Difference between..

Intrinsic Semiconductor	Extrinsic Semiconductor.
I) Pure Semiconductor	I) Impure Semiconductor
II) $n_h = n_e$	II) $n_h \neq n_e$
III) Conductivity is low	III) Conductivity is High.
IV) Conductivity depend only on temperature	IV) Conductivity depend on temperature and concentration of Doping..

n-type Semiconductor	P-type Semiconductor.
I) Impurity atom is Pentavalent	I) Impurity Atom is Trivalent
II) Electrons are Majority & Holes are Minority charge carriers. $n_e > n_h$	II) Electrons are Minority and holes are Majority charge carriers $n_h > n_e$
III) Impurity atom is known as Donor atom	III) Impurity atom is known as acceptor Atom.
IV) Donor level is formed just below the conduction band	IV) Acceptor level is formed just above the valence band
V) Conduction is mainly due to electrons	V) Conduction is mainly due to holes.

Example 6.3 *The energy near the valence band edge of a crystal is given by* $E = -10^{-39} k^2$ *Jm*^{2}. *An electron with wave vector* $10^{10}\,\hat{k}_x$ m^{-1} *is removed from an orbital in the completely filled valence band. Determine effective mass and momentum.*

Solution. Given : $E = -10^{-39} k^2$. Hence $\frac{d^2E}{dk^2} = -2 \times 10^{-39}$

Effective mass of the electron

$$m^* = \hbar^2 / \frac{\partial^2 E}{\partial k^2} = -\frac{(1.05 \times 10^{-34})^2}{2 \times 10^{-39}} = -5.5 \times 10^{-30}\,\text{kg}$$

Momentum of electron $= \hbar k = 1.05 \times 10^{-34} \times 10^{10}\,\hat{k}_x = 1.05 \times 10^{-24}\,\hat{k}_x$ Js m^{-1}.

Comparison between Ordinary Diode and Zener Diode

S.No.	Ordinary Diode	Zener Diode
1.	Ordinary diode is operated in forward biased condition.	Zener diode is always operated in reverse biased condition.
2.	It utilizes the forward characteristics.	It utilizes, the reverse characteristics. In forward bias it acts like a *PN* junction diode.
3.	It does not have any sharp breakdown voltage.	If property doped, it has a sharp breakdown V_Z.

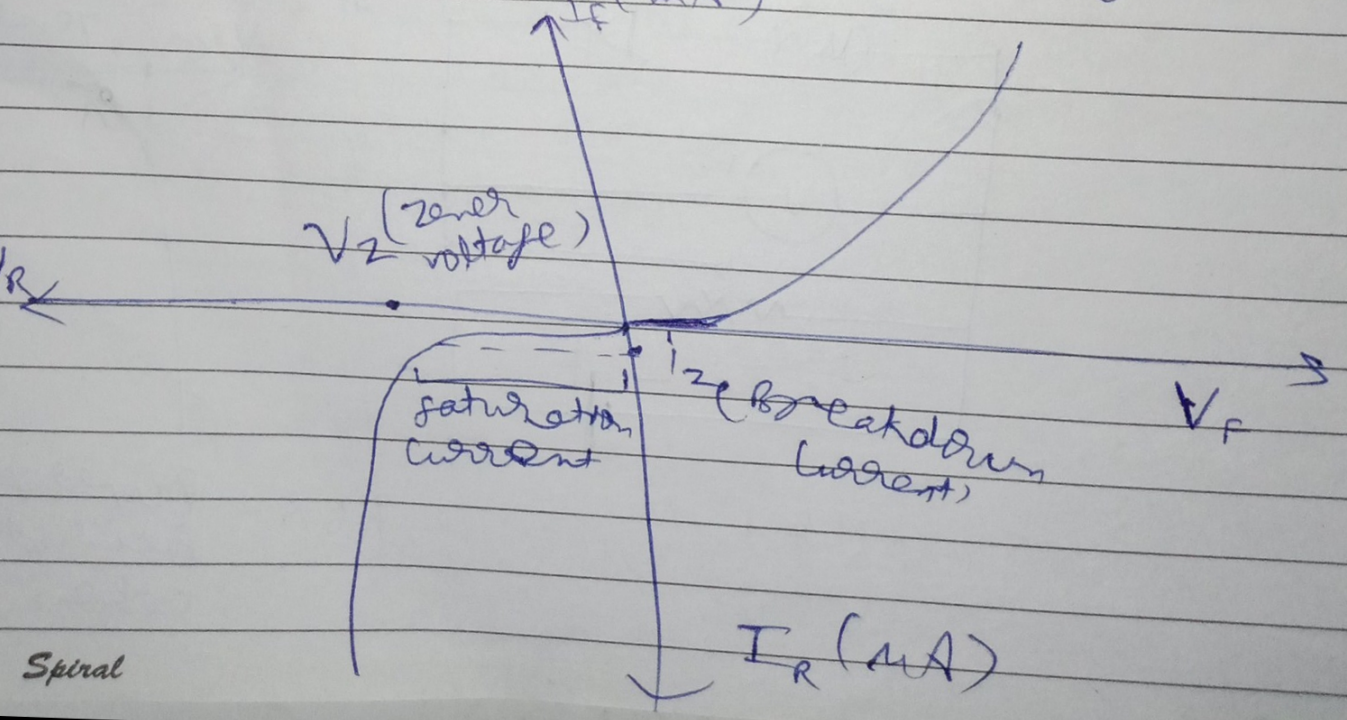
Semiconductor Devices

• Zener Diode

Zener diode is specially designed P-N junction diode that can operate in reverse breakdown region continuously without being damaged.

In Zener diode, the P & N regions are heavily doped. As a result of it, the depletion region of Zener diode is extremely thin ($< 10^{-6}$ m) & Electric field set up across the junction is very high that cause covalent break & cause charge carriers further a large amount of current is generated.

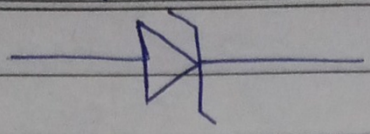
For eg: if reverse voltage is 5 V is applied across P-N junction then $E = -\frac{dV}{dx} = \frac{5}{10^{-6}} = 5 \times 10^6$ V/m



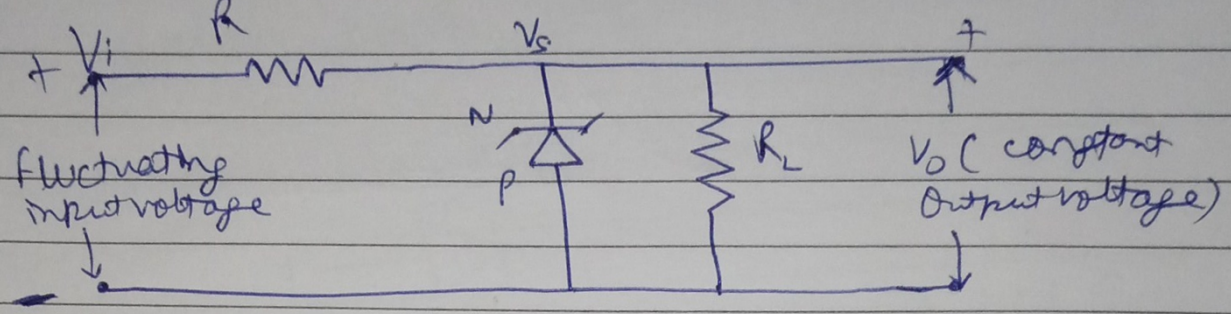
Spiral

P N

Date .....



Zener Diode as Voltage Regulator



Zener diode is joined in reverse bias to the fluctuating input voltage through a resistor R. The constant output voltage is taken across load resistance R_L connected in parallel with Zener Diode

$$V = E - IR$$

$$100 = 200 - 10 \times 10$$

$$100 = 300 - 20 \times 10$$

$$100 = 100 - 0 \times 10$$

Case I: When input reverse bias voltage across zener diode increase beyond a certain limit (i.e. V_z) the current through circuit rises, causing an increase in voltage drop across R. As a result of it the voltage across the zener diode remains constant, even though current through zener diode changes.

Case II: When V_i decreases below V_z, the current through circuit decreases; causing decrease in voltage drop across R; without any change in voltage across D; As a result of it, the voltage across zener remains constant.

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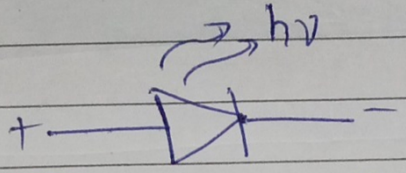
LED

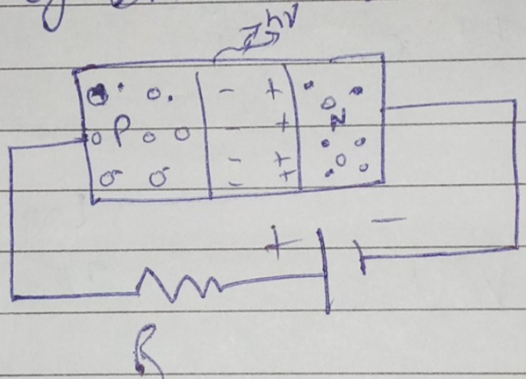
- Light Emitting Diode
- It is heavily doped P-N junction diode which converts electrical energy into light energy.

- This diode emits light under forward biasing.

Symbol →



In this, P-N Junction diode is connected from a battery through Resistance R which controls brightness of emitted light.



Working → When P-N Junction is forward biased, e- & holes more towards opposite side of junction. Therefore excess minority charge carriers on the either side of junction boundary, recombine with majority charge carriers near the junction.

On recombination of e- & holes; the energy is given out in form of light. The released energy is nearly equal to energy gap.

$$E_g = h\nu$$

$$E_g = \frac{hc}{\lambda}$$

$$\boxed{\lambda = \frac{hc}{E_g}}$$ wavelength of emitted light

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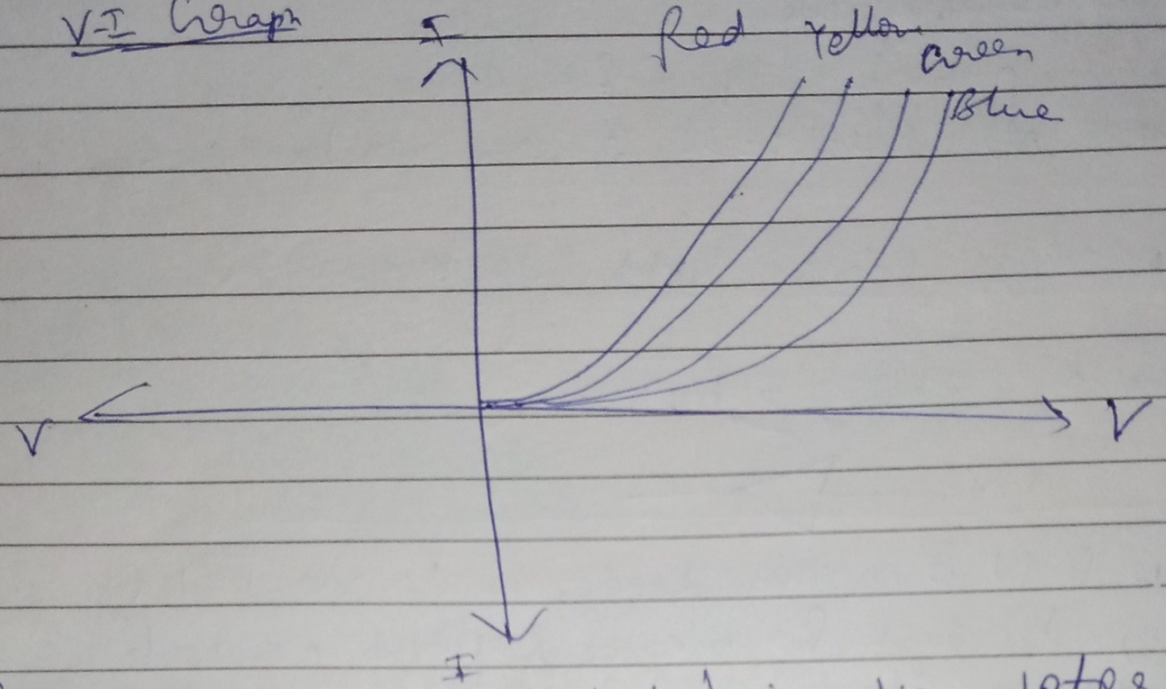
V-I Graph



forward current conducted by junction determines intensity of light emitted.

Merit of LED:

1. Long Life
2. Low Operational Voltage
3. Less consume of Power
4. Cheap & easy to handle.

Use of LED:

1. In Burglar Alarm System
2. In Traffic Light
3. In Remote Control
4. In calculator & digital watches.