Exercise 3

Problem 1

An n-type silicon has 1.5 * 10^{14} phosphorus atoms/cm^3.

a- Calculate the position of the donor level E_D and Fermi level E_F.
b- Verify that the donor atoms are ionized.
c- Show how Fermi level shifts with temperature.

Problem 2

In a Silicon sample E_F is 250meV below E_C. What is the probability that an electron is kT eV above E_C?

Problem 3

December 1997: A Silicon sample is doped with Arsenic (donor) at a concentration of $N_D=10^{14}$ atoms/cm^3. Sketch the band diagram showing the position of E_F and E_D. Calculate carrier concentrations without making any approximations.

Problem 4

A Silicon sample is doped with 10^{16} /cm^3 Boron atoms (acceptor) and a certain concentration of donors. If E_F is 0.36eV above E_{Fi}, what is the donor concentration?

Problem 5

If a Silicon sample is doped with 10^{15}, 10^{18}, 10^{20}/cm^3 donor atoms; calculate the position of Fermi level in each case. In these calculations you assumed full ionization in all cases, check this assumption using the position of Fermi level you obtained.

Problem 6

A Silicon sample is doped with 10^{14} /cm^3 Phosphorous atoms. Find n_o and p_o at 300K. Do the calculation twice, once using approximation in charge neutrality and the other time solving exactly. Is the approximation appropriate? Repeat at 500K, is the approximation a good one in this case?