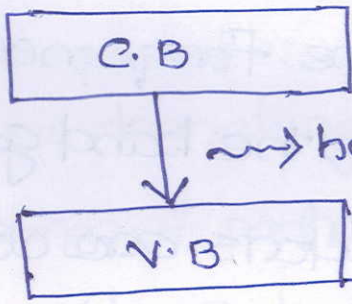
(2) SEMICONDUCTOR PHYSICS

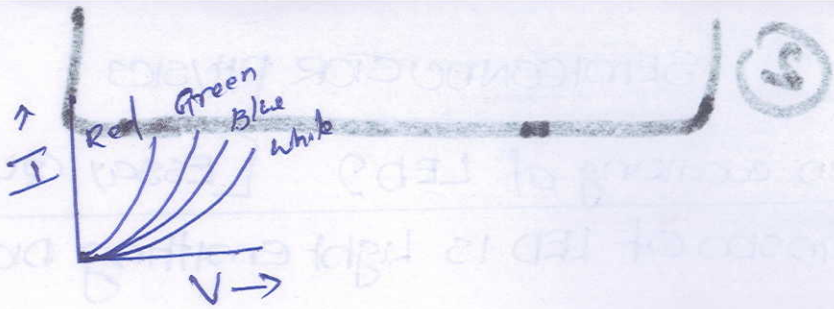
(1) Explain working of LED? [Essay Question]

Expansion of LED is Light emitting Diode. It is a heavily doped PN Junction diode. Spontaneous emission under forward biasing condition is the working Principle of LED.



The electrons are in the conduction band and holes are present in the valence band. The electrons from the conduction band of N type and holes from the valence band of P type undergoes recombination. During these recombination they produce light of sufficient wave length.

When forward current is small intensity is also small. When forward current increases the intensity reaches a maximum Value. Further increase in the ~~intens~~ current results in the decrease of Intensity.



The V-I characteristics of Light-emitting Diode is similed to an addinary diode except in the knee voltage. It will be different for different colours.

The foreqeency of emitted radiation depends on the band gap energy. Direct band gap semicandcetors are used for making LED. Inp & GaAs are direct band gap semicandectors and they are used in LED.

→ GaAs - Infrared

→ GaAs p-on Gallium Arsenide Substrate

Produces Visible red light.

[anile pargerties & Application foram Text along with essay, Page No: 281]

-) Explain the working of Tunnel Diode? [Essay]

→ It is also called Esaki diode, The doping is 1000 times greater than ordinary diode. Fermi level lies with in the conduction band on n type and valence band on p type.

→ The working principle of Tunnel diode is Quantum mechanical tunnelling. In classical mechanics penetration of particle through potential barrier is not possible. But in Quantum mechanics due to wave nature ~~of~~ there is a possibility of Penetration.

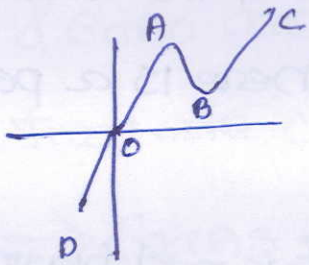
→ First connect the diode in forward biasing condition. Due to this an alignment takes place between filled electron level in N type and unfilled hole level in p type. Due to thin depletion layer electrons Penetrate through a potential barrier from n to p. Due to this current flows from p to n. It acts like a conductor. It is represented by OA.

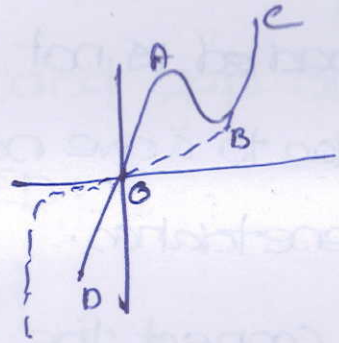
→ when voltage further increases the current reaches a maximum value. But when voltage again increase tunnel current decreases and reaches a minimum value. It is represented by AB.

At this stage there is a violation of ohm's law region is called Negative resistance region.

→ when voltage again increases tunnelling disappears then the substance changes to normal P-N Junction diode. It is represented by BC.

→ called Reverse biasing more alignment between filled levels in the valence band of n type and conduction band of n type takes place. so electrons tunnel from p to n. current flows from n to p.





Explain working of Varactor Diode?

[Note already given] [5 mark Qn]

- called variable capacitor diode.
- P & n type regions are equivalent to parallell plates of capacitor and depletion layer acts as the dielectric medium.

- $C = \frac{\varepsilon_0 \varepsilon_r A}{d}$
- When forward biasing applied, thickness of depletion layer is small, capacitance is maximum.
- When Reverse biasing applied, thickness of depletion layer is high, capacitance is minimum.

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(4) Explain the working of Liquid crystals?

[essay]

→ Substances having properties between that of a liquid and that of a solid are called Liquid crystals. The molecules moves as in a liquid but their interaction is like solid materials.

Eg:- proteins, cell membranes, soap solutions etc.

Based on the arrangement of molecules Liquid crystals can be classified into Nematic cell and Twisted Nematic cell.

[Draw figure, Page No: 287 of Text]

Construction of Nematic cell :-

→ Thin layer of Liquid crystal is placed between two parallell flat glass plates.

→ Two coatings are made on one face face of each glass plate. First coating is done with Indium Tin oxide [ITO] and second coating is with dielectric material.

→ The molecules of the liquid crystal are arranged parallell to the plate or their orientation is parallel to the axis.

→ Before the alignment the dielectric surface is rubbed with cotton cloth to produce grooves to make the molecules align in uniform orientation.

Twisted Nematic cell

→ If one glass plate is rotated through 90° then molecules are aligned in a vertical direction on one plate and gradually they get horizontally oriented in another plate.

→ The action is like that when a light which is horizontally polarised is passed through crystal plane of light get twisted through 90° or it will shows optical activity.

Liquid crystal display - working

[Draw figure from page No: 288 of Text]

→ The liquid crystal is placed between two glass plates. The light first incident on a horizontal polarised it get horizontally polarised. The horizontally polarised light passess through Liquid crystal and undergoes a 90° rotation to the plane of vibration. ie, it gets vertically polarised. These vertically polarised light passess through vertical polarised and it is reflected from the mirored placed at the bottom. It produces a bright state or grey state.

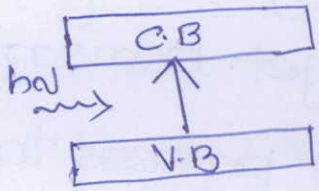
→ When a voltage is applied the liquid crystal looses it's optical activity. so the horizontally polarised light cannot passess through the vertical polarised and produces a dark state.

→ These grey & dark states are Important in the working of LCD.

(5) Solar cells – Explain the construction & working

[Essay]

[Draw figures from Text, Page No: 290]



→ working is opposite to the working of LED

→ It is also called photo voltaic cell. when light is incident on the pn Interface of a pn Junction diode it will be converted to electric current.

→ The incident light excites electrons from the valence band of p type to the conduction Band of N type.

→ The emf of solar cell is about 0.6V and current is very small. A solar cell of area $1cm^2$ produces a p.d of 0.5 Volts and current of 60mA.

→ Solar cells are grouped in to a module or panel which is known as solar panel. Storage batteries are used for storing excess energy which can be used in night time.

(5)

→ The minimum photon energy required to produce a current is given as

$$\nu_{min} = \frac{eE_g}{h} Hz$$

or the longest wavelength $\lambda_{max} = \frac{hc}{eE_g}$.

The longest wavelength which can produce a photocurrent in silicon is 1.1 Mm and for germanium it is 1.7 Mm.

[Also write Advantages & uses of Solar cell from Text, Page No: 291]

(6) Explain Law of Mass action? [5 Marks Qns]

(7) Explain Fermilevel? Explain the Fermilevel in the case of intrinsic & extrinsic semiconductors?

[5 marks Qns]

(8) Explain the working of Zener diode as Voltage regulated/stabilized? [5 marks]

(9) Distinguish between Zener & Avalanche breakdown?

[2 mark Qns]

(10) Explain CE & CB characteristics of transistor?