Class 1

1. Derive de degeneracy factor for the third order nonlinear polarization (slide 29)
2. Using the SVEA (Slowly-Varying Envelope Approximation), derive coupled mode equations given in slide 34. What is a criterion to apply SVEA?
3. Demonstrate conservation of photon flux in a third-order parametric process.
4. Using un-depleted approximation, calculate the phase-sensitive parametric gain in a degenerate Four-Wave Mixing process.
5. Explain physically what “phase matching condition” means. Give both a classical and a quantum interpretation.
6. Reproduce the Modulation Instability gain spectrum for the dispersion parameters given in slide 54.

Class 2

7. For Brillouin scattering, derive the phase-matching condition for forward and backward scattering. Explain why forward Brillouin scattering has been referred to as Raman-like scattering.
8. Considering the dispersion relation for the axial-radial and torsional-radial modes in a silica nanowire (slide 45), what are the expected frequency-shifts of the scattered light for both backward and forward scattering?
9. Why is the moving-boundary perturbation much smaller for torsional-radial modes as compared to axial-radial modes?
10. The well-defined peaks in the Brillouin spectrum arise from the nanowire. Where do the scattering “bands” come from?
11. In the case where the photo-elastic effect contribution to the total scattering is zero (slide 63), does that mean the strain no longer perturbs the refractive index? If not, then how come to total contribution is zero?