MANIPAL UNIVERSITY

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DEPARTMENT OF SCIENCES, M.Sc (PHYSICS)
IV SEMESTER END SEMESTER EXAMINATIONS, APRIL 2017
SUBJECT: CONDENSED MATTER PHYSICS – II [PHY706.2]
(REVISED CREDIT SYSTEM)

Time: 3 Hours Date: 24-04-2017 MAX. MARKS: 50

Note: (i) Answer any five full questions.

(ii) Missing data, if any, may suitably be assumed.

1. (a) Arrive at an expression for recombination rate using Shockley –Read –Hall theory assuming single type of recombination center exists within the band gap.

   (b) A cylindrical n-type semiconductor of cross sectional area 0.1 cm^2 carries a current of 20mA.If the carrier concentration is 10^{15} /cm^3, find the current density and the average drift velocity of the electrons. If the length of the sample is 2cm and the current is caused by a 0.3V applied across its ends, determine the electron mobility and the conductivity.

   (7+3)

2. (a) Using the ambipolar transport equation obtain the expressions for excess minority carrier concentrations in the n and p regions of a forward biased p-n junction and hence obtain ideal diode I-V equation.

   (b) Discuss the phenomenon of base width modulation in bipolar transistor.

   (8+2)

3. (a) Describe the zone melting technique of crystal growth with a neat diagram and write a note on wafer preparation.

   (b) Write various steps involved in the processing of a planar p-n junction diode.

   (6+4)

4. (a) Draw the energy level diagram for a Schottky diode under (i) no bias (ii) forward bias and (iii) reverse bias conditions. Obtain an expression for space charge width under no bias condition.

   (b) A uniformly doped silicon n-channel JFET has doping concentrations of $N_a = 1\times10^{18}$ /cm^3 and $N_d = 1\times10^{16}$ /cm^3 .Calculate the internal pinch off voltage and pinch off voltage if metallurgical channel thickness is 0.75µm. Given $n_i = 1.5\times10^{10}$ /cm^3 and $\varepsilon_s = 11.7\times8.85\times10^{-14}$ F/cm.

   (6+4)

5. (a) Describe the fabrication and principle of operation of a p-n junction solar cell and derive expressions for short circuit current, open circuit voltage and maximum power delivered to the load.

   (b) Write a note on optical concentration.

   (8+2)

6. (a) Explain the working of working of diode laser with reference to population inversion and laser cavity.

   (b) Calculate the steady state photocurrent density in a reverse biased long p-n diode with following parameters: $\tau_{no} = 5\times10^{-7}$ s , $\tau_{po} = 1\times10^{-7}$ s, $D_n = 25cm^2$ /s, $D_p = 10cm^2$ /s, $V_{bi} = 0.695V$, $W = 1.21$ µm. $G_L = 10^{21} cm^{-3} s^{-1}$

   (7+3)