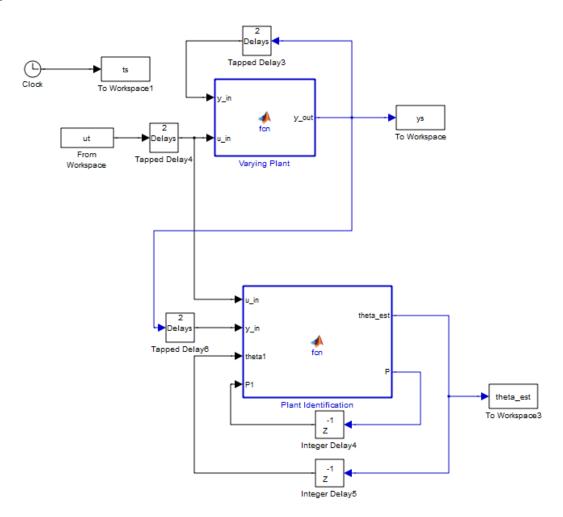# ECE-420: Discrete-Time Control Systems
Project Part C

In this part of the project you will implement a recursive least-squares algorithm with a forgetting factor in Simulink using the Matlab embedded system toolbox. You should start with the Simulink file **plant_identification.mdl** (save the file before you edit it!). You need to implement a recursive least squares algorithm for plant identification. Your final system should look something like that shown below.

You need to run this Simulink model from the Matlab driver file **plant_identification_driver.m** you used in your homework, and show that your results are the same (identical for Matlab and Simulink) for at least three different forgetting factors and the two plants from homework 5 (problem 1 and problem 3).

Some things to note:

- all of the variable dimensions in the plant identification routine should be a function of **Nbp**,

- you will need some code like the following in your plant identification block to initialize the algorithms

```
%
%  persistent variables remain in memory
%
persistent initial_flag;% is this the first time through the
algorithm
persistent tol;          % tolerance for resetting P

% initialize the covariance (P) matrix

  if isempty(initial_flag)
    initial_flag = 1;
    tol = 1e-3;
    P1 = eye(5,5);
  end;
```

Mathematical Background: Consider a simple discrete-time transfer function with input $R(z)$ and output $Y(z)$,

$$G_p(z) = \frac{Y(z)}{U(z)} = \frac{b_0 + b_1 z^{-1} + b_2 z^{-2}}{1 + a_1 z^{-1} + a_2 z^{-2}}$$

Cross multiplying we get

$$Y(z) + a_1 z^{-1} Y(z) + a_2 z^{-2} Y(z) = b_0 U(z) + b_1 z^{-1} U(z) + b_2 z^{-2} U(z)$$

In the time-domain this becomes

$$y(n) = -a_1 y(n-1) - a_2 y(n-2) + b_0 u(n) + b_1 u(n-1) + b_2 u(n-2)$$

Defining

$$\phi^T(n) = \begin{bmatrix} y(n-1) & y(n-2) & u(n) & u(n-1) & u(n-2) \end{bmatrix}$$
$$\theta^T = \begin{bmatrix} -a_1 & -a_2 & b_0 & b_1 & b_2 \end{bmatrix}$$

we can write

$$y(n) = \phi^T(n)\,\theta$$

The output of your system identification should be called **theta_est**, to match the Matlab plotting program.

To turn in: write a short memo including your graphs (with captions and figure numbers), and any suggestions you may have for improving this part of the project. E-mail me your memo and both your Matlab and Simulink.