

# ECE 763

## Homework #9

### Problems:

1. Pressure feedback is to be used to stabilize the pump-controlled, linear hydraulic actuator discussed in the previous two homeworks. The pressure feedback term is given as follows:

$$\phi = \phi_o - KP_L .$$

- (a) Derive the transfer function  $X_p(s)/\Phi_o(s)$  for the no load case (and no coulomb friction).
  - (b) What value of  $K$  will give two equal and real poles for the transfer function (in addition to the pole at zero)?
  - (c) How has pressure feedback changed the response?
2. A feedforward control voltage is to be generated for the U12M4T motor to provide a load torque of 30 nt-m at a constant speed of 0.5 rad/sec.
    - (a) Compute the value for the feedforward voltage for the conditions given.
    - (b) Repeat the problem for the case that the load is to be accelerated at 3 rad/sec<sup>2</sup>. (Assume the load inertia and damping are small in comparison with those for the motor.) Which term is the most significant in computing the voltage in this case? Least significant?

Use the following values for the parameters of the motor:

$$\begin{aligned} K_\tau &= 0.101 \text{ n}\cdot\text{m}/\text{amp} \\ K_b &= 0.101 \text{ V}\cdot\text{sec}/\text{rad} \\ B &= 3.03 \times 10^{-4} \text{ n}\cdot\text{m}\cdot\text{sec}/\text{rad} \\ J &= 2.33 \times 10^{-4} \text{ n}\cdot\text{m}\cdot\text{sec}^2/\text{rad} \\ n &= 102 \\ R &= 0.75 \text{ ohms} \\ L &= 0 \text{ }\mu\text{h} \\ \tau_f &= 4.24 \times 10^{-2} \text{ n}\cdot\text{m} \end{aligned}$$

3. Speed control of an unloaded U12M4T motor is to be implemented:

$$V = K_1(\dot{\theta}_d - \dot{\theta}).$$

where  $V$  is the motor input voltage,  $\dot{\theta}_d$  and  $\dot{\theta}$  are the desired and actual speed, respectively, and  $K_1$  is the gain for proportional control. Note the values for the motor parameters from problem #2. (Ignore  $\tau_f$ .) What must the gain  $K_1$  be to obtain a time constant of 10 ms. for a step of desired rate?