Lasers 168; HW #2; Due Thurs 9/3

1. Consider a 3-level atomic system, with energy levels at 0.0eV (level 0), 2.0eV (level 1), and 3.0eV (level 2). The spontaneous emission rate from 2->1 is 10^8 Hz, the spontaneous emission rate from 2->0 is 3 10^8 Hz, and the spontaneous emission rate from 1->0 is 5 10^8 Hz. There is a pump that takes atoms from 0->2 at a rate of 10^{20} atoms per second per cm^3. The total density of atoms is 10^{15} atoms per cm^3.

A) What is the lifetime of the upper state (2)?

B) Write the rate equation for the population of each of the three 3 states.

C) Solve your equations at steady-state; in other words, find the steady-state value of the population density in each state.

D) Is there a population inversion? If so, what wavelength will lase?

2) Continuing the above problem, after being at steady-state, the pump suddenly shuts off at time t=0. Find an expression that will tell you the density of each state at any time t>0.

3) Find both the full-width-half-maximum of the linewidth and the maximum value of the lineshape $g(\nu)$ for the states (1) and (2) in Problem #1. Assume lifetime broadening.

4) A typical Helium-Neon laser is filled with 90% He and 10% Ne; the combined pressure is about 1 Torr (1/760 atm). Assume the gas laser operates at a temperature of about 400 K.

A) Given that it is the Neon atoms that lase (at 632.8nm), what is the expected full-width-half-maximum of the linewidth?

B) What is the maximum value of the lineshape $g(\nu)$?