ME 531 Problem Set 3
Fall 2014 • Due November 24

Problem 3.1: Use Matlab to design two full-state feedback controllers for the double-piston problem shown on the next page. These controllers should attempt to bring the two pistons to arbitrary positions (and hold them there) as

(1) a critically-damped system, with eigenvalues of −7 for the first controller; and
(2) **a maximum steady-state error of 5% of *x_in*** on the position of either bar for the second controller when the input is *x_in* = $[^1/_2;\ ^5/_6]$ (an equilibrium point under constant pull from the applied force

Your code should use only standard Matlab commands (i.e., not any of the control-system functions listed in the textbook).

Turn in:
(a) Your code, with comments describing what it does;
(b) The system matrices that you identified, including any modifications you had to make to the system; and
(c) Plots showing the system response from zero initial conditions to input *x_in* = $[^1/_2;\ ^5/_6]$.

Problem 3.2: Use Matlab to design a integral full-state feedback controller for the double-piston problem shown below. This controller should bring the two pistons to arbitrary positions and hold them there with **no steady state error for** *x_in* = $[^1/_2;\ ^5/_6]$, and eigenvalues of −7.

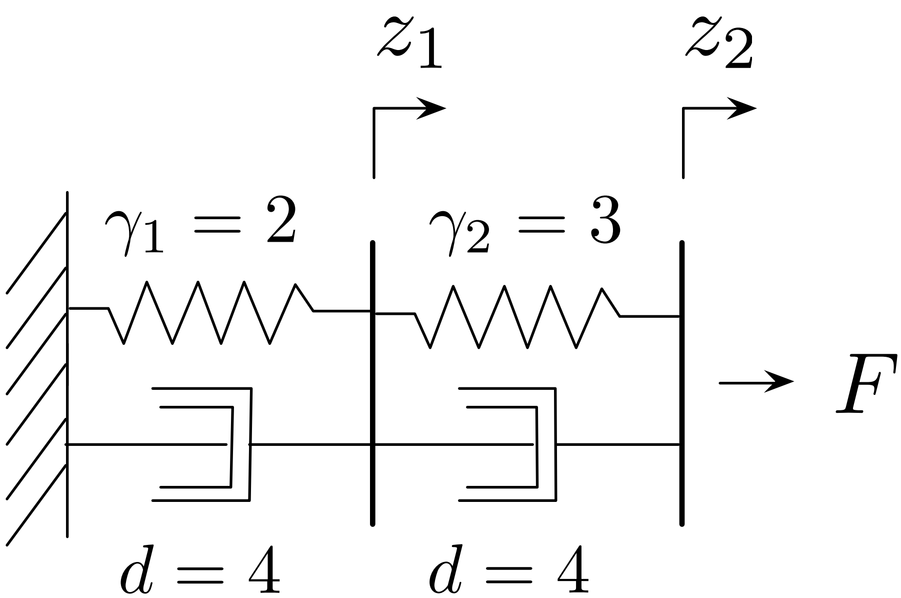
Your code should use only standard Matlab commands (i.e., not any of the control-system functions listed in the textbook).

Turn in the same information as asked for in Problem 3.1

Problem 3.3: Design an observer for this system that can estimate the full state of the system from measurements of only the absolute position of the end of the second piston. This observer's estimated state should converge on the actual state with eigenvalues of −70(1±i).

Your code should use only standard Matlab commands (i.e., not any of the control-system functions listed in the textbook).

Turn in:
(a) Your code, with comments describing what it does;
(b) The system matrices that you identified, including any modifications you had to make to the system;
(c) A plot showing the state estimate for a constant state *x* = $[^1/_2;\ ^5/_6]$ and initial condition on the observer of *x_hat = [0;0]*; and
(d) A plot showing the system response from zero initial conditions to input *x_in = x_in* = $[^1/_2;\ ^5/_6]$, with *x_hat(0) = [2;0]*, where you use your observer to provide a state estimate for your controller from 3.1. Comment on how response differs from 3.1(c), and include appropriately-zoomed plots to illustrate the difference.


z_1
z_2
$\gamma_1 = 2$
$\gamma_2 = 3$
F
$d = 4$
$d = 4$