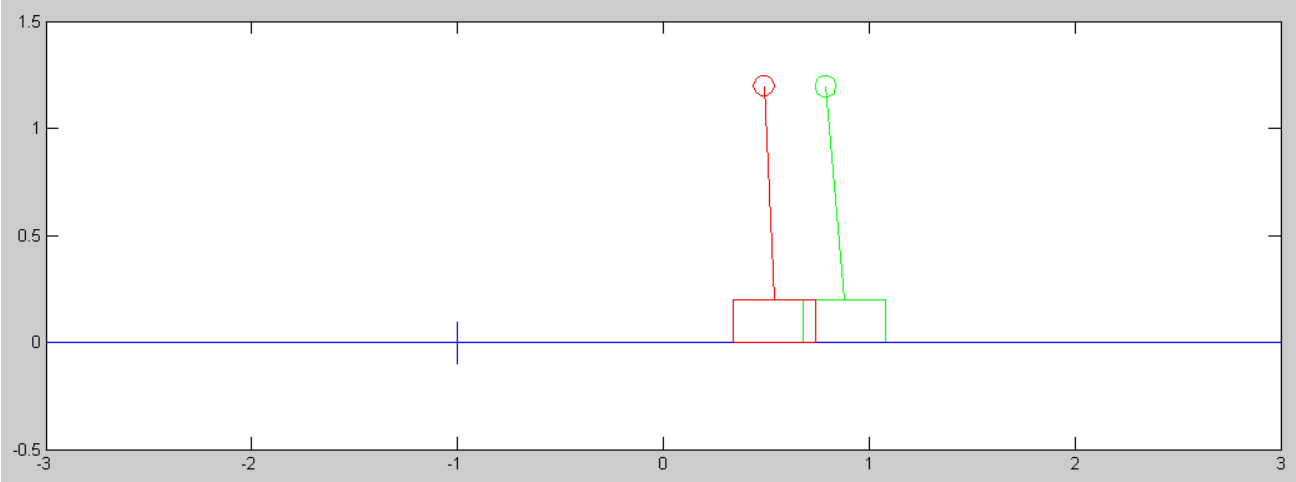
ECE 463: Homework #7

Linear Observers. Due Monday March 23rd



Cart and Pendulum from homework #4 with a state estimator (green)

Use the dynamics for the cart and pendulum from homework set #4

1) Design a full-state feedback control law of the form

$$U = F = K_r R - K_x X$$

so that the closed-loop system has

- A 2% settling time of 6 seconds, and
- 10% overshoot for a step input.

Plot the step response of the linarized system in Matlab.

2) Assume you can only measure the cart position as well as beam angle.

2a) Design a full-order observer to estimate all four states so that the observer is 2-5 times faster than the plant. You may use either cart position or beam angle (or both) as measurements.

2b) Give the state-space model of the closde loop system using the actual states:

$$U = F = K_r R - K_x X$$

and plot the step response with initial conditions of

$X(0) = [0, 0, 0, 0]'$ $\quad$ $X_{observer}(0) = [0.1, 0.1, 0.1, 0.1]'$

(note: use the function step3)

2c) Give the state-space model of the closed loop system using the state estimates:

$$U = K_r R - K_x X_{observer}$$

and plot the step response with initial conditions of

$X(0) = [0, 0, 0, 0]'$ $\quad$ $X_{observer}(0) = [0.1, 0.1, 0.1, 0.1]'$

3) Modify the cart and pendulum system to include

- your control law, and
- A full-order observer

using only cart position and/or beam angle

Find the step response when U is defined as

$$U = K_r R - K_x X$$

and

$$U = K_r R - K_x X_{observer}$$

with intial conditions of

$X(0) = [0, 0, 0, 0]'$ $\quad$ $X_{observer}(0) = [0.1, 0.1, 0.1, 0.1]'$