HW#2, Electronic Circuit, Spring semester 2020

March 27, 2020

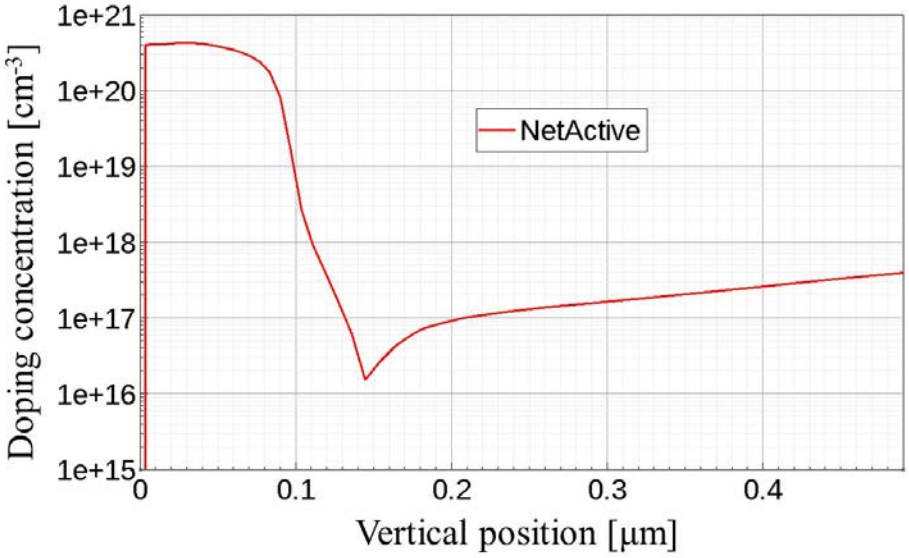
Due: 23:55, April 1 (Wednesday night)

We have 8 problems.

In your answer file, specify both the **SOLUTION PROCEDURE** and the **FINAL SOLUTION**.

1. In the silicon substrate, boron(B) atoms are uniformly doped. Its doping density is 10^{16} /cm^3. Then, what is the expected electron density?

2. Starting from the p-well, arsenic ions are implanted with a dose of 5X10^{15} /cm^2 and an energy of 40 keV. The resultant doping concentration (actually, its absolute value) is drawn. Write down the position of the metallurgical junction.



3. In the drift-diffusion scheme, the particle current density is written as a sum of the drift current density and the diffusion one. Write down the electron current density, $\mathbf{J}_\mathrm{n}$. (Signs are important.)

4. Derive an expression for $W_{d,n}$, the depletion width in the N-type region.

5. For a PN junction, the donor density is fixed to be 10^{20} cm^{-3}. However, the acceptor density varies from 10^{15} cm^{-3} to 10^{20} cm^{-3}. Calculate the built-in potentials for 10^{15} cm^{-3}, 10^{16} cm^{-3}, 10^{17} cm^{-3}, 10^{18} cm^{-3}, 10^{19} cm^{-3}, and 10^{20} cm^{-3}. Assume 300 K.

6. Based upon the solution of Problem 5, calculate the depletion widths for 10^{15} cm^{-3}, 10^{16} cm^{-3}, 10^{17} cm^{-3}, 10^{18} cm^{-3}, 10^{19} cm^{-3}, and 10^{20} cm^{-3}.

7. Based upon the solution of Problem 6, calculate the amount of the positive space charges (charge per area) in the N-type region for 10^{15} cm^{-3}, 10^{16} cm^{-3}, 10^{17} cm^{-3}, 10^{18} cm^{-3}, 10^{19} cm^{-3}, and 10^{20} cm^{-3}.

8. Repeat Problem 2 at a low temperature of 77 K. In this problem, we must consider the intrinsic carrier density at 77 K.