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Roll No. ----------

Serial No. of Question Paper : 2267 F-4
Unique Paper Code : 2511201
Name of the Paper : Semiconductor Devices
Name of the Course : B.Tech Electronics
Semester : II
Duration : 03 hours
Maximum Marks : 75

Instructions for the 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) If a plane has intercepts at 2a, 3a and 4a along the three Cartesian coordinates, where 'a' is the lattice constant, determine the miller indices of the plane. (3×5)
   b) Explain what the diffusion current is and which way it is flowing for forward bias and reverse bias *p-n* junction diode.
   c) What is Pinch-off voltage in a FET? What happens to drain current and gate current at this point?
   d) Bipolar junction transistors are referred as "normally off devices". Explain why?
   e) Find the room temperature (300^0K) resistivity of silicon doped with 10^{16} phosphorous atom/cm^3.

2. a) Derive the expression of carrier concentration in the intrinsic semiconductor. Show that in an intrinsic semiconductor Fermi-level lies close to the middle of the band gap. 8
   b) A hypothetical semiconductor has an intrinsic carrier concentration of 1.0×10^{10} cm^{-3} at 300 K. If the semiconductor is doped with $N_d = 1x10^{16}$ donors/cm^3, what are the equilibrium electron and hole concentrations at 300K? 4
   c) What is Hall-effect? Explain its physical significance 3

3. a) Derive the ideal diode equation and explain the I-V characteristics of p-n junction diode. 8
   b) An abrupt Si p-n junction is doped with $N_D = 10^{18}$ cm^{-3} and $N_A = 10^{15}$ cm^{-3} at room temperature. Calculate the built-in potential at 300^0 K 4
   c) Explain the mechanism of Zener breakdown using proper energy band diagrams 3

4. a) Derive an expression for the collector (or emitter) terminal current for a bipolar junction transistor (n-p-n or p-n-p) in the active mode of operation. 8
   b) A p-n-p transistor has the following current components: $I_{Ep} = 4$ mA, $I_{En} = 0.01$ mA, $I_{Cp} = 3.98$ mA, and $I_{Cn} = 0.001$ mA. Determine the base transport 4

factor, the emitter efficiency γ, common base current gain (α) and common emitter current gain (β) for a bipolar junction transistor.

c) Explain base width modulation. 3

5. a) Derive an expression for drain current of a JFET. When is the channel of a JFET said to be pinched off? 8

b) A FET operates with a drain current of 100 mA and a gate source bias of negative 1V. Device transconductance is 0.25 mho, determine the change in drain current if the gate source bias is increased to -1.1 V. 4

c) Give the circuit symbol of enhancement-n-MOSFET, depletion n-MOSFET and n channel JFET. 3

6. a) Explain the phenomena of diffusion of charge carriers in a semiconductor and show that electron current density is given by the following expression 8

$$J_n = qD_n \frac{dn}{dx}.$$ 4

b) Explain the difference between an abrupt and linearly graded *pn* junction. 3

c) 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 400 K?

7. a) Draw the equivalent circuit of unijunction transistor. What is intrinsic stand-off ratio? And explain the negative resistance region. 8

b) What do you understand by Ohmic and Rectifying contacts? 4

c) What are advantages of using CMOS? 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
μ_n (Si) at 300K	1300 cm^2/Vs
μ_p (Si) at 300K	420 cm^2/Vs
n_i(300 K) for Si	$1.45\times10^{10} cm^{-3}$