़ाई बढ़ जाती है।

Wider depletion zone

Due to minority carrier as reverse current is observed.

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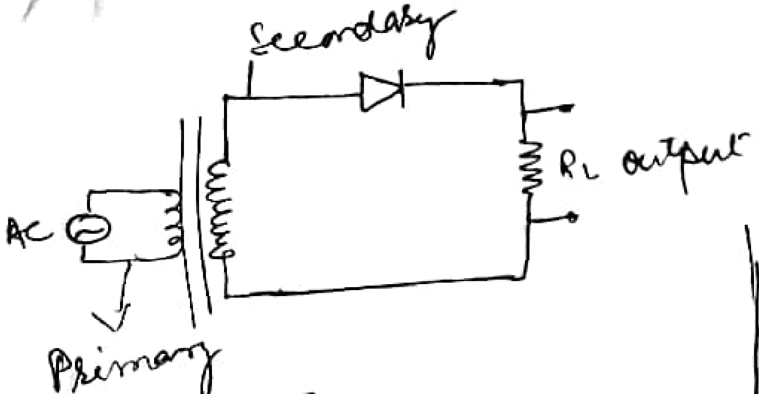
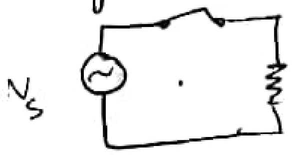
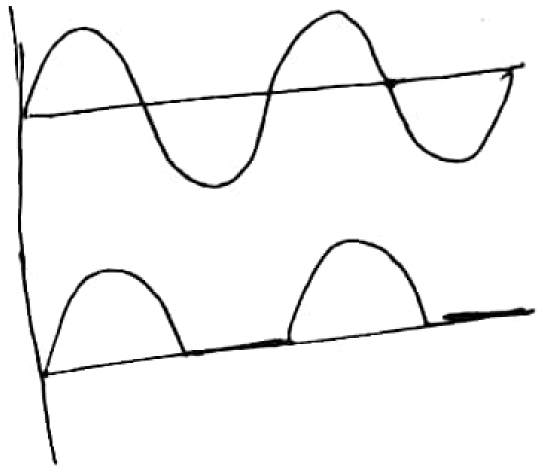
## Half wave Rectifier

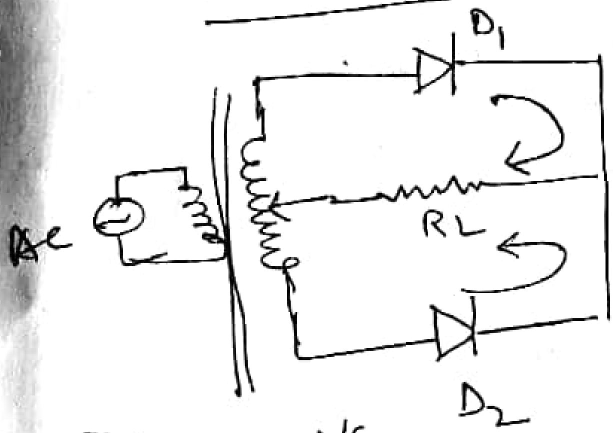


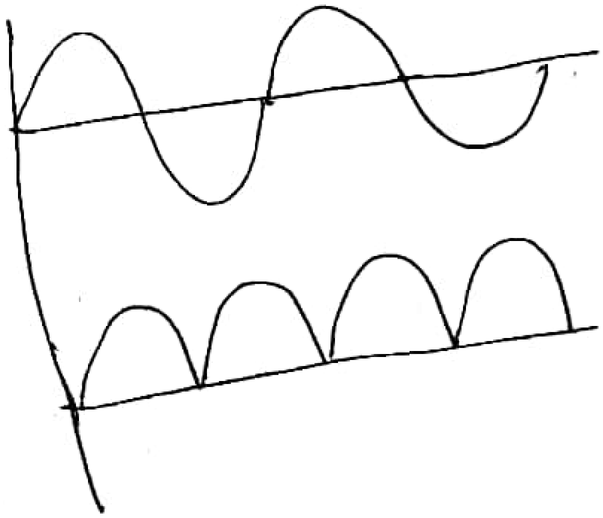

Step up transformer
Fwd Biasing

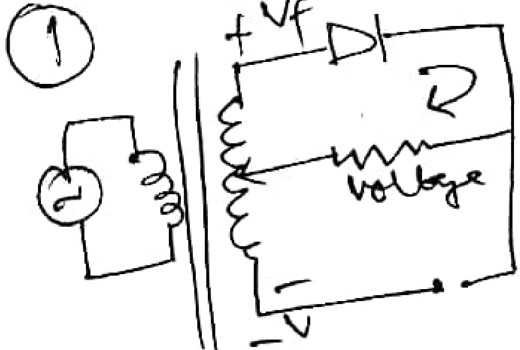


## Full wave Rectifier



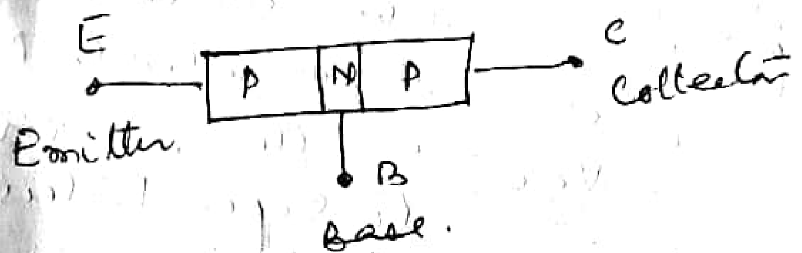



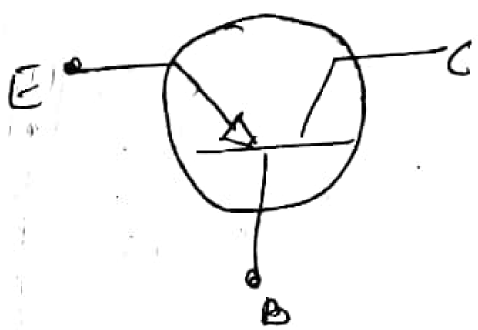


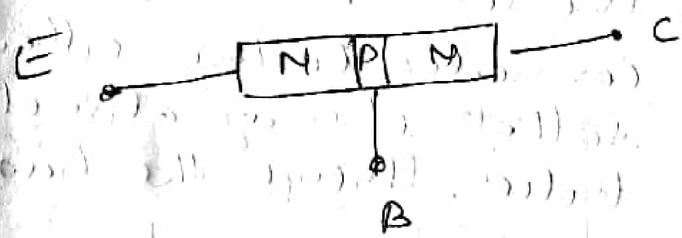

It is basically resistor that amplifies electrical impulse

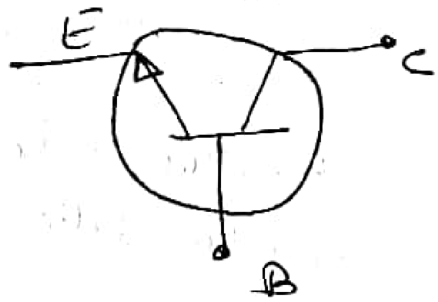
# The Transistor ⟨ Transfer Resistor.

**Transistor** Transistor consists of two back to back P-N junctions manufactured in a single piece of a semiconductor crystal. These two junctions give rise to three regions called emitter, base and collector. In other words, we can say junction transistor is simply a sandwich of one type of semiconductor material between two layers of other type.




**Emitter**

It forms the left hand section of the regions of the transistor. It is more heavily doped than any off the other regions because its main function is to supply majority charge carriers to the base.

**Base** — It forms the middle section of the transistor. It is very thin ($10^{-6}$ cm) and very lightly doped.

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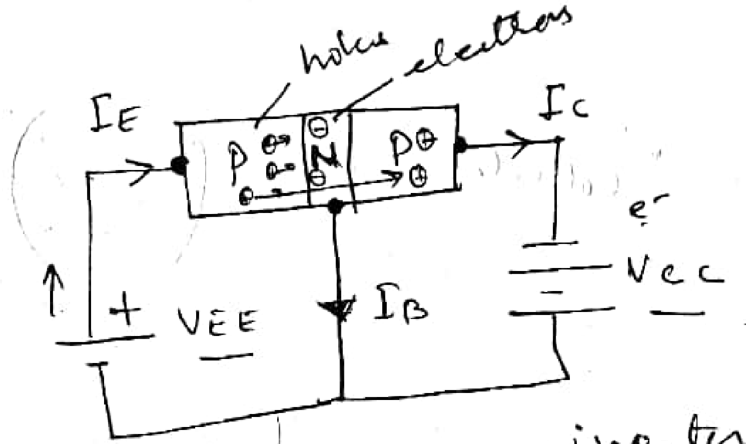
Collector — It forms the right hand side section of the transistor. It collects to the majority charge carriers through the base.

Transistor biasing

There are two type transistor biasing
(i) Forward biasing / Emitter - base junction
(2) Reverse biasing / collector - base junction.




+ive terminal of VEE is connected to P of emitter in order to repel holes in to base.

-ive terminal of Vcc is connected to the collector so that it may attract holes through the base.

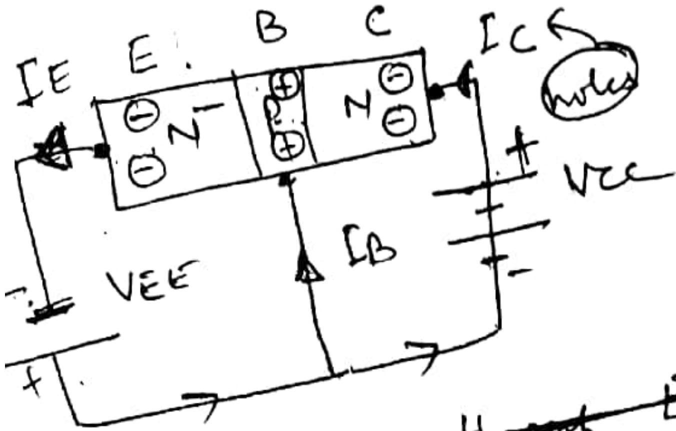
Emitter → Cathode
Collector like Anode

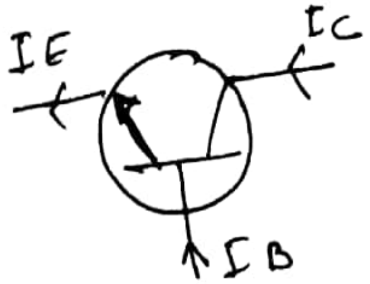
Holes get diffuse in N by recombine with $e^-$ and remaining holes come in to the collector due to VCC -ive voltage.

due to this cycle E B we get $I_B$.
जैसे ही holes collectors में आता है तो Vcc के -ive terminal $e^-$ ~~उत्सर्जित~~ करता है hole को diffuse करने के लिए $I_C$ मिलता है

$$I_E = I_B + I_C$$

# N-P-N Transcistor (C-B) Reverse Beased




~~e⁻ will pass through E-B and base in~~

collector से

in NPN transistor, both collector and base are +ive with respect to the emitter.

→ E-B will in Fwd Bias
& CB in Reverse Bee

→ e⁻ Base में ... | e⁻ get diffuse i
Base (P) with holes. Remaing e⁻ com
into collector (N) and received by the +ive terminal of voltage Vcc.

→ due to this ~~Ee~~ we get Ic