ECE 763
Homework #8

Problems:

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

\[ \dot{x} = Ax + Bu \ . \]  

Use the following state variables:

\[ x = [x_p \ \dot{x}_p \ P_L]^T \ . \]  

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 \( \phi \)). What is the approximate time constant for the pressure response? (Note the expression for \( P_L \) and its relationship with \( P_L \).)