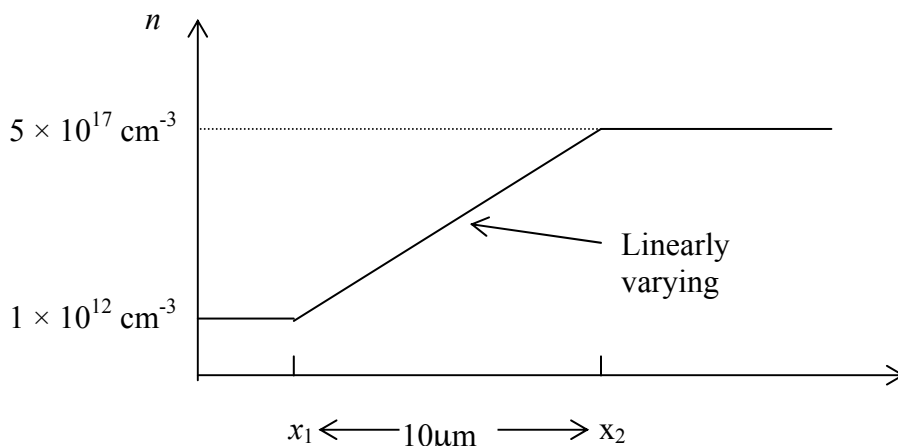


ECSE-2210 Microelectronics Technology
Homework 3

Reading Assignment: Pages 74-104

1. A silicon sample maintained at 300 K under thermal equilibrium has a non-uniform doping concentration profile, such that the electron concentration, n , varies linearly from $1 \times 10^{12} \text{ cm}^{-3}$ to $5 \times 10^{17} \text{ cm}^{-3}$ while going from point x_1 to point x_2 (see figure below). Assume that the mobility is constant at $1000 \text{ cm}^2/\text{Vs}$ throughout the sample. Answer the following.



- (a) Calculate the diffusion coefficient, D_n (in cm^2/s) for the electrons.
 - (b) Explain why the electrons do not diffuse everywhere such that the concentration is uniform throughout.
 - (c) Plot the diffusion current density (A/cm^2) for the electrons as a function of x . Mark the numerical value on the graph. (Hint: What is the equation for diffusion current density?)
 - (d) Plot the drift current density for electrons as a function of x (Hint: What should be the total current? Then, obtain answer to this from part c).
 - (e) Plot the energy band diagram as a function of x . (Hint: Plot the band diagram for $x < x_1$ and for $x > x_2$ and then plot qualitatively between x_1 and x_2).
 - (f) What is the potential difference (give a numerical value) between the two ends of the sample? (Hint: Read it off from the band diagram!)
 - (g) Plot a graph of the electric field versus x . (Hint: You can get this from part d and from the equation for the electron drift current density).
2. A $5\text{-}\Omega$ resistor is to be made from a bar-shaped piece of n-type Si. The bar has a cross-sectional area of 10^{-2} cm^2 . The silicon is doped with $N_D = 5 \times 10^{17} \text{ cm}^{-3}$ and $N_A = 4 \times 10^{17} \text{ cm}^{-3}$. Determine the length of the silicon bar.