MECH 7710 January 15, 2015
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MECH 7710 Homework Assignment #0
(This should all be a review)

1. A control law for a simple rotation table is to be designed. The table has a rotational moment of inertia (J) of 10 kg-m^2 and rotational damping (b) of 1 N-m-s/rad. Torque is commanded to the motor and the table's position is measured using a rotary encoder.
    a) Derive the simple differential equation for the system
    b) Convert the system into a state-space format
    c) What are the eigenvalues of the system

2. Design an observer for the above system
    a) Show that the system is observable
    b) Design L such that the estimator with: ω_n=50 Hz and ζ=0.7
    c) Provide a plot of the step response of the estimator

3. Design a state-feedback controller for the table
    a) Show that the system is controllable
    b) Design Design K such that the estimator with: ω_n=10 Hz and ζ=0.7
    c) Provide a plot of the step response of the combined controller and estimator

4. Solve for the equivalent compensator for the system.
    a) What kind of classical compensator does it resemble
    b) Calculate the closed-loop transfer function
    c) Provide Bode and Nyquist plots for the closed-loop system
    d) What can you say about the "robustness" of the compensator

5. Design the controller in the discrete domain assuming a 1 kHz sample rate.
    a) Discretize the state space model. Where are the eigenvalues?
    b) Design the L to provide the same response as problem #2
    c) Design K to provide the same response as #3
    d) Simulate the control system
    e) Where are the closed loop estimator and controller poles located
    f) Solve for the equivalent compensator transfer function

6. Write "code" to implement the controller in software. Simulate your system and provide the results using the "coded" equations.
    a) Use the discrete estimator and controller
    b) Use the equivalent discrete compensator