HW #3
Due October 2 (Thursday) in class

1. Problem 9.6 in Chuang.

2. Consider an optical transition from E_a to E_b in a 10-nm wide GaAs single quantum well. Here, E_a and E_b are related by an optical transition (i.e., they have the same k). Use the following effective masses: $m_e^* = 0.067m_0$ and $m_h^* = 0.5m_0$. The bandgap energy of GaAs is 1.42 eV. Use infinite potential well for the calculation. Use the valence band edge as the reference for all energies (i.e., $E_V = 0$ eV).
   a. Find E_a and E_b as functions of the photon energy, $\hbar\omega$.
   b. Derive the Fermi-Dirac distribution for electrons in the first conduction subband with a quasi-Fermi level of F_C, $f_C(E_b(\hbar\omega))$, as a function of $\hbar\omega$.
   c. Similarly, derive the Fermi-Dirac distribution for electrons in the first valance subband with a quasi-Fermi level of F_V, $f_V(E_a(\hbar\omega))$, as a function of $\hbar\omega$.
   d. Calculate and plot optical gain spectra for the GaAs quantum well for photon energy from 1.4 eV to 2 eV at T = 300 K. Plot the spectra for two quasi Fermi level separations: ΔF = 1.5 and 1.8 eV. (Again, use your numeric program for calculation and plotting)
   e. Calculate and plot the spontaneous emission spectra for the GaAs quantum well for photon energy from 1.4 eV to 2 eV at T = 300 K. Plot the spectra for two quasi Fermi level separations: ΔF = 1.5 and 1.8 eV. (Again, use your numeric program for calculation and plotting)