

MECH 3140 Homework #9

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 Bandwidth 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