The objectives for this assignment are:

1. to develop some system identification skills,
2. to build some experience using MATLAB and ID Toolbox.

You may work together in groups to complete the assignment, but you must hand in your own assignment solution. **If you work with a group, please identify the people that you worked with on your solution**. Computer printout may be included with your solution as an appendix, but please do not provide these as your entire solution report.

---

1. You have been asked to fit a discrete model to two different data sets. (The data is available on the course web page in the Matlab data file "che572_assn5q1_2012.mat). The first set of data (ya, ua) was collected using step tests and the second data set (yb, ub) was collected using a PRBS test. The process engineers believe the model has the ARX form:

$$y_t = \frac{(b_0 + b_1 z^{-1})z^{-2}}{1 + a_1 z^{-1} + a_2 z^{-2}}\, u_t + \frac{1}{1 + a_1 z^{-1} + a_2 z^{-2}}\, \epsilon_t, \qquad \epsilon_t \in N(0, \sigma_\epsilon^2)$$

   Using the provided data, please do / answer each of the following:

   a) Using the step test data (ya, ua) estimate the model parameters, the variance of the prediction errors, and the covariance matrix of the model parameters.

   b) Using the PRBS test data (yb, ub) estimate the model parameters, the variance of the prediction errors, and the covariance matrix of the model parameters.

   c) The actual process model is

$$y_t = \frac{(1 - 0.25 z^{-1})z^{-2}}{1 - 0.9 z^{-1} + 0.2 z^{-2}}\, u_t + \frac{1}{1 - 0.9 z^{-1} + 0.2 z^{-2}}\, \epsilon_t, \qquad \epsilon_t \in N(0, 1)$$

      Which plant test (step or PRBS) gave you the better parameter estimates? Explain your answer in terms of the parameter estimates and their covariance matrices, and so forth.

   d) How would you improve you plant tests? **Explain**.

   e) Are your two models and the actual process model stable? **Explain**.

2. Figures 1 through 5 give the results of a Time Series Analysis for some plant data. From the given plots, answer each of the following:

   a) Is the output data stationary? **Explain**.

   b) Estimate the process order *(i.e.*, the dead time, number of poles and zeros).

   c) Estimate the order of the noise model *(i.e.*, the order of the auto-regressive, integrating and moving average terms).

   d) Using your estimates of the order of both parts of the model, write the general form of the complete model.

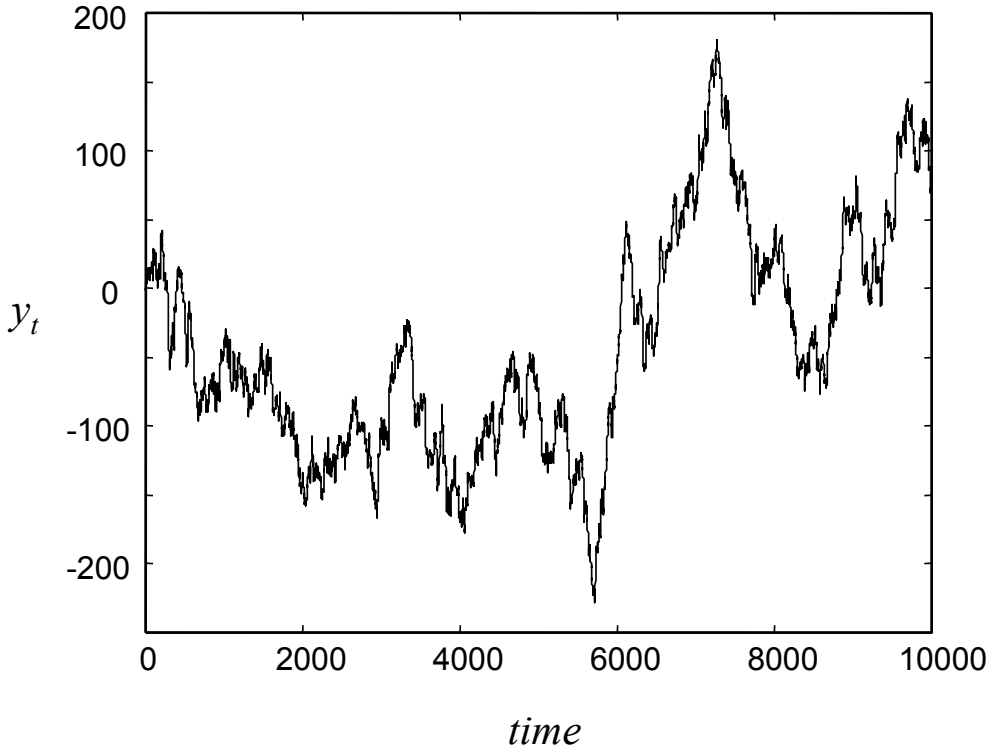

Figure 1: Output Variable Time Series (deviation form).

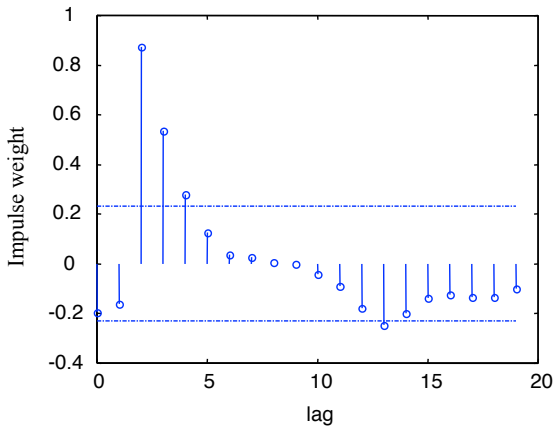

Figure 2: Estimated Impulse Weights (using Matlab's CRA Function on once differenced data).

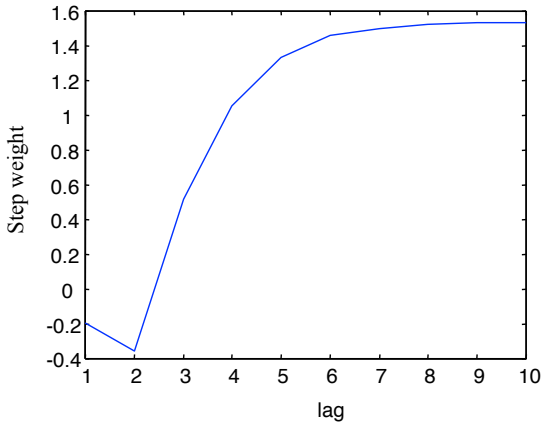

Figure 3: Estimated Step Weights.

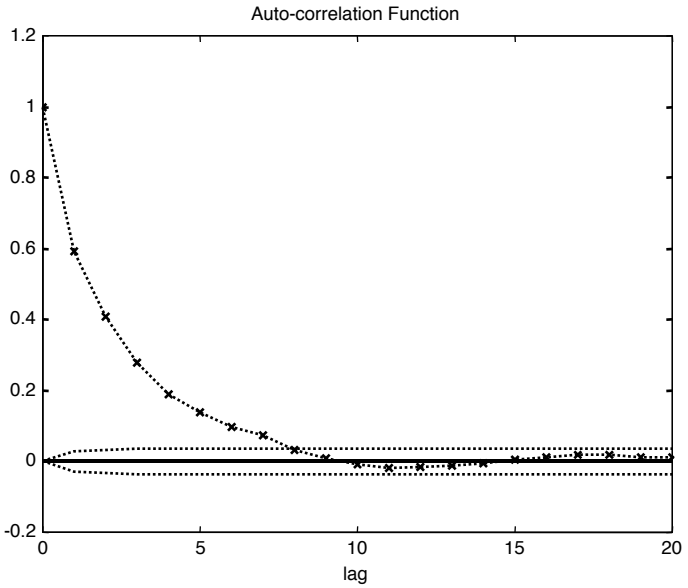

Figure 4: Estimated Auto-correlation Function (using once differenced data).

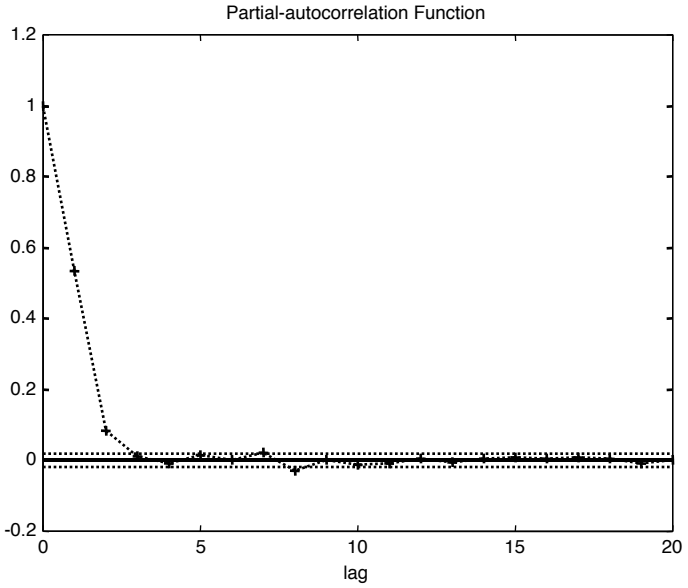

Figure 5: Estimated Partial Auto-correlation Function (using once differenced data).