MODULE-4

26th July 2024

SEMICONDUCTOR DEVICES

* Topics:

1. Pn junction diode : symbolic representation,
2. Internal structure, modes of operation, characterstics
2. Half and full wave rectifier circuits,
3. ~~zinode~~ zenar diode: symbolic representation, interal structure , mode of operation, characterstic, zenar voltage regulator
4. BJT (Bipolar Junction transister): symbolic representation, internal structure, types of configrations, characterstic.

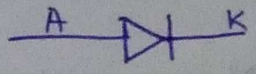
* Introduction to semiconductors:

Semiconductors are the materials which have conductivity between conductors and non-conductors (or insulators).

- Types of semiconductor device:
  1. pn-junction
  2. zenar diode.
  3. FET (Field effect transistor)
  4. MOSFET (Metal oxide semiconductor field effect transistor)
  5. BJT (Bipolar Junction transistor)
  6. SCRT (Silicon control rectifier circuit)

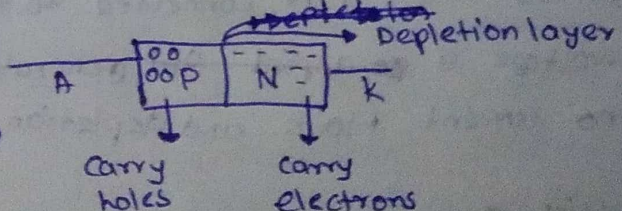
* P-N-Junction diode

- Symbolic representation:



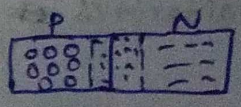
A is anode, K is cathode.

- Internal structure:



① How depletion layer is formed?

Access e from N & Access hole from P form depletion layer.

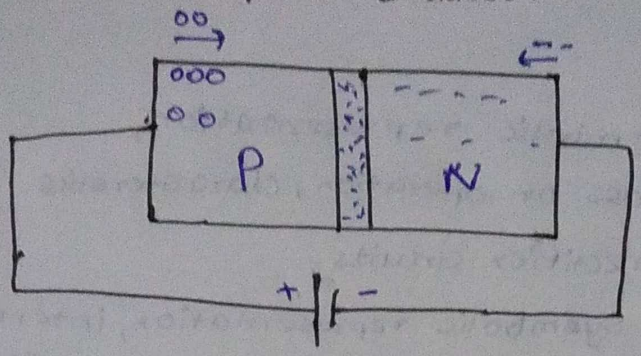


② Width of depletion layer depends on doping (adding impurities) ∄ width imp. for current generation

③ when heavily dopped ∄ thin depletion layer ∄ forward direction of I
when lightly dopped ∄ thick depletion layer ∄ No current.

Types of modes in pn junction:

1. Forward conduction mode / Forward biased:



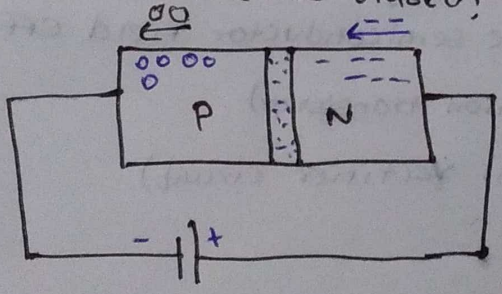
Circuit representation of PN junction F.B

Positive terminal of battery is connected to p and negative terminal of battery is connected to n.

In forward biased mode, applied voltage, ~~applied emf~~ and generated are in opposite direction then depletion layer becomes thinner. Then current will flow in forward direct and maximum current is generated.

$I_F \rightarrow I_D$.

2. Reverse conduction mode / Reverse biased:



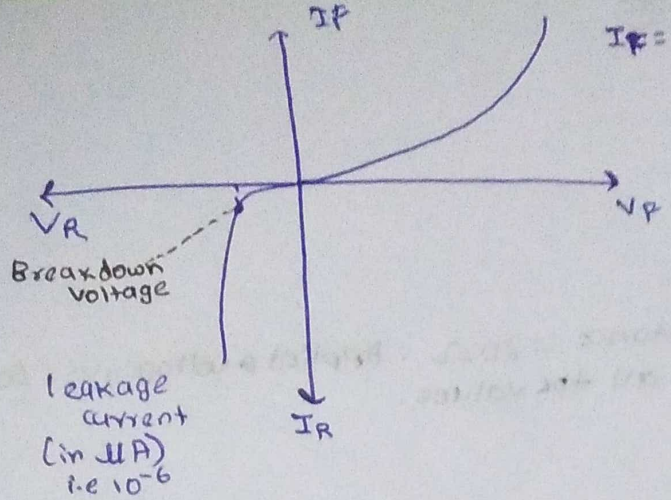
Circuit representation of pn junction RB.

P connected to -ve , N connected to +ve.

Applied voltage & ~~applied emf~~ generated voltage in opposite direction.

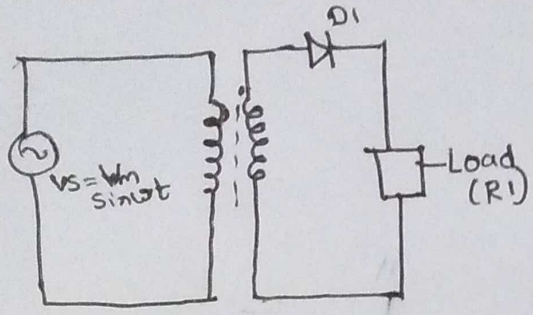
Hence no current flows and depletion layer gets thicker.

Characterstics :



$I_F = I_D = I_{max}$

★ Half and full wave Rectifier circuit:

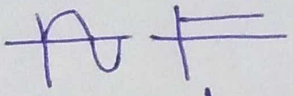


Using rectifier we can convert AC to DC.

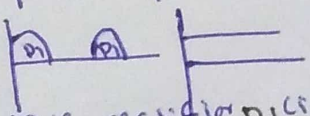
⇒ Uncontrollable diode ~~circuit~~ Half wave circuit

Half wave rectifier circuit

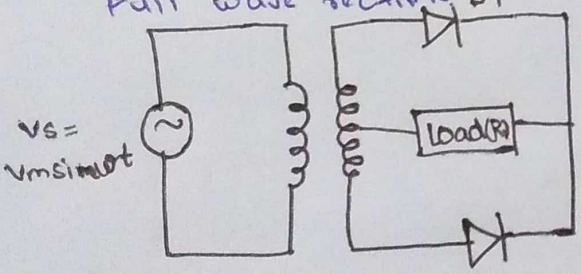
I/P:



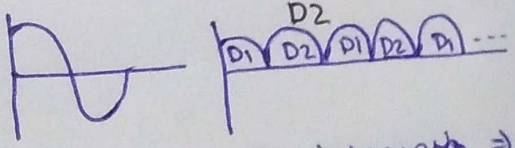
I/P:



Full wave rectifier circuit



I/P:



NO interuption ⇒ Continuous power supply

Efficiency:
Full wave is better than Half wave

Costly:
Full wave more costly than Half wave

Half wave	Full wave
① Circuit representation	① Circuit representation
② Efficiency : 40.6	② Efficiency : 81.2
③ Peak inverse voltage = Vmax	③ Peak inverse voltage = 2 × Vmax
④ Ripple factor = 1.21	④ Ripple factor = 0.482
⑤ Form factor = 1.57	⑤ Form factor = 1.11
⑥ Peak factor = 2	⑥ Peak factor = 1.414
⑦ I_{DC} or $I_{avg} = I_{max}/\pi$	⑦ I_{DC} or $I_{avg} = 2I_{max}/\pi$
⑧ $I_{rms} = I_m/2$	⑧ $I_{rms} = I_m/\sqrt{2}$
⑨ AC Power input $= I^2_{rms} \times R_T$	⑨ AC Power input $= I^2_{rms} \times R_T$
⑩ DC Power output $= I^2_{DC} \times R_L$	⑩ DC Power output $= I^2_{DC} \times R_L$

(11) DC output voltage

$I_{DC} \times R_L$

(12) Efficiency = $\frac{\text{DC O/P Power}}{\text{AC I/P Power}}$

Q.1) Crystal diode having internal resistance = 20Ω. Applied voltage, $v_s = 50\sin\omega t$ load resistance, $R_L = 800\Omega$. Find out all the values.