ECE-420: Discrete-Time Control Systems
# Project Part D State: Putting it all together

Due: *By 5 PM on Friday November 14th (e-mail me a memo **and** your modified Simulink model)*

In this part of the project you will combine all of the pieces you have constructed to make an adaptive closed loop systemYou will need to download the project files from the class website for this. This project was written for Matlab R2012b with a 64 bit operating system. You should start the Simulink files you have used before and the Matlab driver **plant_identification_driver_closedloop.m.** This file assumes your Simulink file is called **projectD_state.slx.**

The file **projectD_state.slx** should look lie the following when you are done:
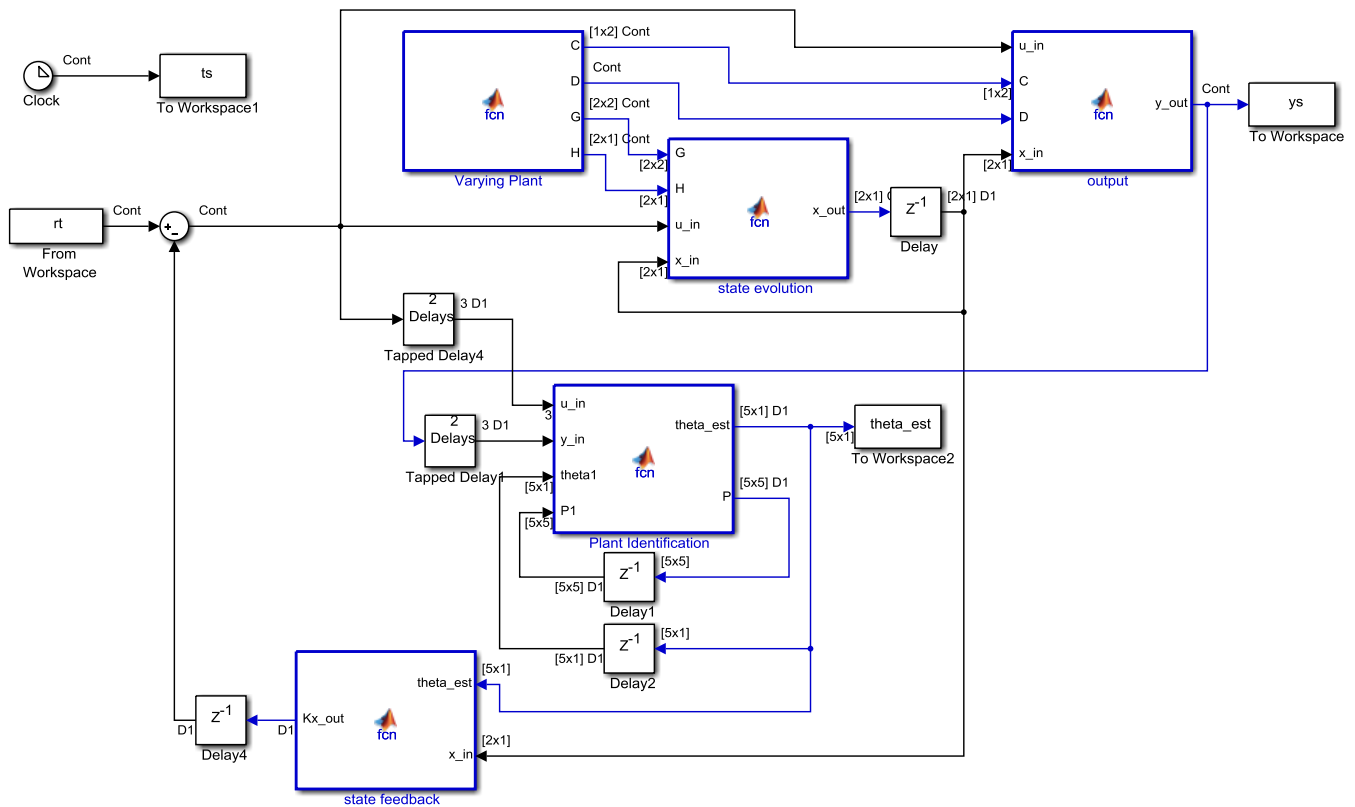
Note that your state feedback block now needs to use the computed parameter estimates to determine the correct feedback gains. You will need to include code like the following to go from the transfer function coefficient estimates to a state variable model in controllable canonical form:

```
%
%   get the estimates of G and H
%
    a1 = -theta_est(1);
    a2 = -theta_est(2);
```
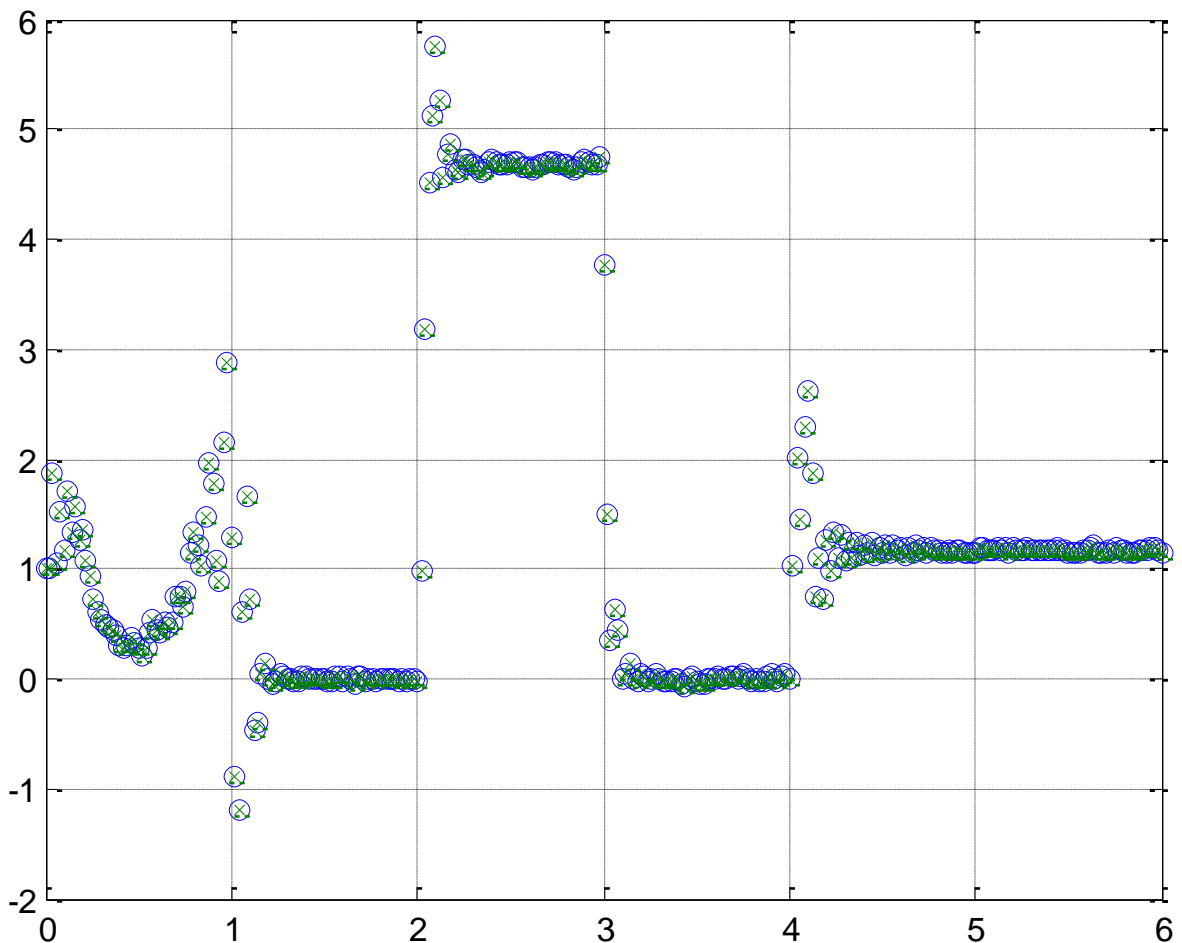
```
    b0 = theta_est(3);
    b1 = theta_est(4);
    b2 = theta_est(5);
%
    G = [0 1; -a2 -a1];
    H = [0; 1];
    C = [(b2-a2*b0) (b1-a1*b0)];
    D = b0;
```

If your Matlab and Simulink are running correctly, the output should look like the following:

At this point you should be elated that you got all of this to work, and disappointed that this is a pretty poor control system—the output is not following the input. This can be fixed by including an integrator in our system or adaptively changing the prefilter gain, which is easier and we will do that next.

You need to modify your **state feedback** block so your Simulink file looks like the following:
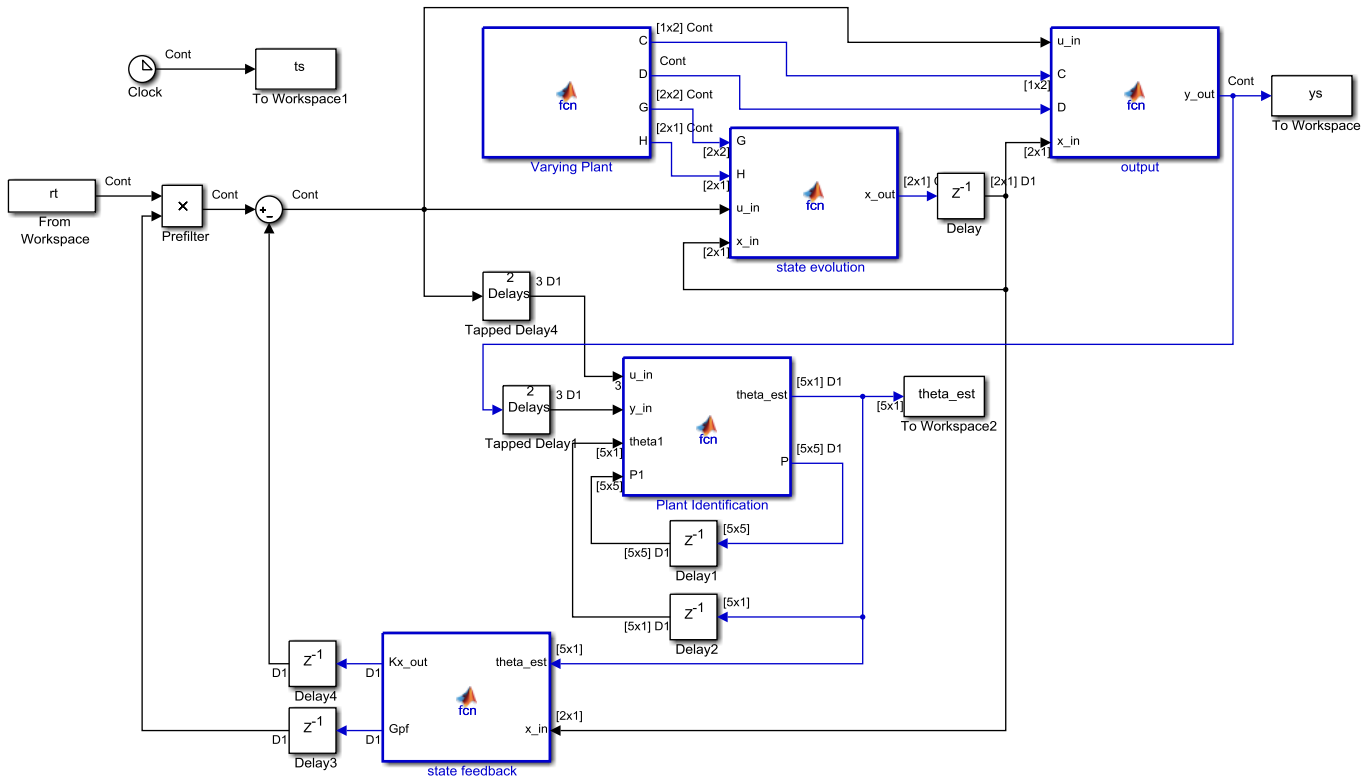
To determine the prefilter gain use the following (or something like it):

```
%
%   determine the prefilter gain
%
  DD = (C-D*K)*pinv(eye(2,2)-G+H*K,0.001)*H+D;
  Gpf = 1/DD;
  if (isnan(Gpf) ) Gpf = 1.0; end;
  if (abs(Gpf) > 1.0) Gpf = sign(Gpf)*1.0; end;
```

Note that the maximum gain has been set to 1, and we set the gain to 1 as a default. This is just a reasonable guess for this system after running a few simulations. Save your new Simulink file as **projectE_state.slx** and use the Matlab driver file **plant_identification_driver_closedloop_Gpf.m.** You should get the result like that on the following page. Note that the output does not behave as well as we would like in the interval [0,1], but it does ok after that. Note also that the poles have changed from previous files and that we have set lambda to 0.95. We could mess around with this for a long time to get better results, but this is enough for now!