[This question paper contains 4 printed pages.]

Sr. No. of Question Paper : 7810 **F–2** **Your Roll No................**

Unique Paper Code : 2511201

Name of the Course : **B. Tech. Electronics** [DC–1.3]

Name of the Paper : Semiconductor Devices

Semester : II

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **five** questions in all.
3. Question No. **1** is compulsory.
4. **All** questions carry equal marks.
5. Use of non-programmable scientific calculator is allowed.

1. (a) Explain the difference between direct and indirect bandgap semiconductors with the help of E-K diagram.

   (b) Draw the energy level diagram of a p-n junction in (i) unbiased condition (ii) forward bias and (iii) reverse bias.

   (c) What do you understand by Ohmic and Rectifying contacts ?

   (d) For an emitter current of 2 mA, collector current is 1.97 mA. Determine the common base current gain and base current ?

   (e) The Fermi-level in a semiconductor is 0.35 eV above the valence band. What is the probability of non-occupation of an energy state at the top of the valence band, at 300 K ? (3×5)

2. (a) Explain the generation and recombination processes of charge carriers in a semiconductor. Also describe how it affects the rate of change of carrier concentration (continuity equation) ? (8)

(b) Discuss the dependence of Fermi level on doping concentration and temperature. (4)

(c) In an intrinsic GaAs semiconductor with $n_i = 2 \times 10^{12}\ m^{-3}$, the electron and hole mobilities are 0.85 and 0.04 $m^2V^{-1}s^{-1}$ respectively. Calculate its conductivity. (3)

3. (a) Derive the expression for electric field within the depletion region. Also derive the expression for depletion width. (8)

(b) A Si step junction maintained at room temperature under equilibrium conditions has a p-side doping density of $N_A = 2 \times 10^{15}\ /cm^3$ and an n-side doping of $N_D = 10^{15}/cm^3$. Use the depletion approximation to compute the electric field at x = 0. (4)

(c) What is law of mass action ? Explain its significance. (3)

4. (a) Describe the four modes of operation of a bipolar junction transistor. Also determine the application of each. (8)

(b) For an ideal p-n-p transistor, the current components are given by $I_{Ep} = 3$ mA, $I_{En} = 0.01$ mA, $I_{Cp} = 2.99$ mA, and $I_{Cn} = 0.001$ mA. Determine (a) the emitter efficiency γ, (b) the base transport factor α_T, (c) the common-base current gain α_0, and (d) I_{CBO}. (4)

(c) Draw the input characteristics of common emitter BJT. (3)

5. (a) Sketch the basic structure of a Junction Field Effect Transistor (JFET) and explain its I-V characteristics. (8)

(b) Explain accumulation, depletion and inversion process for an ideal Metal Oxide Semiconductor (MOS) structure under different biasing conditions. (4)

(c) Calculate the drain current in a JFET for $V_{GS} = 0, -2$ and $-4V$, if $I_{DSS} =$ 25 mA and $V_{GS(OFF)} = -5V$. (3)

6. (a) What is Hall Effect ? Consider a sample of Silicon doped with 10^{16} Phosphorous atoms per cm^3. Find the Hall voltage in the sample, with W = 700 μm, $A = 5\times10^{-3}\, cm^2$ current I = 2.5 mA and $B_Z = 10^{-4}\, Wb/cm^2$. Also determine its type. (8)

(b) What do you understand by breakdown of a p-n junction ? Name its mechanisms. (4)

(c) Explain the working of a Solar cell. (3)

7. (a) Draw the doping profile of semiconductor controlled rectifier (SCR). Explain the working of an SCR using two transistor equivalent circuit. (8)

(b) Why do bands bend near the semiconductor surface for the ideal MOS structure under different biasing conditions ? (4)

(c) In a Uni-junction Transistor $\eta = 0.8$, $V_p = 10.3$ V and $R_{B2} = 5\ k\Omega$. Determine R_{B1} and V_{BB}. (3)

Constants	Value
k	1.38×10^{-23} J/K
e	1.6×10^{-19}C
ε(Silicon)	11.9
ε_0	8.854×10^{-14} F/cm
n_i(300 K) for Si	1.45×10^{10} cm^{-3}