Spectral Analysis
ELEC 532
Assignment 3

Due: Wednesday 16 February 2000

1. Derive the general formula for the expected value of an averaged, data-windowed, lag-windowed periodogram. Derive an approximate formula for the variance of this periodogram. Explain each term.

Do the following exercises with your group and turn in one set of plots per group.
Save trees — use subplots and overlays!

2. **More Peridograms of "Steven Kay's Test Data"**

   (a) Compute lag-windowed periodograms of Steven Kay's real test sequence $x[n]$ using Bartlett windows of total lengths $M = 7$ (the length suggested by Blackman and Tukey), $15, 23, 33, 63$. Use the `hold` command to place all five plots on the same set of axes.

   Comment on your results compared to your basic and data windowed periodograms from Assignment 4.

   Hint: Check your ACF estimator with a square-window input sequence.

   (b) What change would you need to make to your program and your interpretation of the plots if a Hamming window were used as a lag window?

   (c) Does the averaged periodogram seem a reasonable tool for this signal? Why or why not?

3. **Steven Kay's Test Data + White Noise**

   No observation noise was present in the previous problem. Repeat Problem 2 with the new signal

$$y[n] \;=\; x[n] \;+\; v[n],$$

where $v[n]$ is an independent white Gaussian process of variance $\sigma_v^2 = 4$. Plot several (20–50[1]) realizations of the PSD estimates on the same plot, and also compute and display an approximate ensemble average and variance. Use subplots to save paper, and try to plot all curves on the same vertical scale.

Comment on your results.

4. With your study group, compute periodograms of one or more of the real world data sets from the class Web page. Try basic, data windowed, and lag windowed periodograms. On an appropriate signal, try the averaged periodogram. Comment on your results and relate them to what we have learned in class. (The sunspot signal looks particularly interesting.)

5. With your study group, discuss and synthesize the major *themes* of this week of lectures. Turn in a one page summary of your discussion. You need turn in only one summary, but include the names of all group members. Please do not write up just a "table of contents."

[1] The more overlapped realizations you plot, the longer your plot will take to print.