Reg. No. : .....

Name : .....

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C – 5365

Third Semester B.Tech. Degree Examination, October 2017
(2008 Scheme)
08-302 : SOLID STATE DEVICES (TA)

Time : 3 Hours

Max. Marks : 100

PART – A

Answer **all** questions. **Each** question carries **4** marks.

1. Show [110] plane and (110) direction related to a cubic crystal.

2. Derive the expression for resistivity of an intrinsic semiconductor.

3. Show that Fermi level remains constant across a junction at equilibrium.

4. Derive a relationship between the dopings (N_A, N_D) and depletion layer widths (X_P, X_N) of an abrupt pn junction.

5. Derive the expression for diffusion capacitance of a diode.

6. Distinguish between a Schottky barrier junction and a pn junction.

7. What is meant by avalanche multiplication ? How is the multiplication factor related to reverse voltage ?

8. Plot the CV diagram of an ideal MOS capacitor and explain.

9. Explain DIBL in a MOSFET.

10. Explain the operation of a UJT. **(10×4=40 Marks)**

P.T.O.

PART – B

Answer **any two** questions from **each** Module. **Each** question carries **10** marks.

Module – I

11. a) Derive the equation for equilibrium electron and hole concentration. **5**

    b) A GaAs sample is doped so that the electron and hole components of currents are equal in an applied electric field. Calculate the equilibrium electron-hole concentrations, the net doping and the sample resistivity at 300K. Given $\mu_n = 8500\ cm^2/Vs$, $\mu_p = 400\ cm^2/Vs$, $n_i = 1.79 \times 10^6\ cm^{-3}$. **5**

12. a) How do the energy band diagram change with application of electric field ? **5**

    b) A sample of n-type silicon has dark resistivity of $1K\Omega$ cm at 300K. The sample is illuminated uniformly to generate 10^{21} EHPs $cm^{-3}s^{-1}$. The hole lifetime is $1\ \mu s$. Calculate the sample resistivity and the percentage change in resistivity after illumination. Assume $\mu_n = 1350\ cm^2/Vs$, $\mu_p = 480\ cm^2/Vs$ and $n_i = 1.5 \times 10^{10}\ cm^{-3}$. **5**

13. Derive the diode current equation of a long base diode. State the approximations used. **10**

Module – II

14. a) Show that the forward current in a p^+n junction with high level injection is given by $I = 2q\ A\ (D_p/L_p)n_i e^{Vj/2VT}$. **5**

    b) A Si diode has a linearly graded pn junction with a grading constant of $10^{20}\ cm^{-4}$ and a junction area of $0.5\ mm^2$. Using depletion approximation, calculate the maximum electric field in the space charge layer and the junction capacitance at reverse bias of 25 V. **5**

15. a) Draw the energy band diagram of a metal n-type semiconductor Schottky diode at equilibrium with forward bias. **4**

    b) A base current pulse of $100\mu A$ and width 300ns is applied to the base of a switching transistor. Given $\tau_{pB} = 0.25\ \mu s$, $W_B = 2.5\ \mu m$ and $D_p = 6\ cm^2/s$. Sketch the waveforms of collector current and the charge Q_B. Find t_{On} and t_{Off}. **6**

16. Derive the expression for I_C, I_E and I_B of a pnp transistor. What are the approximations used ? **10**

Module – III

17. An n channel silicon JFET has $N_D = 5\times10^{15}\ cm^{-3}$, $N_A = 10^{19}\ cm^{-3}$, $a = 1.5\,\mu m$, $L = 30\ \mu m$, $Z = 200\ \mu m$. Assume $\mu_n = 1350\ cm^2/Vs$. Determine at

    i) built-in voltage

    ii) pinch-off voltage

    iii) channel conductance G_o

    iv) drain current at $V_{GS} = 0V$; $V_{DS} = 4V$

    v) $V_{D(sat)}$ for $V_{GS} = -2V$

    vi) $I_{D(sat)}$ for $V_{GS} = -2V$

    vii) g_m at $V_{GS} = -2V$. **10**

18. a) Draw the energy band diagrams of a ideal MOS capacitor under

        i) Flat band condition

        ii) Accumulation and

        iii) Inversion. **5**

    b) What are the non-idealities in a real MOS capacitor ? How do they change flat band voltage and threshold voltage ? **5**

19. a) Explain :

        i) Body effect

        ii) Hot electron effect and

        iii) Subthreshold conduction. **6**

    b) What is the difference between enhancement and depletion MOSFETs ? Draw the transfer and drain characteristics. **4**

(6×10=60 Marks)