Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SIXTH SEMESTER B.TECH. (E & C) DEGREE END SEMESTER EXAMINATION
APRIL/MAY 2019
SUBJECT: SEMICONDUCTOR DEVICE PHYSICS (ECE – 4015)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. A Si sample is doped with $10^{17}cm^{-3}$ Arsenic atoms. What is equilibrium hole concentration at 300K. Where is E_f related to E_i

1B. Define bonding and Anti bonding orbitals for a two atom system.

1C. With examples define direct and indirect band semiconductors. Define the effective mass of electrons in terms of curvature of the band.

(3+3+4)

2A. Hall measurements are performed on p-type semiconductor bar of 500 µm wide and 20 µm thick, The Hall contacts are displaced 2 µm with respect to each other in the direction of current flow of 3 mA. The voltage between the contacts with a magnetic field of 10 KG pointing out of plane of the sample is 3.2 mV and the magnetic field direction is reversed the voltage changes to – 2.8mV. What is the hole concentration and mobility

2B. How long does it take an average electron to drift 1 µm in pure Si at an electric field of 100V/cm. Repeat for 10^5 V/cm. $\mu_n = 1350\ cm^2/V\text{-sec}$.

2C A Si sample with $10^{15}\ cm^{-3}$ donars is uniformally optically excited at room temperature such that $10^{19}\ cm^{-3}$ electron hole pairs are generated per second. Find the seperation of the quasi Fermi levels and change of conductivity upon shining the light. Electron and hole life times of both are 10 µsec. $D_p = 12cm^2$ /sec.

(3+3+4)

3A. An abrupt Si pn junction has $N_a = 10^{18}\ cm^{-3}$ on one side and $N_d = 5x10^{15}cm^{-3}$ on the other and has a circular cross section with a diameter 10 µm. Calculate X_{n0}, X_{p0}, Q_+, and E_0 for this junction at equilibrium (300K). Sketch E(x) and charge density.

3B. Calculate the capacitance for the following n^+P junction. Given that : $N_a = 10^{15}cm^{-3}$, area = $0.001cm^2$, reverse bias = 1.5 V and 10 V.

3C. In P^+N junction, the n doping N_d is doubled. How do the following changes if everything remains unchanged. i) Junction Capacitance ii) Built in potential

(4+3+3)

4A. Explain formation of n-type semiconductor - metal junction (with a condition that work function of metal is greater that that for semiconductor) with band diagram and its function

under various biasing conditions. How the metal-semiconductor system is to be modified to switch from rectifying contact to ohmic contact.

4B. The work function of platinum is 5.0 eV and the electron efinity for Si is 4.05 eV Determine the barrier heights and built-in voltage for MS contact of Pt with N – type Si having doping concentration $N_d = 2.8 \times 10^{14}$ cm^{-3} . Assume the effective density of states at the conduction band edge $N_c = 2.8 \times 10^{19} cm^{-3}$.

4C. discuss the origin of storage time delay in switching properties of diodes and how to decrease the problem. Name any device which does not have similar problem and why?

(4+3+3)

5A. Explain Capacitance-Voltage characteristics of ideal MOS capacitor.

5B. Explain with the aid of band diagrams how strong inversion conditions in the MOS structure on p-type semiconductor will be formed?

(4+6)