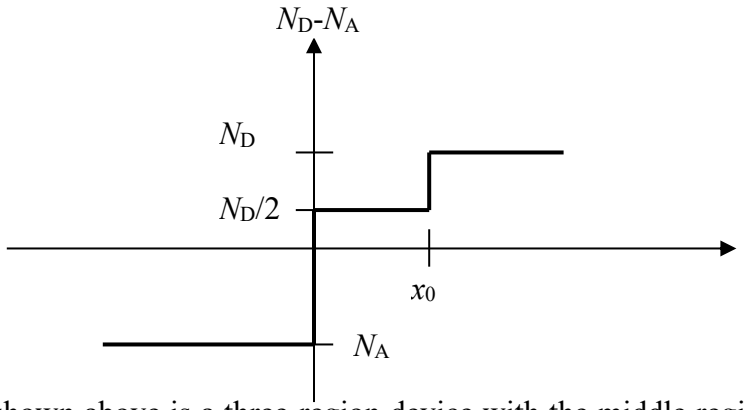
ECSE-2210 Microelectronics Technology
Homework 5

Reading list: Chapter 5 (pages 195 - 223. Ignore section 5.2.5).

1. (Problem 5.4 in text) A Si step junction under equilibrium at 300 K has a p-side doping of $N_A = 2 \times 10^{15}$ cm^{-3} and n-side doping of $N_D = 10^{15}$ cm^{-3}.
   Calculate:
   (a) The contact potential (also called built-in voltage).
   (b) The depletion layer width at the p-side and n-sides, and the total depletion layer width.
   (c) The electric field at the metallurgical junction.
   (d) The potential at the metallurgical junction.
   (e) Make sketches of the charge density, electric field and electrostatic potential as a function of position, that are roughly to scale
2. (Problem 5.5 in text) Repeat problem 1 taking $N_A = 10^{17}$cm^3 to be the p-side doping. Briefly compare the results here with those obtained in problem 1.
3. (Problem 5.10 in text). A p-n junction diode has the doping profile sketched below. Make the assumption that $x_n > x_0$ for all applied bias of interest. Answer the following:
   a. What is the built-in voltage across the junction? Justify your answer.
   b. Sketch the charge density ρ versus x inside the diode
   c. Sketch the expected electric field as a function of x inside the diode.



4. The p-i-n diode shown above is a three-region device with the middle region that is intrinsic and relatively narrow. Assuming the p- and n-regions to be uniformly doped and N_D-N_A = 0 in the i-region:
   a. Roughly sketch the expected charge density, electric field, and electrostatic potential inside the device. Also, draw the energy band diagram for the device under thermal equilibrium conditions.
   b. What is the built-in voltage drop between the p- and n-regions? Show how you arrived with your answer.