2002 SCHEME

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EC56

Fifth Semester B.E. Degree Examination, June 2012
Solid State Devices and Technology

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. Using Poisson's equation, show that the electric field developed in the depletion region of a PN junction diode has maximum magnitude at its metallurgical junction during no bias condition. **(08 Marks)**

b. Explain with energy level diagram, why the bands bend during the formation of PN junction. **(04 Marks)**

c. A silicon abrupt PN junction has $N_A = 10^{17} em^{-3}$ and $N_D = 10^{15} cm^{-3}$ at room temperature. Calculate the depletion layer width at, i) zero bias ii) forward bias of 0.3 volt
Given : $n_i = 1.0 \times 10^{10} cm^{-3}$; $\in_r$ for Si = 11.8. **(08 Marks)**

2 a. Starting from the continuity equation, obtain an expression for the forward current in a P^+N junction diode. **(10 Marks)**

b. Derive an expression for the built-in potential in a PN junction in terms of doping densities. **(06 Marks)**

c. For a silicon PN junction at 300 K, $N_A = 10^{18} cm^{-3}$ on the P-side and $N_D = 10^{14} cm^{-3}$ on the N-side. Find the ratio of depletion layer widths on both sides of the junction. **(04 Marks)**

3 a. With appropriate diagram, explain the system used for growing N silicon layer over N^+ substrate. **(07 Marks)**

b. Explain the different steps involved in the fabrication of a BJT in an integrated circuit. **(08 Marks)**

c. A Silicon crystal doped with phosphorus is to be grown by Czochralski method. If the melt contains one kg of silicon, how many grams of phosphorus should be introduced to the melt to achieve a donor concentration of $2 \times 10^{15} cm^{-3}$ during the growth?
Given : K_0 for P in S_i is 0.32; Atmotic weight of P is 30.97
Density of S_i is 2.53 gm/cm^3; $N_A = 6.023 \times 10^{23}$. **(05 Marks)**

4 a. Show that the base current is the controlling current for I_C and makes the BJT in the common-emitter configuration a linear current amplifier. **(06 Marks)**

b. Starting from the expressions for emitter and collector currents in a PNP transistor, obtain EBERS-MOLL equations. Draw EBERS – MOLL model using these equations. **(08 Marks)**

c. Explain the terms "Early Effect' and "Punch through effect" with respect to a BJT. **(06 Marks)**

5 a. Derive expressions for Turn-ON and Turn-OFF times in a PNP transistor. **(10 Marks)**

b. Establishing appropriate relations explain why BV_{CBO} is larger than BV_{CEO} in a transistor. **(04 Marks)**

c. A silicon NPN transistor has $N_{DC} = 10^{18} cm^{-3}$, $N_{AB} = 10^{15} cm^{-3}$ and $W_B = 1$ μm. Determine the punch through voltage at 300 K. Given $n_i = 1.5 \times 10^{10} cm^{-3}$. **(06 Marks)**

6 a. Analyse quantitatively the transit time of carriers in the base region of a BJT. **(06 Marks)**

b. Derive the expression for the drain current of an N-channel JFET in terms of drain voltage, built-in voltage and pinch-off voltage. **(08 Marks)**

c. An N-channel silicon JFET has $N_D = 10^{15} cm^{-3}$, $N_A = 10^{18}$ cm^{-3} and a = 2.0 μm; $n_i = 1.5 \times 10^{10}$ cm^{-3} and $\in_r = 11.8$. Determine :

i) Built-in potential.

ii) Pinch-off voltage.

iii) Threshold voltage. **(06 Marks)**

7 a. Discuss the energy band diagram of metal-N semiconductor junction before and after contact at thermal equilibrium. **(06 Marks)**

b. Draw the 'ID-VD characteristics' of a MOSFET for different values of VG and explain the three regions of operation. **(08 Marks)**

c. An N-type SBD has $N_D = 2 \times 10^{15} cm^{-3}$ and $\phi_m = 4.9V$, affinity of S_i is 4.15 V. At 300K, determine:

i) The Schottky barrier height.

ii) The built-in voltage. **(06 Marks)**

8 a. Obtain expressions for the depletion region, thickness and charge density of MOS system. **(08 Marks)**

b. Explain the band bending of MOS devices. **(06 Marks)**

c. A silicon N-substrate is doped with $N_D = 5 \times 10^{15} cm^{-3}$. Determine the surface potential needed to make the surface, i) intrinsic and ii) Strong inversion. Given $n_i = 1.5 \times 10^{10}$ cm^{-3}. **(06 Marks)**

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