ECE/PHY 235: Introduction to Solid State Electronics, Fall 2024
University of Wisconsin, Madison
Homework #8, Instructor Ying Wang
Due Thursday, Dec 5th , 11:59 PM, by electronic upload

PN junction

1. Given the width of the depletion region (W) as: $W = \sqrt{\frac{2\varepsilon_s}{q}\frac{(N_A+N_D)}{N_A N_D}V_{bi}}$, where N_A and N_D are the doping concentrations, V_{bi} is the build-in potential, and ε_s is the permittivity of the semiconductor.

   A silicon PN junction has $N_A=10^{16}$ cm^{-3}, $N_D=10^{15}$ cm^{-3}, and the intrinsic carrier concentration $n_i=1.5\times 10^{10}$ cm^{-3}. The permittivity of silicon is $\varepsilon_s = 11.7\varepsilon_0$ and $\varepsilon_0 = 8.85\times 10^{-14} F/cm$.

   a) Calculate the built-in potential V_{bi}
   b) Calculate the depletion region width at equilibrium.

2. Electric Field in the Depletion Region, the expression for the maximum electric field in the depletion region is $E_{max} = \frac{qN_A W_P}{\varepsilon_s} = \frac{qN_D W_N}{\varepsilon_s}$, where W_P and W_N are the widths of the depletion region on the P and N sides, respectively.

   a) Using the information from problem 1, calculate the maximum electric field at equilibrium
   b) Show that the built-in potential V_{bi} is the integral of the electric field across the depletion region:

$$V_{bi} = \int_0^W E(x)dx$$

Please upload a write-up of your solution as a single PDF file. Name the file "Lastname_HW8.pdf"