University of California, Berkeley
EE 236
Fall 2004

Homework set 9
Due Friday, November 12

1) Assume that you have an atomic population in a lossless cavity (perfectly reflecting walls). The atoms have an upper state with and energy E_2 and a lower energy state with an energy E_1. The spontaneous lifetime of the upper state is τ_2 and it is dominated by the transition to state 1. The population of the upper state is maintained at N_2, and the population of the lower state is maintained at N_1 by some process (both populations given in number/volume). Assume that the electromagnetic modes which interact with these atoms come into steady state (not necessarily thermal equilibrium, because of the process maintaining the population). Find the electromagnetic energy density, for all of the modes which are interacting more strongly with this pair of states than they are with anything else in the cavity. What happens when N_2 approaches N_1?

2) The Einstein A and B coefficients change for an atom in a narrow cavity, one in which the 3-D blackbody radiation approximations fail. For a very narrow cavity between two perfect conductors, find the new relationships between the A and B coefficients.

3) Find the Doppler linewidth for a He-Ne laser at a temperature of 600 C, keeping in mind that the Ne atoms provide the gain? (He-Ne is briefly described in section 10.5). Is this homogeneous or inhomogeneous broadening?

Reading: Chapters 9, 10.5