**Assignment 3**

**(Semiconductors & pn junction Diode)**

**Q1** Calculate the conductivity and resistivity of intrinsic Si at 300 K. Given that intrinsic concentration is 1.5 \* 1010 /cm3and the mobility of electrons is 1300 cm2 /V-s and holes is 500 cm2/V-s .

**Q2** A sample of pure silicon has electrical resistivity of 3000Ωm. The free carrier density in it is 1.1x1016/m3. If the electron mobility is three times that of hole mobility, find electron mobility and hole mobility.

**Q3** A n type sample of Si has a uniform density of ND = 1016 cm/3 of phosphorous and a p type Si sample has NA = 1015 cm/3 of boron. For each of the semiconductor materials, determine the equilibrium minority carrier concentration. Given ni =1.5 x 1010 /cm3

**Q4** An intrinsic semiconductor (Si) is doped with a donor type impurity such that there is one impurity atom on 106 atoms of semiconductor. The total concentration of semiconductor is 5\* 1022/m3 and intrinsic concentration is 2.5\*1012/m3.Calculate:

a) Resulting donor atom concentration. b) Resulting electron concentration. c)Resulting hole concentration. d)Conductivity of the doped sample if mobility of electrons is 3800m2/V-s

**Q5** A Sample of pure Ge has an intrinsic charge carrier density of /m3 at 300 K. It is doped with donor impurity of 1 in every Ge atoms. Electron and hole mobilities are 0.38 m2/v-sec and 0.18 m2/v-sec respectively. Ge atom density is /m3 .

1. What is the resistivity of the doped Ge?
2. If the Ge bar is 5mm long and m2 in cross sectional area, What is its resistance?

c. What is the voltage drop across the Ge bar for a current of 1µA?

**Q6** Calculate the drift current density in a p type semiconductor material at T = 300 K with doping concentration of NA= 1016 cm/3. Assume electron and hole mobilities are 3900 cm2/V-sec and 1900 cm2/V-sec. The applied electric field is E = 50 V/cm.

**Q7** A bar of pure silicon has cross sectional area of 1mm2 and intrinsic concentration of silicon is 1.5x1016m-3. The free electron and hole mobilities are 0.13m2/V-sec and 0.05m2/V-sec respectively. Find the conductivity and length of bar whose resistance is 50KΩ

**Q8** A Si bar, 0.1 cm long and 100 µm2 in cross sectional area is doped with 1016 cm-3 antimony atoms. Find the current through the Si bar if 10 V potential is applied. Mobility of electrons is 1300 cm2 /V-s

**Q9** Calculate the current produced in a Ge semiconductor of area 2cm2 and length 0.4mm, if concentration of free electron is 2x1019/m3and a battery of 2volts is applied across its length. Given that mobilities of free electrons and holes is 0.36m2/v-sec and 0.17m2/v-sec.

**Q10** Find the Diffusion coefficients of electron and holes of a silicon crystal at room temperature ifmobilities of electrons and holes in Si are 1300 cm2 /V-s and 500 cm2/V-s respectively**.**

**Q11** A Si diode has reverse saturation current of 2.5µA at 300k. Find forward voltage for a forward current of 10 mA. Given that VT= 0.02586V.

**Q12** A Si diode has reverse saturation current of 10µA at 300k. Calculate forward diode current for a forward voltage of 0.6V at 25oC.

**Q13** An abrupt silicon pn junction with intrinsic concentration1010 /cm3 consists of 1016 /cm3 Boron atoms in p region and 5x1016 /cm3 Arsenic atoms in n region. Calculate built in(barrier) potential at 15oC.

**Q14** In a step graded Ge pn junction, donor concentration is 1000 times the acceptor concentration. If the acceptor impurity is added at the rate of 1 atom per108 Ge atoms. Calculate built in potential at room temperature if density of Ge is 4.4x1026/cm3 and intrinsic concentration is 2.5 x 1013 /cm3