NNSE 508 EM

Home assignment # 5 **Due: March 05, 2014**

1. The effective densities of states in the conduction and valence bands of GaAs at room temperature are 4.7×10^{17} cm^{-3} and 7×10^{18} cm^{-3}, respectively. The energy gap of GaAs is 1.42 eV.
(a) How many electrons do you expect to find in a one cm cube of undoped GaAs at room temperature? How many holes?
(b) What if the same GaAs cube is doped with shallow donors with concentration 10^{13} cm^{-3}. How many electrons do you expect to find now? How many holes?

2. Consider a two-dimensional square metal crystal of lattice spacing a=3 Å, and one electron per unit cell. If the electrons are considered free within the two-dimensional plane,
a) Calculate the density of states for these electrons;
b) Calculate the Fermi energy E_F . (Provide a numerical value in eV relative to the bottom of the band.)

3. Calculate and plot the density of conduction band states for 10x10 nm^2 quantum wire. How many conduction band electrons exist in 1cm - long wire if Ef = 200 meV above the edge of the band. Effective mass of electron is 0.1 m_0.

4. A piece of non-uniformly doped silicon has a built-in electric field of 10^4 V/cm and an electron gradient (dn/dx) at x = 0 which equals -10^{20} $cm^{-4.}$ Assuming the semiconductor is in thermal equilibrium, calculate the electron and hole density as well as the hole gradient at x = 0. Use μ_n = 1000 cm^2/V-s and μ_p = 300 cm^2/V-s.

5. At room temperature oxygen is a paramagnetic gas with a molar susceptibility 4.33×10^{-8} m^2/mol.
(a) Estimate the effective number of Bohr magnetons per molecule and
(b) show that it is consistent with two electrons in s-tates. [In the ground state of the oxygen molecule, the electron spins are coupled parallely to form the resultant S=1, and the electronic orbital angular momentum is zero]