Phys 532/822 Final Exam 9:00am - Noon, May 13

Instructions:

This is an in-class, open-books & notes exam that must be completed during the allowed 3 hour period.

The exam consist of 4 problems, each worth 10 points. For all problems, partial credit will be given, so be sure to show your work and explain your reasoning when appropriate.

1. Suppose an argon ion laser is oscillating at a wavelength of 488 nm. It has a 1-m long cavity filled with gas that supports a Gaussian mode with an approximately uniform beam area of 5×10^{-6} m^2. The output coupler transmission is 5%, and additional losses amount to 3% per round trip. The laser transition has a spontaneous emission time of 7×10^{-9} s and a homogeneously broadened linewidth $\Delta\nu = 3$ GHz. If the laser's output power is 200 mW, what is the *saturated* gain coefficient γ for the medium?

2. Suppose a uniaxial electro-optic material has nonzero EO coefficients $r_{13} = r_{41} = r_{43}$. Design a phase modulator using this material: draw a clear picture showing a possible orientation of the x, y, and z crystal axes, the orientation of the light polarization, and the direction of the applied electric field.

3. Is it possible to use the d_{11}, d_{22}, or d_{33} nonlinear optical coefficients for second harmonic generation in a critically phase matched uniaxial crystal? For each element, if you think the answer is no, explain the problem. If you think the answer is yes, draw a sketch showing an example setup. (The sketch should show the crystal axes and the polarization of all the beams involved.)

4. Consider a uniaxial medium having anomalous dispersion, so that $dn/d\omega < 0$. If it has indices of refraction $n_o(\omega) = 2.0, n_e(\omega) = 2.5$ and $n_o(2\omega) = 1.9, n_e(2\omega) = 2.3$, what is the phase matching angle for second harmonic generation?