Chemistry 620
Analytical Spectroscopy
PROBLEM SET 6: Due 03/27/08

1. Use graph paper or computer to sketch the spectra of the interferograms depicted in Figure 8.2 of *Chi*. Label and briefly explain your graph.

2. Write the Fourier transform of $\cos(\omega_0 t)\sin(\omega_0 t)$.

3. Explain why narrow pulses in one domain correspond to broad spectra in the domain of the conjugate variable.

4. Explain the relevance of the sinc function to spectral measurements. In other words, explain how baseline oscillations described by sinc waves occur in experimental spectra.

5. In the first week of class we saw that the frequency dependence of the refractive index of a dielectric is a complex quantity approximated by

$$n_{real} = D(\omega) = 1 + \frac{Ne^2}{m_e} \cdot \frac{\left(\omega_0^2 - \omega^2\right)}{\left(\left(\omega_0^2 - \omega^2\right)^2 + 4\gamma^2\omega^2\right)}$$

$$n_{imag} = A(\omega) = \frac{Ne^2}{m_e} \cdot \frac{2\gamma}{\left(\left(\omega_0^2 - \omega^2\right)^2 + 4\gamma^2\omega^2\right)}$$

   Revisit the derivation of these expressions, identify their inverse Fourier transforms and use them to explain what these expressions say about what happens to the electrons when radiation of frequency ω is launched into a dielectric.

6. In *Chi*, it says "All measurements don't end up being improved by Fourier transformation ..." List and discuss the reasons that more than 90% of the infrared absorption spectrometers sold in the world are Fourier transform instruments, but 90% of the UV/VIS absorbance spectrometers are dispersive.

7. Derive expressions that show that the Fourier transform of a unit impulse pulse train (period T) is also a unit impulse pulse train. Compute the pulse spacing in the frequency domain.

8. Use library functions and convolution ideas to predict the transform of a rectangular pulse train with the period and amplitude of the square wave in Figure 8.6.