Registration No. : | | | | | | | | | | |

Total number of printed pages – 3

B. Tech

BSCP 1207

Third Semester Regular Examination – 2014

PHYSICS OF SEMICONDUCTOR DEVICES

BRANCH(S) : AEIE, BIOTECH, CSE, EC, EEE, EIE, ELECTRICAL, ETC, IEE, IT

QUESTION CODE : H 379

Full Marks – 70

Time – 3 Hours

*Answer Question No. **1** which is compulsory and any **five** from the rest.*

The figures in the right-hand margin indicate marks.

1. Answer the following questions : 2×10

(a) Define Early effect.

(b) Draw the k-space diagrams of Si and GaAs.

(c) Explain density of state function.

(d) What is meant by freeze out condition ?

(e) Draw the energy band diagram for a metal semiconductor junction under forward and reverse bias.

(f) In which way n-type MOSFET is different from p-type MOSFET ?

(g) Why the base region of a transistor is made very thin ?

(h) Define the term built-in-potential barrier for a pn-junction.

(i) Explain the meaning of mobility.

(j) With the help of suitable diagrams, show the minority carrier distribution in an npn transistor for cut-off mode and saturation mode.

P.T.O.

2. (a) Write the expression for the probability function of electrons and holes in the donor and acceptor states. Discuss complete ionization and freeze out conditions with suitable energy band diagram. 5

(b) What do you mean by charge neutrality in semiconductor. Discuss equilibrium electron and hole concentration for a compensated semiconductor ? 5

3. (a) Derive the Einstein relation. 5

(b) Consider silicon semiconductor at T = 300° K in which $N_a = 10^{16}$ cm^{-3} and $N_d = 3\times10^{15}$ cm^{-3}. Assume that $n_i = 1.5\times10^{10}$ cm^{-3}, determine the thermal equilibrium electrons and hole concentration in a compensated p-type semiconductor. 5

4. (a) Discuss about the scattering mechanism available in semiconductor material. 4

(b) Assume that the diffusion co-efficient of a carrier at T = 300° K is D = 28.3 cm^2/s. Calculate the carrier mobility. 3

(c) Draw the plot of variation of E_F with doping concentration and temperature. 3

5. (a) Derive an expression for electric field and potential in the space charge region of a uniformly doped pn-junction. Where does the maximum electric field occur in space charge region ? Derive an expression for space charge width. 5

(b) Derive the Ebers-Moll equations for a BJT. Sketch the equivalent circuit which satisfy these equations. 5

6. (a) Derive the expression for the excess minority carrier electron concentration in forward active mode in an npn bipolar transistor. 4

(b) Derive voltage-current relationship of pn junction diode. From this relation explain the meaning of reverse saturation current. 4

(c) A silicon pn-junction at T = 300^0 K has doping concentration of $N_d = 3.5 \times 10^{16}$ cm^{-3} and $N_a = 8.2 \times 10^{15}$ cm^{-3} and has a cross-sectional area of A = 5×10^{-5} cm^{-2}. Determine the junction capacitance at $V_R = 4$ V. 2

7. (a) Define the Flat-band condition. Derive the expression for Flat-band voltage of a MOS Capacitor. 4

(b) An MOS device has the following parameters aluminum gate, p-type substrate with $N_a = 3 \times 10^{16}$ cm^{-3}, $t_{ox} = 250$ A^0 and $Q'_{SS} = 10^{11}$ cm^{-2} and $Q_{ms} = -0.981$ V. Determine the threshold voltage. 2

(c) What is a MOSFET ? Describe the constructional features and working of an n-channel enhancement mode MOSFET. 4

8. (a) Draw and explain the C-V characteristics of accumulation region, depletion region and inversion region of a p-type substrate MOS capacitor ? 5

(b) What do you mean by CMOS technology ? Sketch the cross-section of a CMOS structure. Discuss what is meant by latch-up in a CMOS structure. 5