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(Pages : 3) **1273 A**

Reg. No. : .....

Name : .....

Third Semester B.Tech. Degree Examination, June 2012
(2008 Scheme)
08.302 : SOLID STATE DEVICES (TA)

Time : 3 Hours Max. Marks : 100

PART A

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

1. Draw the crystal planes equivalent to (001).
2. Find the energy momentum (E,k) relationship for a free electron and relate it to the effective mass.
3. Prove that the maximum resistivity of a semiconductor at a given temperature is $\rho_{max}=(2qn_i)^{-1}(\mu_n\mu_p)^{-1/2}$, where n_i is the intrinsic carrier concentration.
4. Plot the minority carrier distribution across a forward biased and reverse biased p-n junction and clearly label it.
5. Draw the energy band diagram of a hetero junction diode under thermal equilibrium condition.
6. Define injection efficiency and base transport factor of a BJT. Write the expressions.
7. What is early effect ? What are its effects on I_C, I_B, I_E, α and β of a transistor ?
8. A Si n-channel JFET has $N_D=10^{15}cm^{-3}, N_A=10^{18}cm^{-3}$ and channel thickness(2a)=2 μ m. Determine i) built-in voltage and ii) pinch off voltage.
9. Explain hot electron effect in MOSFETs.
10. Draw the two transistor equivalent of an SCR and explain the principle of operation.

P.T.O.

PART B

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

Module – I

11. a) Derive the expression for mobility and conductivity of a semiconductor. **6**

    b) A Ge sample is doped with $4x10^{13}$ As atoms/cm^3. Determine the carrier concentration and Fermi level position at 300 K. **4**

12. a) What is Hall effect ? Derive the expression for Hall co-efficient. **5**

    b) A Si sample is doped uniformly with 10^{15} As atoms per cm^3 and has τ_p=1 μs. Determine the photogeneration rate that will produce 2×10^{13} cm^{-3} excess EHPs in the steady state. Also calculate the conductivity of the sample and position of the electron and hole quasi Fermi levels in the steady state condition at 300 K. **5**

13. Starting from the fundamentals derive the diode current equation. State the approximations used.

Module – II

14. a) Plot the minority carrier distribution across an abrupt pn junction under
    i) forward bias and ii) reverse bias. **5**

    b) A Si pn junction at 300K has $N_A=10^{16}$ and $N_D=10^{15}$ cm^{-3}, $\tau_n = \tau_p$=0.1 μs, $A=10^{-3}cm^2$. At 300k determine i) junction capacitance at zero bias & ii) storage capacitance at V_a= 0.5 V. **5**

15. a) Derive the expression for built in potential across an abrupt pn junction. **5**

    b) Draw the energy band diagram of a metal n type semiconductor ohmic contact under thermal equilibrium. **5**

16. Derive expressions for emitter current and collector current of an npn BJT. State the approximations used.

Module – III

17. An n channel silicon JFET has $N_D = 5x10^{16}cm^{-3}$, $N_A = 10^{18}\ cm^{-3}$, $a = 0.5\,\mu m$. Determine at 300K (a) V_o (b) $V_{D(sat)}$ for $V_{GS} = -3V$ (c) V_{GS} for $V_{D(sat)} = 1V$ (d) width of undepleted channel if $V_{GS} = -2V, V_{DS} = 0$.

18. Draw a simplified structure of MOS capacitor and explain the different conditions of operation. Explain its CV diagram.

19. a) Explain the principle of operation of IGBT. 4

    b) Derive expression for the drain current of a MOSFET. 6
