HW 9 due 11/27/2017

1) Compute the ionization potential for five-times ionized carbon C^{5+} and also compute the wavelength of the transition from *n*=3 to *n*=2 for that species. (5 points) (Hints: consider equations (3.9) and (3.13) in Laser Fundamentals)

2) Consider a laser system with a gain coefficient γ=0.015 cm^{-1}. Assume that a beam with intensity of 1pW/cm^2 is injected into a F-P cavity immediately in front of the rear mirror. The cavity is 50 cm long and has no additional input besides the beam. Furthermore, assuming that there is no saturation (i.e. small signal).
a) If both mirrors have power reflectivity =100%, find the beam intensity at the rear mirror after six passes of the cavity.
b) If the front mirror (output coupler) reflectivity is 80% while maintaining the rear mirror reflectivity at 100%, find the beam intensity at the rear mirror after six passes of the cavity.
c) Assuming the beam intensity can be added up at the front mirror, what is the output intensity at the front mirror? (10 points)

3) Consider a transition of 5000Å with a width of 1Å, a cavity of 2 cm^3 in volume and let n=1.

a) Convert this wavelength interval (1Å) to frequency units (i.e. GHz and cm^{-1}).
b) How many electromagnetic modes exist in this frequency band for this cavity?
c) Suppose that the cavity were in the form of a cylinder with a cross-sectional area of 0.1 cm^2 (and thus is 20 cm long). How many $TEM_{0,0,q}$ cavity modes would fit within the frequency band specified by this 1 Å? (Do not forget the 2 polarizations.)
d) Combine the results of b) and c) to estimate the probability of a spontaneous photon appearing in one of the polarized $TEM_{0,0,q}$ modes.
e) If the A coefficient for this transition is 10^{7} sec^{-1}, what is the stimulated emission cross section? (20 points)

4) Problem 13.3-3 (page 530 of the text book) (10 points) (Note: Book does not include degeneracy, i.e. $g_1=g_2=1$. Probability density can be discrete and there are only two freq. in this problem. Read example 13.3-1 on page 509.) (Problem 12.2-1, page 459 of the 1st Ed.)

Extra Credit

5) Derive the LG mode solution from the paraxial wave equation with separation of variable. (20 points)