GOVERNMENT POLYTECHNIC COLLEGE, BHILWARA

MODEL TEST PAPER

ELECTRONICS II YEAR

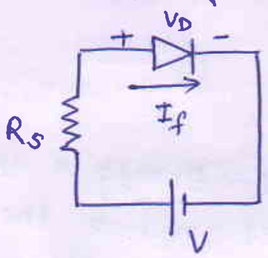
ELECTRONIC DEVICES AND CIRCUITS - EL 204

Time - 1 Hour. Max. Marks - 15

NOTE - (i) Answer all questions.
(ii) marks carried by a question is indicated against it.

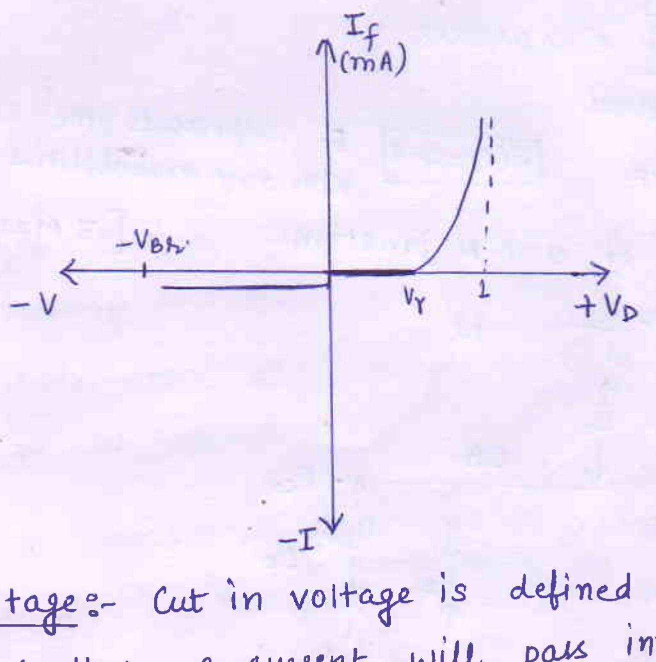
1. Draw V-I characteristics of a diode. Explain Breakdown voltage and cut in voltage in these characteristics. [4 Marks]

Ans. Forward characteristics of diode is plotted with I_f Vs V_D



$$I_f \simeq I_s e^{\frac{V_D}{\eta V_T}}$$

V-I Characteristics-



V_γ = cut-in voltage of Diode

V_{Br} = Breakdown voltage of Diode.

Cut-in Voltage :- Cut in voltage is defined as the min. forward voltage required so that a current will pass into the diode. If the forward voltage is less than barrier voltage forward current is zero. If the forward voltage equals the cut in voltage, the effect of barrier is nullified and forward current flow into the diode.

for Ge diode - V_γ = 0.1V to 0.5V

for Si diode - V_γ = 0.6 to 0.9V

Breakdown voltage - (V_{BR}) It is the manufacturer specification and it varies from device to device.

When a normal p-n junction diode is reverse Biased, the reverse voltage should be always less than breakdown voltage of the diode or else diode will be destroyed. This voltage depends upon the ~~breakdo~~ doping concⁿ.

$$V_{BR} \propto \frac{1}{\text{Doping Conc.}}$$

[2 Marks]

(2) Write Fermi-Dirac probability function.

Ans. Fermi Energy is measured in eV. Fermi energy is defined as the max. energy possessed by an e^- at 0K.

For a metal or a S.C. -

$$f(E) = \frac{1}{1 + e^{\frac{E - E_F}{KT}}}$$

E = Energy of the e^- in eV

f(E) specifies the fraction of all the states and energy E occupied under thermal equilibrium

At T = 0K

(i) when $E > E_F$ $f(E) = 0$ e^- is absent

(ii) when $E < E_F$ $f(E) = 1$ e^- is present

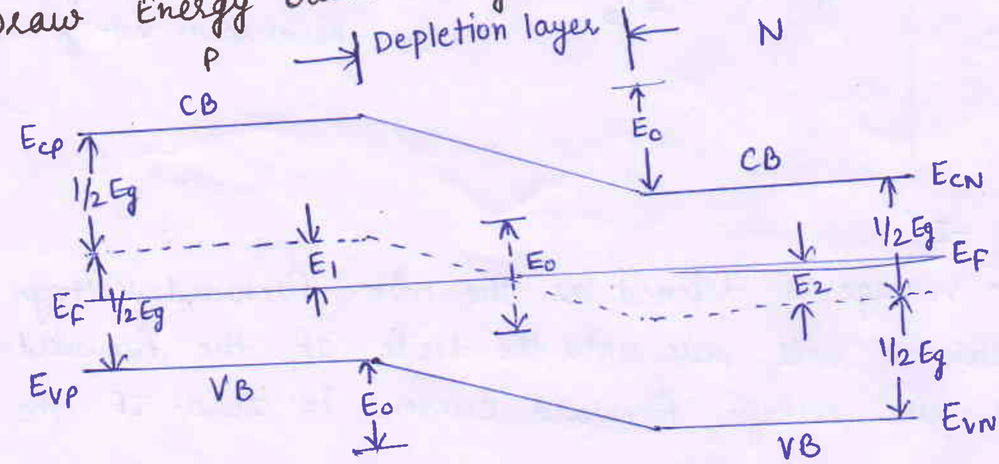
(iii) when $E = E_F$ Not defined.

At $T \neq 0K$, $T > 0K$ if $E = E_F$ $f(E) = 0.5$ E_F represents the energy state with 50% probabilities of being filled.

[3 marks]

(3) Draw Energy band diagram of a P-N junction.

Ans.



$$E_0 = E_{Cp} - E_{CN} = E_{VP} - E_{VN} = E_1 + E_2$$

$$E_F - E_{VP} = \frac{1}{2}E_G - E_1$$

$$E_{CN} - E_F = \frac{1}{2}E_G - E_2$$

(4) What is doping? Write name of the dopants for making N-type and P-type semiconductor. [2 Marks]

Ans- It is the process of adding the impurities into the semiconductor.

Doping increases carrier concentration and thereby increases the conductivity of the semiconductor.

→ for P type SC (Trivalent / Acceptor Impurities) ⇒ B, Al, Ga & In [III group]

→ for N type SC (Pentavalent / Donor Impurities) ⇒ P, As, Sb & Bi [V group]

(5) What is diffusion and diffusion current in semiconductor? [2 Marks]

Ans. Diffusion is a natural phenomena. The migration of charge carriers from higher concentration to lower concentration or from higher density to lower density is called diffusion.

$\frac{dn}{dx}$ = e^- concentration gradient in e^-s/cm³/cm

$\frac{dp}{dx}$ = hole concentration gradient in holes/cm³/cm

Diffusion is mainly due to concentration gradient. Diffusion current is present only in the semiconductors. In SC there is always unequal distribution of charge carriers and this is due to smaller concentration of atoms.

In a SC e^- concentration and hole concentration will be decreasing with the distance & therefore the slope is always -ve or concentration gradient is -ve. i.e. $\frac{dn}{dx} \rightarrow -ve$ and $\frac{dp}{dx} \rightarrow -ve$

e^- diffusion current density $\boxed{J_n(diff.) = +qD_n \frac{dn}{dx}}$ A/cm²

hole diffusion current density $\boxed{J_p(diff.) = -qD_p \frac{dp}{dx}}$ A/cm²

$$\boxed{J_{diff} = J_n(diff.) + J_p(diff.)}$$

(5) What is Transition capacitance of a diode ? [2 Marks]

Ans. Transition capacitance (C_T) is the junction capacitance in a Reverse biased diode. capacitance is defined as the rate of change in charge due to a change in voltage.

$$C = \frac{dQ}{dV}$$

When reverse bias voltage changes, width of the depletion layer changes and also the immobile charges changes. This rate of change of immobile charges with respect to a change in reverse bias voltage is called transition capacitance (C_T).

$$\boxed{C_T = C_j = \frac{A\epsilon}{W}} \ F$$

$$C_T \propto \frac{1}{W}, \quad \boxed{C_T \propto \frac{1}{\sqrt{\text{Reverse Bias voltage}}}}$$