1. The intrinsic carrier concentration of germanium (GE) is expressed as:

$$n_i = 1.66 \times 10^{15} T^{3/2} \exp\frac{-Eg}{2kT} \text{ cm}^{-3}$$

   where Eg = 0.66 eV.
   (a) Calculate n_i at 300 K and 600 K and compare the results with those obtained in Example 2.1 for Si.
   (b) Determine the electron and hole concentrations if Ge is doped with P at a density of 5×10^{16} cm^{-3}.
2. A n-type piece of silicon with a length of 0.1 μm and a cross section area of 0.05 μm × 0.05 μm sustains a voltage difference of 1 V.
   (a) If the doping level is 10^{17} cm^{-3}, calculate the total current flowing through the device at T = 300 K.
   (b) Repeat (a) for T = 400 K assuming for simplicity that mobility does not change with temperature. (This is not a good assumption.)

3. Figure 2.37 shows a p-type bar of silicon that is subjected to electron injection from the left and hole injection from the right. Determine the total current flowing through the device if the cross section area is equal to 1 μm × 1 μm.

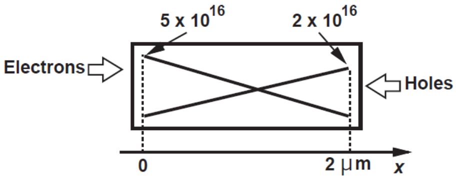

Figure 2.37

4. Compute the total number of electrons "stored" in the material from x = 0 to x = L; if the electron and hole profiles are "sharp" exponentials, i.e., they fall to negligible values at x = 2 μm and x = 0, respectively (Fig. 2.38).

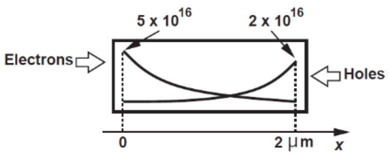

Figure 2.38

5. A pn junction with $N_D = 3 \times 10^{16}$ cm^{-3} and $N_A = 2 \times 10^{15}$ cm^{-3} experiences a reverse bias voltage of 1.6 V.
   (a) Determine the junction capacitance per unit area.
   (b) By what factor should N_A be increased to double the junction capacitance?
6. Due to a manufacturing error, the p-side of a pn junction has not been doped. If $N_D = 3 \times 10^{16}$ cm^{-3}, calculate the built-in potential at T = 300 K.
7. A junction employs $N_D = 5 \times 10^{17}$ cm^{-3} and $N_A = 4 \times 10^{16}$ cm^{-3}.
   (a) Determine the majority and minority carrier concentrations on both sides.
   (b) Calculate the built-in potential at T = 250 K, 300 K, and 350 K. Explain the trend.
8. An oscillator application requires a variable capacitance with the characteristic shown in Fig. 2.39. Determine N_A and N_D.

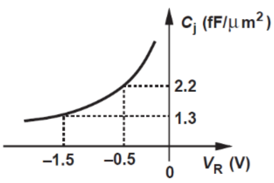

Figure 2.39