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UNIT - 1
Introduction to Electronics

* Evolution of Electronics:

(1) Electronics actual history began in 1897 with the invention of vaccum diode followed by vaccum triode. This led to introduction of tetrode and pentode tubes until world war - II.

(2) Transistor era began with its invention in 1948 but still vaccum tubes were used for high power operation.

(3) Digital Integrated circuits (ICs) were also developed along with PMOS, NMOS and CMOS fabrication Technology.

(4) All these changes led to introduction of micro-processor. soon after, operational amplifier were introduced for processing.

* Impact of electronics on industry and society.

(1) Electronics helps in many way in our day to day life in following areas:

• Industry -

(a) Electronic circuits are used to control the parameters in various industrial application.

(b) They are used to convert one form to the another form and also to amplify weak signals

• Defence -

(a) The most important application of electronics in defence is RADAR which detects exact location of enemy aircraft, missiles and bombs.

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• Medical-
(a) Electronics helps doctors and scientists in the diagnosis and treatment of various diseases.
(b) X-ray machine, ECG, sonography are some apps
• Social media communication -
(a) most powerful application of electronics is mobile communication.
(b) Internet appl like instagram, fb, wp, etc.
• LED Traffic Lights, LED Displays, CT scan / MRI

* Active and passive components:

	Active	Passive
Behave Actively	(1) components which require external source to their operation is called Active component.	(1) components which do not require external source to their operation is passive
Behave Passivly	(2) They are an energy donor.	(2) They are an energy acceptor.
	(3) Able to regulate current flow rate / current supply.	(3) Incapable of the flow of charge regulation.
	(4) The type of linearity is Non-Linear.	(4) The type of linearity is Linear.
	(5) They can amplify a signal as they have a larger output gain of more than 1.	(5) The have a signal gain of less than 1. Hence, they cannot amplify a signal.
	(6) E.g. voltage sources, current sources, diodes, transistors, OP-amp, etc.	(6) E.g. Resistors, inductors, capacitors, the potentiometers, etc.

sc = semiconductor

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* semiconductor:

A solid substance that allows heat or electricity to pass through it or along it in particular condn. Not used practically for manufacturing devices

Parameter	Intrinsic	Extrinsic
Form of semiconductor	Pure form of semiconductor outermost shell - 4 electrons	Impure form of semiconductor
conductivity	It exhibits poor conductivity	It exhibits better conductivity.
Band Gap	Band Gap betn conduction and valence band is small.	The energy gap is higher than intrinsic sc.
carrier conc.	Equal amt of electron and holes are present in band.	majority presence of electrons and holes depend
Type	Not further classified	p type and n type s.c
E.g.	si, Ge, etc.	GaAs, GaP, etc.

F C B C T

used for manufacturing of electronic devices.

* n-type semiconductor:

(1) It is type of extrinsic semiconductor which is created by adding small amount of pentavalent impurity to pure semiconductor.

(2) The added impurity provides extra electrons for conduction called as free electrons.

(3) Antimony, Arsenic and phosphorous are e.g. of pentavalent impurity.

(4) Hence, flow of current is mainly due to electrons and are called majority carriers.

AAP

(6) Holes are also present but are minority carriers.

* P-type semiconductor:

(1) It is type of extrinsic semiconductor which is created by adding small amt of trivalent impurity to pure semiconductor.

(2) The added impurity generates a hole for conduction for each impurity atom.

(3) Boron, Gallium and Indium are e.g. of trivalent impurity.

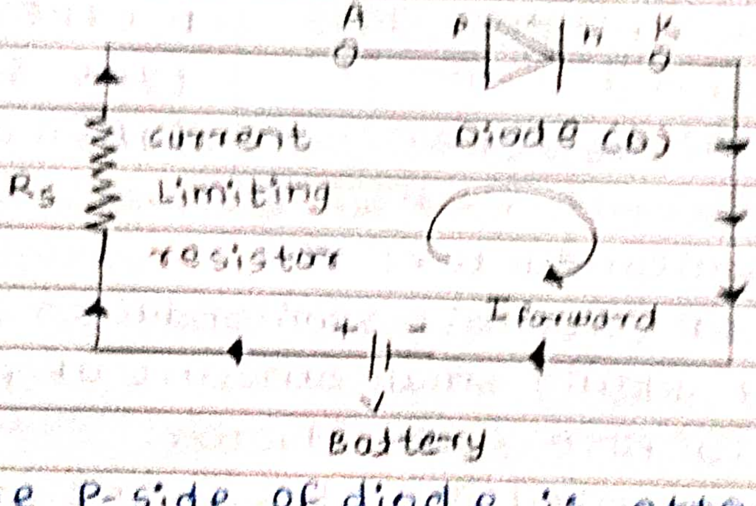
ROI

(4) more impurity = more holes for conduction.

(5) Holes = majority carrier

Electrons = minority carrier

* P-N Junction Diode in Forward Biased:



(1) The P-side of diode is attached to positive terminal and N-side to negative terminal.

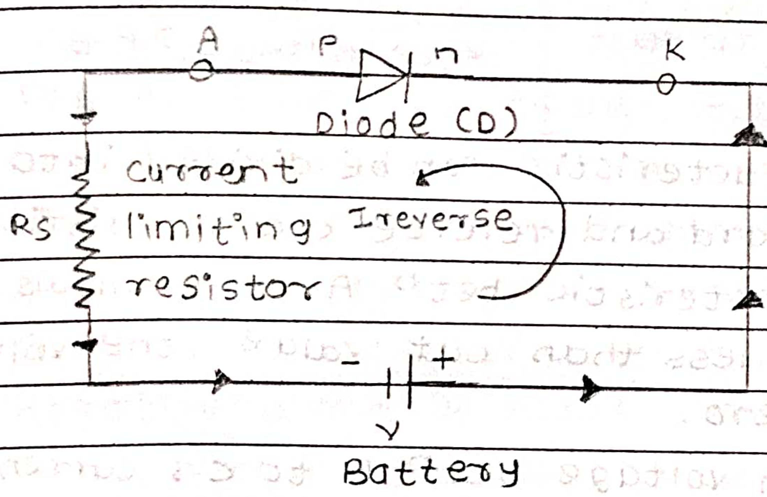
(2) The conduction is not possible as long as the applied forward voltage is less than barrier potential.

(3) When applied voltage becomes more than barrier

potential, -ve terminal pushes free electrons from N to P region and +ve pushes holes from P to N region.

(4) The depletion region gets reduced and majority carriers passes through junction and causes a current to flow.

* P-N Junction Diode in Reverse Biased:



(1) The P-side of diode is connected to negative terminal and N-type is connected to the positive terminal.

(2) The free electrons in N region are attracted by +ve terminal and holes in P region are attracted by negative terminal.

(3) Due to this, the depletion region widens and hence barrier potential increases.

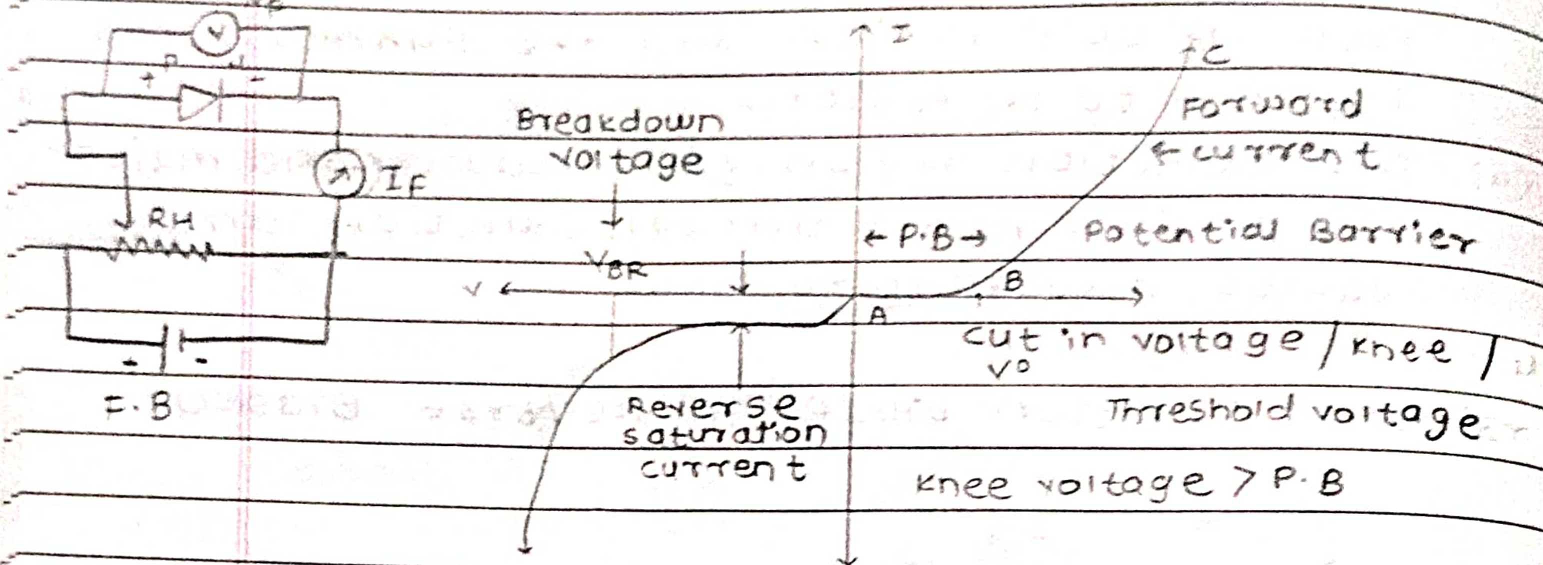
(4) Thus, very small reverse current flows due to the minority carriers which constitute holes in N-region and electrons in P-region.

(5) The reverse current is very small.

(6) Due to barrier at junction due to reverse bias, the majority carriers do not cross pn junction and current due to majority carriers is zero.

PI-V	VF	IF	VR	IR
max forward current	0	0	0	0
	1	0	1	1 uA 10^{-6}
	2	0	2	1 uA
	3	0	3	1 uA
	4	1	4	10 mA 10^{-3}
VF - forward	5	2	5	20 mA
			6	30 mA

* V.I characteristic of P-N Junction Diode:



(1) The V-I characteristic can be divided into two parts - forward and reverse characteristics.

(2) Forward characteristic bet^n A to B shows that
Region-1 for voltage less than cut value, the voltage current is zero.

(3) After cut,in voltage bet^n B to C, current
Region-2 increases suddenly in exponential nature.

(4) When diode is in reverse bias, the operation is
Region-3 in third quadrant.

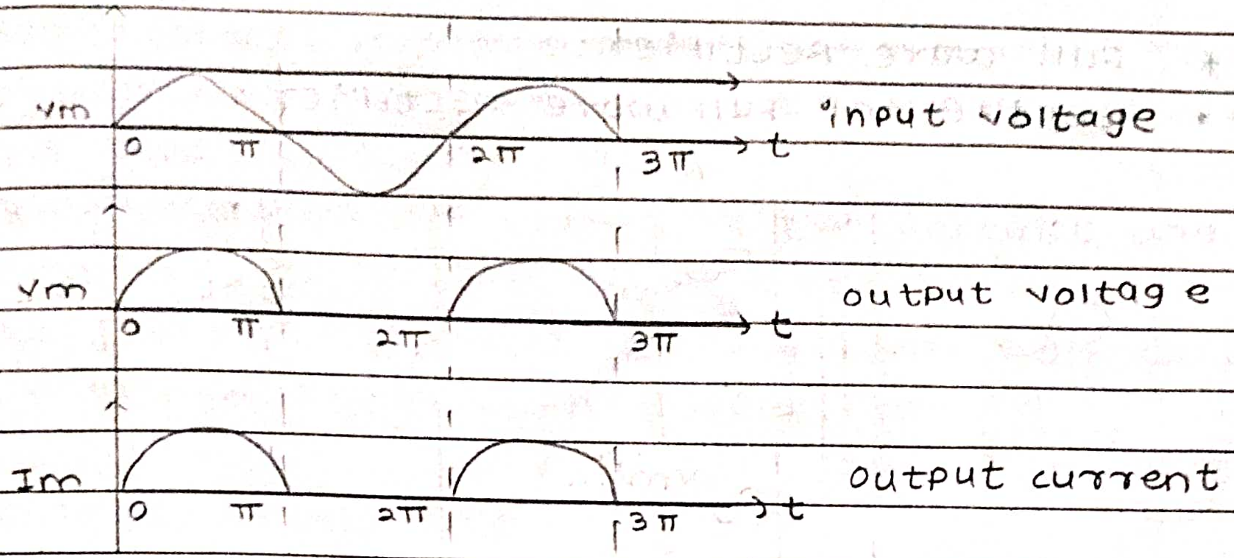
(5) As reverse voltage increases, only reverse saturation current flows and is constant.

(6) When reverse voltage reaches breakdown huge amount of current flows. This region is to be avoided as it can permantly damage the diode.

* Half-wave rectifier:

(1) Half wave rectifier consists of a step down transformer, P-n junction diode and load rest. RL.

(2) The step down transformer converts 230 V AC to Vm voltage at secondary.



(3) For positive half cycle, the input point A becomes positive w.r.t B hence diode is forward biased and current flows through load resistance producing output voltage and output current.

(4) For negative half cycle, the input point A becomes negative w.r.t. B hence diode becomes reverse bias hence no current flows producing no output voltage and output current.

(5) The graph of input voltage, O/P voltage and O/P current is shown in figure.

(6) As output is produced only for half of the input cycle, it is called as half wave rectifier.

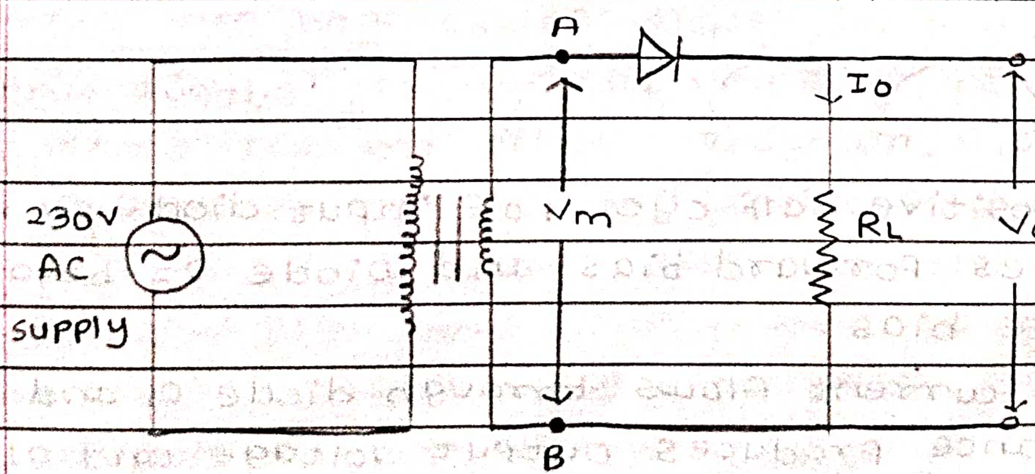
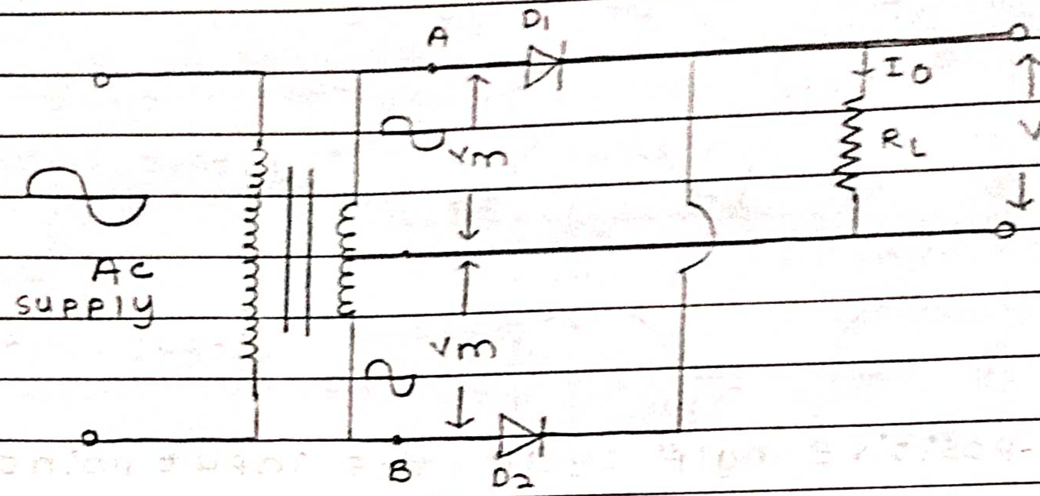


Fig: Half wave Rectifier

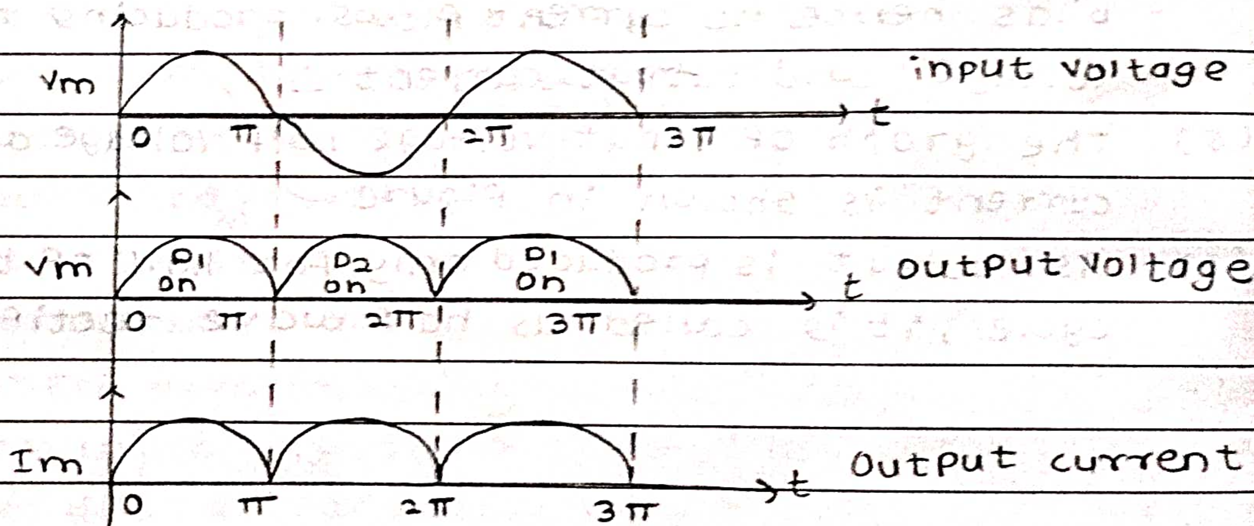
* Full wave Rectifier:

• centre tap full wave rectifier:



(1) Full wave rectifier consists of centre tap transformer, two diodes and a load resistance.

(2) centre tap transformer produces Vm voltage at upper secondary and 180 phase shift across lower secondary.



(3) For positive half cycle, of input diode D_1, becomes forward bias and Diode D_2 becomes reverse bias.

(4) Hence current flows through diode D_1 and load resistance produces output voltage and o/p curr

(5) For negative half cycle, input diode D_1 becomes reverse bias and D_2 becomes forward bias.

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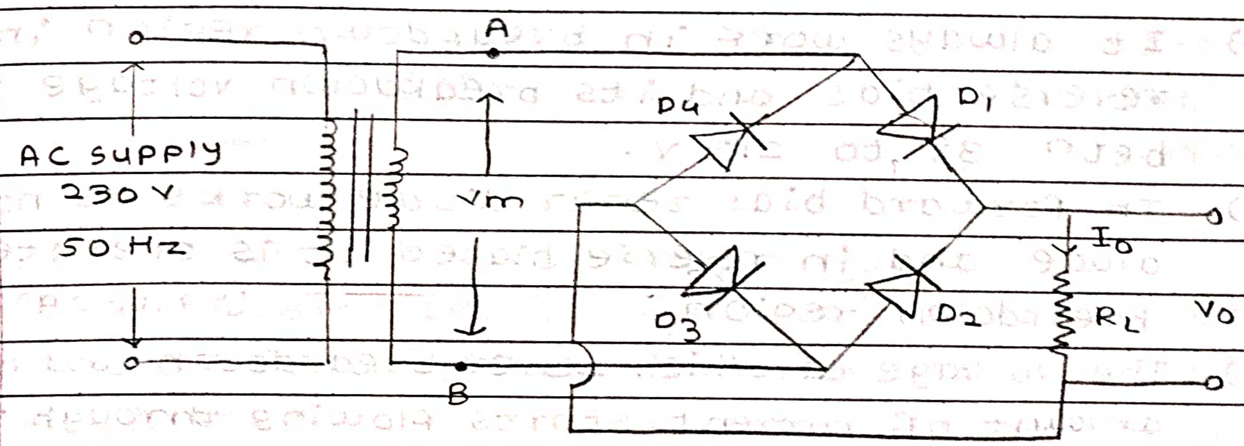
(6) Hence current flows through D_2 and R_L in same direction proooducing output voltage and current in positive half cycle.

(7) The graph of O/P voltage, I/P voltage and O/P current is shown in figure.

(8) As output is produced for both half cycles, it is called full wave rectifier.

* Bridge Rectifier:



(1) Bridge Rectifier consists of a stepdown transformer, four diodes and a load resistance.

(2) The secondary Load voltage betn Point A and B is Vm generated by step Down transformer.

(3) For +ve half cycles diodes D_1 and D_3 are forward bias and D_2, D_4 are reverse bias.

(4) Hence current flows through D_1, R_L and D_3 Producing O/P voltage and current.

(5) For -ve half cycles diodes D_2 and D_4 are forward bias and D_1, D_3 are reverse bias.

(6) Hence, current flows through D_4, R_L and D_2 producing O/P voltage and current.

(7) The I/P voltage, O/P voltage and O/P current graphs are shown in figure.

Rectifier - Device which converts AC voltage to DC voltage using one or more pn junction diodes

(Graph same as Full wave Rectifier)

(8) From graph it is seen that O/P is produced for full cycle hence bridge rectifier is also full wave rectifier.

* Zener Diode :

(1) Zener Diode is specially designed P-n junction diode which is supposed to work in reverse bias.

(2) It always work in breakdown region in reverse bias and its breakdown voltage is betn 3V to 210 V.

(3) In forward bias zener diode works as normal diode and in reverse biased it is operated in breakdown region.

(4) The voltage at which zener breakdown and huge amount of current starts flowing through it is called breakdown voltage.

(5) After breakdown voltage across, zener remains constant.

(6) Breakdown voltage depends upon the doping level

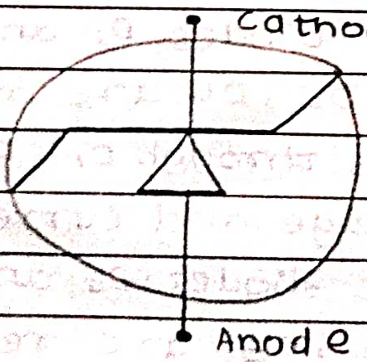


Fig: Zener Diode

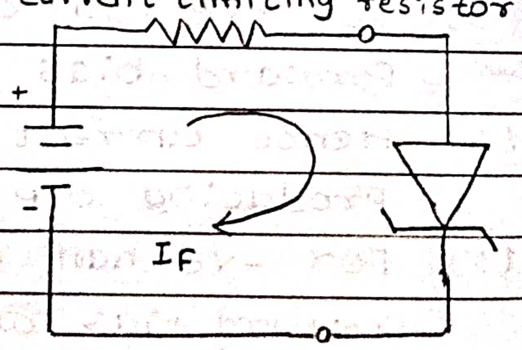
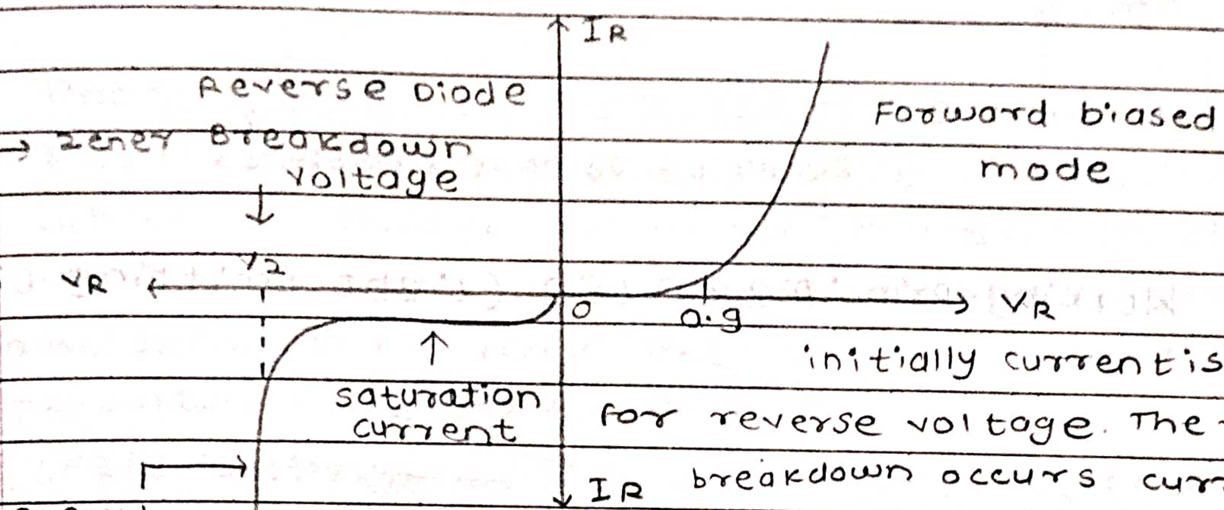


Fig: Forward Biasing

For Reverse Biasing, alternate connection of the diode voltage Regulator

- If Vin increases, total current I increases.
- IL is const Iz increases to keep IL constant
similarly for decreasing

(1) The V.I characteristics of zener looks same as like normal diode but after breakdown normal diode is damaged but zener is designed to work in breakdown also.



reverse voltage at which breakdown occurs

initially current is small for reverse voltage. The reverse breakdown occurs current increases rapidly.

* zener as Voltage Regulator:

(1) circuit diagram for zener voltage regulator is shown where zener is connected in reverse bias.

(2) when reverse voltage across the zener is greater than breakdown, huge amount of current flows through zener keeping voltage across it constant.

(3) The voltage across zener after breakdown is independent of changes in input voltage and is constant. Load current = constant

(4) AS $I = I_Z + I_L$ and $I_L = \frac{V_Z}{R_L}$; $V_0 = V_Z$

Hence, when breakdown occurs I_L is constant. change in input supply changes I_Z keeping I_L constant.

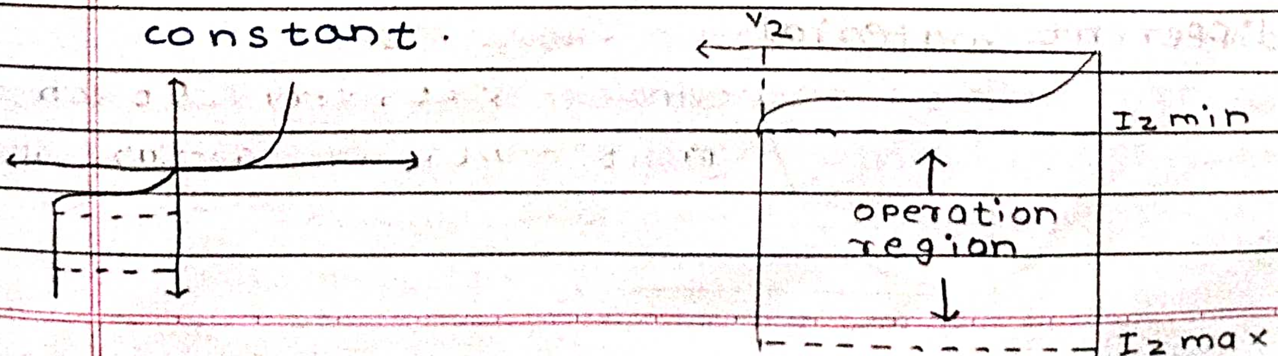


Fig: V.I characteristics

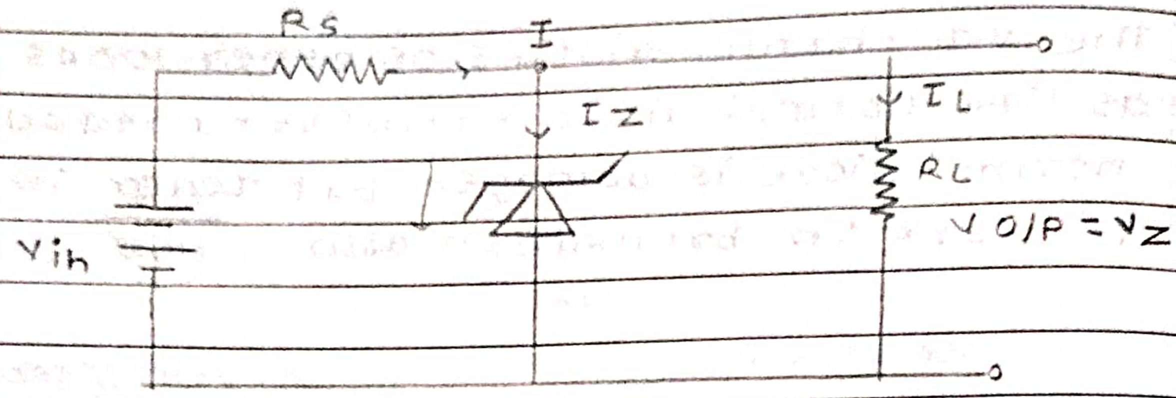
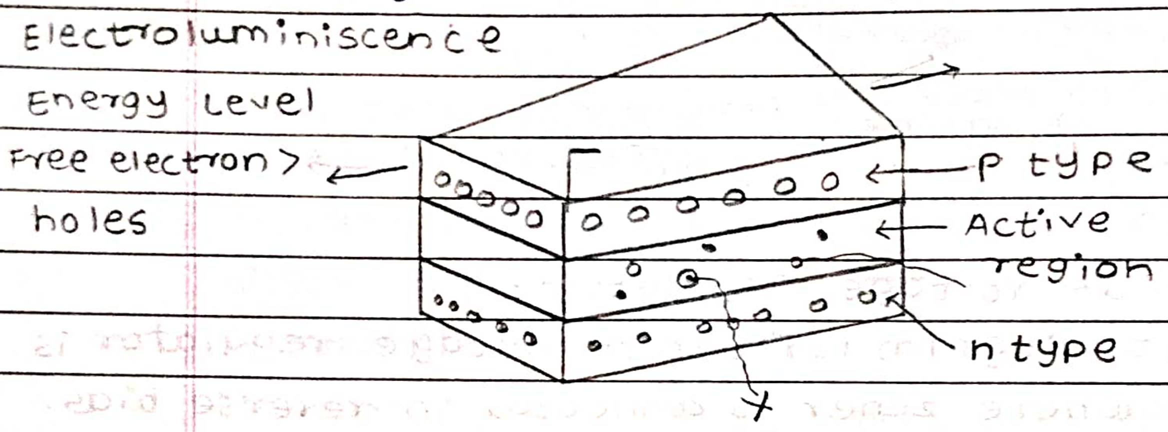
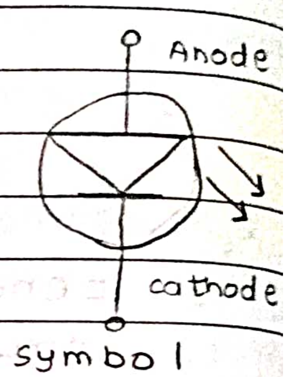


Fig: zener as voltage Regulator

* **Working principle of LED (Light Emitting Diode):**



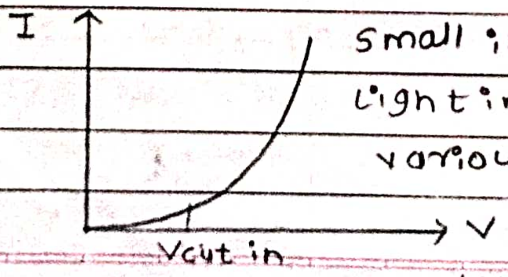


(1) Constn of LED consists of three semiconductor layers, P type, Active region and N type

(2) when LED is connected in forward bias holes from P and electrons from N type combine with each other.

(3) Recombination of electrons takes place in active region and it produces or emits light. This process is called electron luminiscence.

(4) The colour of light depends upon the material of active region. we get different colour from different material.



• Advantages:

Small in size, very fast, cheap, Light in weight, available in various colours.

• Disadvantages:

Low luminous efficiency
Temp dependent characteristics

App...
(1) All kinds of visual displays in watches and calculators.
(2) On-off indicator
(3) LED's in burglar alarm, remote control

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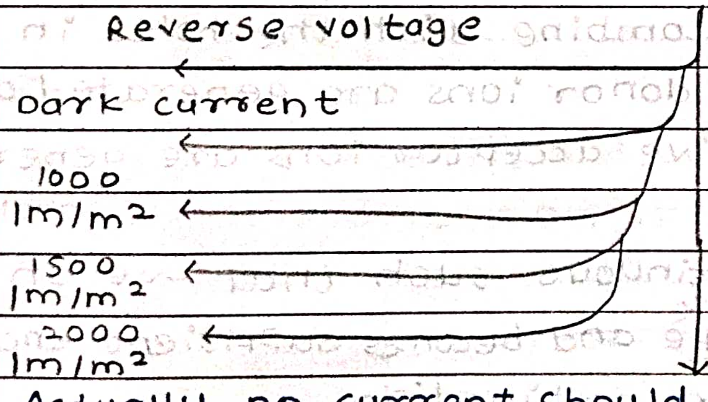
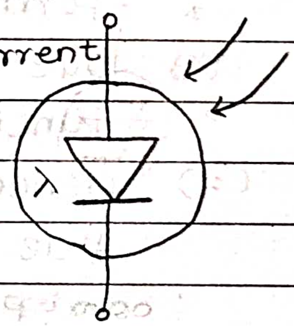
(5) V-I characteristic of LED is same as that of normal diode and is always operated in F.B.
(6) Cut in voltage or bias voltage is between 1.2 to 3.4 V based on active region material

* Photo Diode: Depletion region is wide
(1) Photo diode is a semiconductor pn junction which is always operated in reverse bias.
(2) When the light in form of photon energy is incident, they form a electron hole pair, which results in reverse current. electron-hole pair depends on intensity
(3) More is the incident intensity of light more electron hole pair are generated and more is the photo current.
(4) The V.I characteristics shows that current through photo diode increases with increase in light intensity. ↑ minority carriers, reverse current ↑ i.e. photocurrent





symbol

(5) Actually no current should flow through diode when no light is incident but due to minority carriers small amount of current flows called as dark current
(6) Dark current is current flowing through photo diode when no light is incident on the photo diode.

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* Drift current:

Type of current which flows through a semiconductor under influence of externally connected supply is called drift current

* Diffusion current:

Type of current which flows through semiconductor from higher conc. to lower conc. is called diffusion current.

The current due to non-uniform doping of P or N type is diffusion current.

Total current I is nothing but sum of Drift current and diffusion current to a semiconductor.

Normally diffusion current is very small compared to drift current and hence negligible.

* Formation of Depletion Region

(1) Due to diffusion, electrons from N type crosses junction and recombine with the holes in P-type

(2) Hence, Positive donor ions are generated on N side and negative acceptor ions are generated on P side.

(3) The process continuous such that -ve on P type and +ve on N type and becomes sufficient enough to oppose further recombination.

(4) Hence, it is called as barrier Potential.

(5) The region near the junction is depleted of mobile charge carriers hence it is called as depletion region. It is 0.7 V for silicon and 0.3 V for Ge.