

ECE 763

Homework #8

Problems:

1. Derive the state equations for the pump-controlled, linear hydraulic actuator:

$$\dot{\mathbf{x}} = A\mathbf{x} + Bu . \tag{1}$$

Use the following state variables:

$$\mathbf{x} = [x_p \ \dot{x}_p \ P_L]^T . \tag{2}$$

Using the equations and values for the actuator parameters as given in the previous homework, determine explicit values for the matrix A and vector B. Note: you may assume $F_L = F_f = 0$.

2. For Parts(a) and (c), give results for integration step sizes of 0.25 ms, 0.5 ms and 1.0 ms (all in tabular form).
 - (a) For zero initial conditions for the actuator in the previous problem, what will the approximate piston pressure be at 1 ms for a 5° swashplate angle?
 - (b) What is the rate of change of pressure at $t = 0$ for the 5° step of swashplate angle?
 - (c) What is the acceleration of the piston at 1 ms (for the 5° step of swashplate angle) if 100 lbs. of force must be applied before the piston moves?
Note: consider this as the coulomb friction, F_f .
 - (d) From the numbers in Part(a) for a 0.25 ms integration interval, give a simple and approximate expression for \dot{P}_L during the 1 ms time interval (as a function of P_L and ϕ). What is the approximate time constant for the pressure response ? (Note the expression for \dot{P}_L and its relationship with P_L .)