Mid-Term Examination
Odd Semester - 2017-18
Semiconductor Devices and Circuits (SEMI)
B.Tech. (ECE) 2nd Year

LNMIIT
The LNM Institute of Information Technology

Time: 1.5 Hrs **Total Marks: 30**

All Questions are compulsory and Self-Explanatory.

Q1. Obtain the Miller indices of a plane which intercepts at a, b/2, 3c in a simple Cubic unit cell. Draw a neat diagram showing the plane.(Where a, b, c are lattice parameters). **2+2**

Q2. Indicate on an energy level diagram the conduction and valence bands, donor & acceptor states and the position of Fermi level for: **1+1+1**

a) an intrinsic semiconductor
b) a n-type semiconductor
c) a p-type semiconductor

Q3. What is a p-n junction? Explain the formation of the depletion region in a p-n junction. How does the width of this region change when the junction is (i) forward biased?
(ii) reverse biased? Explain. **1+1+1+1**

Q4. An abrupt Si p-n junction has $N_a = 10^{18}$ cm^{-3} on one side and $N_d = 5 \times 10^{15}$ cm^{-3} on the other. This junction has a circular cross section with a diameter of 10 μm. Calculate x_{n0}, x_{p0}, Q_+ and ε_0 for this junction at equilibrium (300 K). **4**

For the Calculation following parameters can be used:
$kT/q = 0.0259$ eV, $q = 1.6 \times 10^{-19}$ C, $n_i = 1.5 \times 10^{10}$ cm^{-3}, $\varepsilon_0 = 8.845 \times 10^{-14}$ Fcm^{-1}, $\varepsilon_{si}/\varepsilon_0 = 11.8$

Q5. An n-type silicon substrate at 300 K has a donor concentration of 2.73×10^{16} cm^{-3} : **2+2+3**

a) Determine the concentration of electrons in the conduction band.
b) Determine the hole concentration in the valence band.
c) If the substrate is overdoped with an acceptor concentration of 3.5×10^{16} cm^{-3}, determine the electron and hole concentration. Is the resulting material n-type or p-type?

Q6. Distinguish between Avalanche and Zener breakdown in p-n junction diode. Discuss them in details. **4**

Q7. Consider two Si samples with the following properties: **2+2**

Sample A: $N_d = 10^{16}$ cm^{-3}; $\mu_n = 1000$ cm^2/V.s; $\mu_p = 300$ cm^2/V.s
Sample B: $N_d = 10^{18}$ cm^{-3}; $\mu_n = 800$ cm^2/V.s; $\mu_p = 250$ cm^2/V.s

Calculate the position of the Fermi levels E_F (assume $E_c = 0.0$ eV) for both the samples with the followings:

$N_c = 2.78 \times 10^{19}$ cm^{-3}, $kT = 0.0259$ eV