NENG 452

Home assignment # 7 **Due: May 02, 2014**

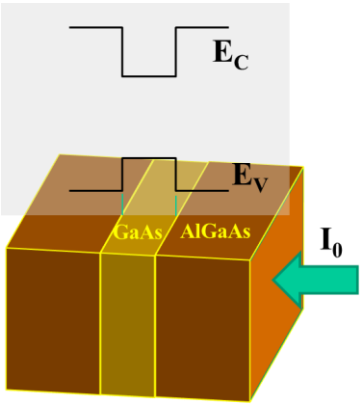
1. A heterostructure with a 6 nm thick GaAs quantum well (QW) as shown in the Figure is doped to have electron concentration of 10^{11} cm^{-2} in the QW at room temperature. The sample is illuminated with infrared light (wavelength 0.78 μm, QW absorption coefficient $\alpha=10^{4}$ cm^{-1}) with intensity $I_0=100$ W/cm^2, and there is no absorption in AlGaAs barriers and no reflection.

(a) Find the position of the Fermi level (in eV) with respect to the edge of first conduction subband in equilibrium (no illumination),

(b) Find the optical power (in W/cm^2) absorbed by the sample.

(c) Find the carrier lifetime if the conductance of the sample is increased by 5% under illumination. (Photoconductivity experiment).

(d) Find separation between quasi-Fermi levels (in eV) under illumination.



Consider infinitely tall barriers.
Bulk GaAs parameters: $E_G=1.43$ eV, $m_e^*=0.067\ m_0$, $m_{hh}^*=0.5\ m_0$, $\mu_e=6000$ cm^2/Vs, $\mu_h=400$ cm^2/Vs.

2. The saturation magnetization of iron is 1.75×10^{6} A/m. Show that this corresponds to 2.22 Bohr magnetons per Fe atom. Density of iron is 7.87 g/cm^3.

3. The susceptibility of $FeCl_2$ obeys the Curie–Weiss law over the temperature range 90 K to room temperature, with $T_C=48$K. Its molar susceptibility at room temperature is 1.475×10^{-2} emu/Oe/(g mol).

(a) What is the effective magnetic moment in Bohr magnetons?

(b) What are the spin-only values of J and μ_H (max)?

(c) At an applied field of 8000 Oe, what is the value of the molecular field at 0^0C and at 100 ^{0}C?

4. 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-states. [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].