Due Tu 10/20

1. For the purpose of sketching a root-locus, the transfer function of a PID-controller can be written as

$$C_{PID}(s) = \frac{k_D s^2 + k_P s + k_I}{s} = \frac{k_D(s^2 + \frac{k_P}{k_D}s + \frac{k_I}{k_D})}{s} = \frac{k_D(s - z_1)(s - z_2)}{s}$$

   where z_1, z_2 are zeros introduced into the open-loop transfer function by the controller as is a pole at the origin.

   (a) Solve for the gains k_P, k_I, k_D in terms of the zeros z_1, z_2.

   (b) Solve for the zeros z_1, z_2 in terms of the gains k_P, k_I, k_D.

   (c) What are the numeric values of the zeros z_1, z_2 that correspond to the gains you used for the pendulum and magnetic-ball in the last homework?

2. Using the PID-controller gains from your last homework and k_D as the parameter to be varied, sketch the root-locus for the pendulum linearized about $\theta = 0$rad. Use the guidelines discussed in class to sketch by hand and then plot with Matlab. Note the closed-loop poles and zeros that correspond to your gains and comment on how they relate to the system's response you observed in the last homework.

3. Using the PID-controller gains from your last homework and k_D as the parameter to be varied, sketch the root-locus for the pendulum linearized about $\theta = \frac{\pi}{2}$rad. Use the guidelines discussed in class to sketch by hand and then plot with Matlab. Note the closed-loop poles and zeros that correspond to your gains and comment on how they relate to the system's response you observed in the last homework.

4. Using the PID-controller gains from your last homework and k_D as the parameter to be varied, sketch the root-locus for the magnetic-ball linearized about $y = 0.5$m. Use the guidelines discussed in class to sketch by hand and then plot with Matlab. Note the closed-loop poles and zeros that correspond to your gains and comment on how they relate to the system's response you observed in the last homework.