Assignment-2[1]
Conduction Phenomenon is Semiconductors

Prerequisite for solving the below problems is thorough understanding of Lecture notes-1 and 2. All the constants are given in table-1 of the lecture notes-1 and -2 . Any missing data may be suitably assumed and stated.

$$n = \frac{dv}{AM} = \frac{A_0 dv \times 10^3}{A}$$

where d= density, kg/m^3; v=valence, free electrons per atom; A= atomic weight; M= weight of atom of unit weight, kg; A_0=Avogadro's number, molecules/mole.

1. (a) Using the above mentioned formula, calculate the concentration of atoms in Germanium, taking monatomic germanium. ($v = 1$)
   (b) Find the resistivity of intrinsic germanium at 300^oK.
   (c) If a donor-type impurity is added to the extent of 1 part in 10^8 germanium atoms, find the resistivity.
   (d) If germanium were a monovalent metal, find the ratio of its conductivity to that of the $n-$type semiconductor in the part (c).

2. (a) Find the concentration of holes and electrons in $p-$type germanium at 300^oK if the conductivity is 100 $(\Omega - cm)^{-1}$.
   (b) Repeat (a) for $n-$type silicon if the conductivity is 0.1 $(\Omega - cm)^{-1}$

3. Consider intrinsic germanium at room temperature (300^oK). By what percent does the conducitvity increase per degree rise in temperature.

4. The hole concentration in a semiconductor specimen is shown in Figure-1.
   (a) Find an expression for and sketch the hole current density $J_p(x)$ for the case in which there is no externally applied eletric field.
   (b) Find an expression for and sketch the built-in electric field that must exist if there is to be no net hole current associated with the distribution shown.
   (c) Find the value of the potential between the points $x = 0$ and $x = W$ if $p(0)/p_0 = 10^3$

5. Repeat problem-3 for intrinsic silicon.

[1] **Due date: 4th September 2006, 3:30 pm. To be submitted in the Office.**

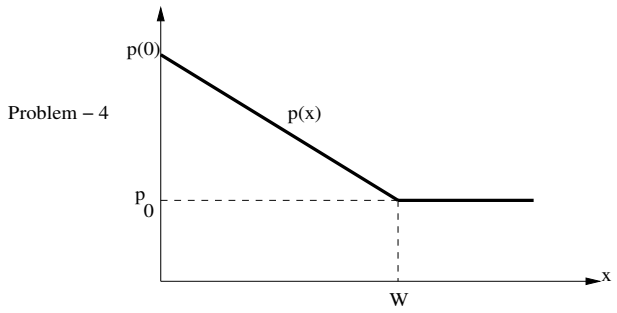

Figure 1: Concentration of holes in the specimen

6. A sample of germanium is doped to the extent of 10^{14} donor atoms/cm^3 and 7×10^{13} acceptor atoms/cm^3. At the temperature of the sample the resitivity of pure (intrinsic) germanium is 60 $\Omega - cm$. If the applied electric field is 2 V/cm, find the total conduction current density.

7. (a) Consider the step-graded germanium semiconductor of Figure-2 with $N_D = 10^3 N_A$ and with N_A corresponding to 1 acceptor atom per 10^8 germanium atoms. Calculate the contact difference of potential V_0 at room temperature.

   (b) Repeat part (a) for silicon p-n junction.

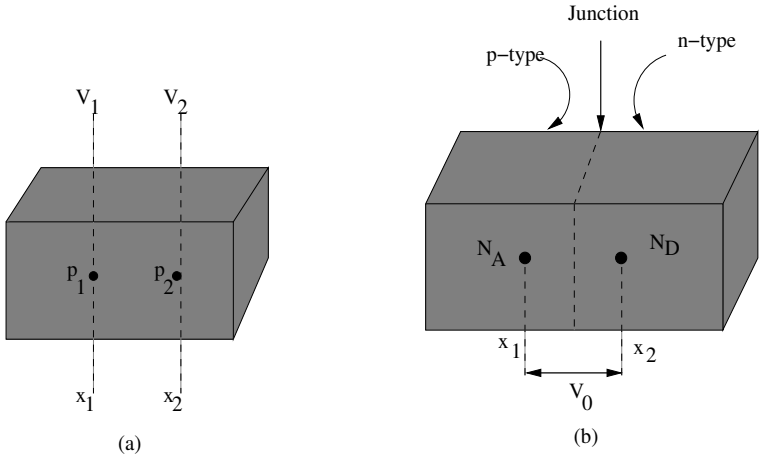

Figure 2: Concentration of holes in the specimen