# Physics 47 — Fall 2017

Problem Set 4
Due Wed, Oct 11, 2017
(before start of class)

## Textbook Problems

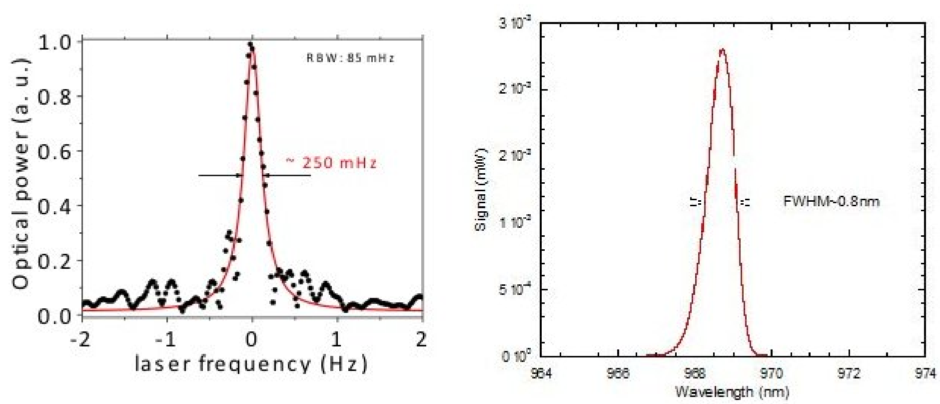
1. Hecht 7.15 [4 pts.]
   This one should be somewhat familiar to you from the microwave lab you've just finished.

2. Hecht 7.36 [6 pts.]
   In class I did a derivation of an expression for the group velocity assuming you know the index of refraction as a function of frequency, $n(\omega)$. In this problem you'll derive a related expression that is useful in the (common) case that all you have is an empirical model of the index as a function of wavelength instead. (For example, see problems 3.62-3.66 in Hecht about the Cauchy and Sellmeier equations, which we didn't have time to cover.)

3. Hecht 7.39 [6 pts.]
   This is a short exercise to help you develop some sense of the physical meaning of the dispersion relation for a plasma.

4. Hecht 7.48 [8 pts.]
   This is an exercise to determine the Fourier sine and cosine coefficients for a function that isn't completely trivial (but also not too hard).

## Additional Problems




a) NIST clock laser

b)VCSEL for OCT imaging

A1. [6 pts.] – Different laser systems can be engineered to have very different coherence properties for different applications. One laser used for state-of-the-art atomic clock experiments at NIST has a central wavelength of 578 nm and a *frequency* bandwidth of 0.25 Hz FWHM (below left). Vertical cavity surface emitting laser diodes (VCSELs) are sometimes used for an imaging technique called optical coherence tomography (OCT). The plot below to the right shows the spectrum of one such device, with a central wavelength of 969 nm, and its *wavelength* bandwidth is 0.8 nm FWHM. Calculate the coherence lengths of both of these lasers. For comparison, the helium-neon lasers you'll find in the optics labs typically have a coherence length of about 100 cm.