Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal)

SIXTH SEMESTER B.Tech. (E & C) DEGREE END SEMESTER EXAMINATION APRIL 2018

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. Consider an n-type silicon sample with a doping concentration $N_D = 10^{-16}$ cm⁻³ If it is illuminated such that electron –holes pairs are generated of the order of 10^{-12} cm⁻³. Give pictorial representation of the Fermi level positions with respect to E_I before and after light source is switched on at room temperature. Given that $n_i = 1.5 \times 10^{-10}$ cm⁻³.
- 1B. Explain physical significance of mass action law in semiconductors
- 1C. Calculate mean free time of electron having mobility of 1000 cm 2 /V-S at 300⁰K. Also calculate the mean free path. Given that $m_n = 0.26 m_o$.
- 1D Derive an expression for minimum conductivity in a semiconductor in terms of mobilities of charge carriers.

(4+2+2+2)

- 2A. Describe the direct and indirect band gap semiconductors with E-K diagrams. How can these diagrams be utilised to calculate effective mass of electron.
- 2B. Hall measurements are made on an p-type semiconductor bar of 500 μm wide and 20 μm thick. The Hall contacts are displaced 3μm from each other in the direction of current flow of 3 mA. The voltage between the Hall contacts with a magnetic field of 10KG pointing out of the plane of the sample 4.2 mV and the magnetic field is reversed the voltage changes to -2.8 mV. What is hole concentration and mobility?
- 2C. What are the relevant equations that must be solved in general for a semiconductor device problem

(4+4+2)

- 3A. In a very long p-type Si bar with cross-sectional area 0.5 cm² and N_A to be 10¹⁷ cm⁻³, holes are injected such that the steady state excess hole concentration is 5 x 10¹⁶ cm⁻³, at x= 0. What is the steady state separation between F_p and E_c at x = 2000 Å? What is the hole current there? How much is the excess stored charge? Assume that $\mu_p = 500$ cm²/V-s and $\tau_p = 10^{-10}$ s.
- 3B. Describe the minority carrier charge profile on either side of the pn- junction when it is reverse biased. If it is switched forward biased what could be minority charge profile on both sides of the junction, at equilibrium.
- 3C. Find an expression for electron current in the n-type material of a forward biased p-n junction

(5+3+2)

4A. What is difference between ohmic and rectifying contacts? Describe how metal - N-type

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semiconductor contacts behave when metal work function is greater than that of semiconductor

- 4B. The platinum work function is 5.0 eV and electron affinity for Si is 4.05 eV. Determine barrier heights and built in voltage for an MS contact of Pt with N-type Si having a doping concentration of $N_D = 2.8 \times 10^{-14} \text{ cm}^{-3}$. Given that $N_c = 2.8 \times 10^{-19} \text{ cm}^{-3}$.
- 4C. What are the advantages of Schottky diodes over PN junction diodes?

(5+3+2)

- 5A. Describe different modes of operation of ideal MOS structure on p-type substrate
- 5B. Describe the capacitance voltage characteristics of MOS capacitor.

(6+4)