Roll No. | | | | | | | | | | | | | Total No. of Pages : 02

Total No. of Questions : 08

M.Tech.(VLSI D) EL-I (2016 & Onwards) (Sem.–2)

SEMICONDUCTOR DEVICES

Subject Code : MTVL-206

Paper ID : [74262]

Time : 3 Hrs. Max. Marks : 100

INSTRUCTION TO CANDIDATES :

1. **Attempt any FIVE questions out of EIGHT questions.**
2. **Each question carries TWENTY marks.**

1. What is the basic principle of carrier injection? Derive the expressions for electron and hole currents injected at the junction in a semiconductor diode and hence define the diode equation.

2. a) In a uniformly doped silicon sample, the hole component of current is hundred times the electron component in an applied electric field. Assuming $\mu_n = 3\ \mu_p$, calculate the equilibrium electron and hole concentrations, the net doping, and the sample resistivity at 300K.

   b) Resistivity of a sample of silicon at a given temperature is 25×10^4 Ω-cm. It is now doped at the extent of 4×10^{10} donor atoms / cm^3 and 10^{10} acceptor atoms/ cm^3. If an electric field of 4 V/cm is applied across the sample, find the total conduction current density.

3. a) An abrupt p-n junction in silicon is doped with $N_D=10^{15}$ cm^{-3} in the n-region and $N_A= 4\times10^{20} cm^{-3}$ in the p-region. At room temperature, calculate :

      i) The built-in potential.

      ii) The depletion layer width and the maximum field at zero bias.

      iii) The depletion layer width and the maximum field at a reverse bias of 5V.

   b) Explain different regions of operation of BJT with suitable diagram. Explain the factors that are responsible for shape of output or collector characteristics of BJT.

4. Explain the Ebers-moll model and its characteristics in detail. Also discuss non-ideal effects in BJTs.

5. a) Draw and explain the energy band diagram for the ideal MOS structure at equilibrium.

   b) For an n-channel MOSFET with a gate oxide thickness of 11nm, $V_T = 0.6$ V, Z = 30 μm, and L = 1 μm. Calculate the drain current at $V_G = 5$ V and $V_D = 0.1$ V. Repeat for $V_G = 3$ V and $V_D = 5$ V. Discuss what happens for $V_D = 7.5$ V. Assume an electron channel mobility of $\mu_n = 200$ cm^2/Vs.

6. Explain short channel, narrow width and substrate bias effects in MOSFETs with the help of suitable diagrams.

7. Explain drain induced barrier lowering (D1BL) and gate-induced drain leakage (GIDL) in MOSFETs with the help of suitable diagrams.

8. Short notes on the following (**Any two**) :

   a) Shockley Read Hall theory of recombination.

   b) Avalanche process.

   c) Gummel poon model.