**Chemistry 620**
**Analytical Spectroscopy**
**PROBLEM SET 7: Due 04/10/08,**
**Provisional answers reviewed if submitted by email before 04/08/08**

1. Predict the Fourier transform of the following signal if the sampling frequency is 250 Hz and the acquisition period is 200 sec –

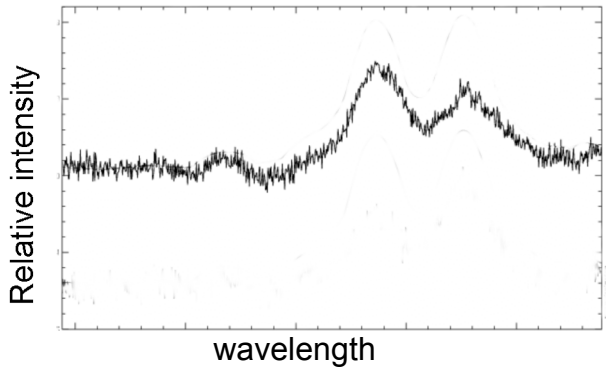
   $f(t) = 5\exp(-t/4)\cos(50\pi t)+4\exp(-t/16)\cos(100\pi t)$

2. Sketch the spectrum you would expect to observe if a signal comprised of three oscillations were being sampled at a rate more than two times the frequency of the fastest component but the acquisition time was so short that the amplitude of the slowest oscillation stayed high. Describe how you would correct this problem and what sketch the corrected spectrum.

3. A spectrum has resonances at 25, 50, 75 and 125 Hz. The relative amplitudes of the resonances are 1:2:1:5. How many points do you estimate the time domain sequence should have in order to measure all the components accurately? How long is the interval between acquisitions. Predict the spectrum that would be observed if the interferogram were sampled at 200 Hz. What is the Nyquist frequency at this rate?

4. Use a computer to calculate the entire discrete convolution of the following pair of sequences, but list which sums contribute to each term of the convolution in a table.
   f(t) = [0 0.05 0.10 0.15 0.20 0.15 0.10 0.05 0]; h(t) = [0 0 0 1 1 1 0 0 0];
   h(k-1) = [0 0 0 1 1 1 0 0 0]; f(5:13) = [0 0.05 0.10 0.15 0.20 0.15 0.10 0.05 0];

5. Chi describes what happens when a signal is improperly filtered. Use similar concepts to predict and compare the results of using rectangular and Gaussian frequency domain filters of similar widths to filter a noisy spectrum, such as the one shown below. It is important that you draw the noisy spectrum and realize that a spectrum can have a forward transform in which the frequency content of the spectrum is measured.




6. Write an expression for the variance of an absorbance measurement. In other words identify which types of noise distort a typical absorbance measurement. How will this expression change for samples that have very small absorbances?

7. Summarize the basics of using source modulation for signal enhancement and explain what distinguishes it from using a lock-in amplifier to enhance the signal.

8. Construct a table that shows the size of the signal and noise in spectra that consist of 1, 10 and 100 equal height bands dispersed across 100 detector elements if they were distorted by shot and flicker noise, respectively. Use these expressions to compute the enhancement if each spectrum/noise combination were measured using a multichannel detector.