MECH 3140 Homework #10

1. Design a motor ***position*** controller using voltage as an input. The velocity step response (to a one volt input) has a time constant of 0.2 seconds and a steady state velocity of 100 rad/sec. The sensor can be modeled using a first order model with a bandwidth of 2 Hz (and DC gain of 1). Design the controller to settle in less than 2 seconds and have less than 5% overshoot.
    a. Sketch the Root Locus (w/ the controller)
    b. What type of controller did you choose?
    c. Where are your open loop roots? Where are your closed loop roots?

2. Assume we are trying to control the position of a motor using a current input. Sketch the Root Locus and give the control TF and control law for the following controllers. State if the controller will work.
    a. P
    b. PD (to achieve a Bandwidth of 5 Hz with a damping ratio of 0.707)
    c. PID
    d. Lead
    e. Lead + Lag (Pick a Lag with a Bandwith of 1 Hz)
    f. Pure integral control

3. Develop a Current Controller for the motor used in HW#3 (L=0.02 mH, R=0.117 Ohm). Treat the motor back EMF as a disturbance. Develop a PI controller such that the maximum overshoot is less than 5%. Use Root Locus.
    a. Why use a PI controller?
    b. What is the maximum achievable bandwidth?
    c. Is this bandwidth acceptable for current controlling a motor? Why?
    d. If needed how could you get a higher Bandwidth?
    e. What are the Controller Gains?

4. Develop a Speed Controller for the motor used in HW#3 (neglect the motor inductance and any gearing).

5. Rework HW#8 Problems (including the Matlab problems) using Root Locus Techniques

OGATA Problems

A-10-4 through A-10-7
A-10-10 through A-10-15