Due W 10/22

1. Show the region where a dominant pole-pair should be placed to meet the step response criteria $t_r \leq \frac{1}{3}$sec, $t_s \leq 1$sec, $P.O. \leq 15\%$, and $e_{ss} \leq 1\%$.

2. Design a state-space controller for the pendulum that will meet the step response criteria provided above at the two equilibria $((0,0,0)$, $(\frac{\pi}{2},0,mgl))$. Assume our motor can provide a peak input torque of 2Nm. Test your controller (both continuous-time and discrete-time versions through simulation) on the nonlinear system remembering that the linearization process changes the variables to $\Delta u = u - u_o$, $\Delta y = y - y_o$ and $\Delta\overrightarrow{x} = \overrightarrow{x} - \overrightarrow{x}_o$, so you'll have to include the operating point in your controller. Try a reference signal of $\Delta r = r - r_o = 0.2$rad. Is your system controllable? Do your controllers meet all the specifications? Include supporting information, figures, pole locations, responses, control algorithm, etc.

3. Design a state-space controller for the magnetic-ball-suspension system that will meet the criteria provided above at the equilibria $(0.5m, 0m/s, -2.215A, -2.215V)$. Assume our voltage supply can provide a peak input voltage of 24V. Test your controller (both continuous-time and discrete-time versions through simulation) on the nonlinear system remembering that the linearization process changes the variables to $\Delta u = u - u_o$, $\Delta y = y - y_o$ and $\Delta\overrightarrow{x} = \overrightarrow{x} - \overrightarrow{x}_o$, so you'll have to include the operating point in your controller. Try a reference signal of $\Delta r = r - r_o = -0.02$m. Is your system controllable? Does your controller meet all the specifications? Include supporting information, figures, pole locations, responses, control algorithm, etc.

4. Find a reference (paper, web site or book) that describes a levitating ball apparatus used in a control experiment. Turn in a copy of it and identify the key components (controller, actuator and sensor) and mathematical model if presented.

5. Do you have any ideas of how to build a levitating ball apparatus? What would you use for the controller, actuator and sensor?