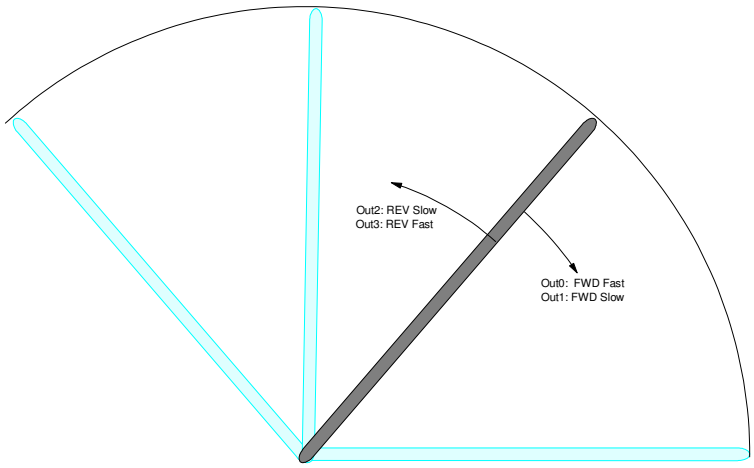
Homework #3: ECE 461 / 661

Structured Text, 1st and 2nd Order Approximations. Due Monday, September 13th
(will accept PLC code any time before December 1st so you can use the Micro810 PLC's)

Windshield Wiper (take 2)

Write a structured text (Pascal) program to control a windshield wiper



Outputs:

- Out0: Forward
- Out1: Reverse
- Out2: Fast (1) or Slow (0)
- Out3: Wiper Fluid On (1) and off (0)

Inputs:

- In0: Stop (all outputs off)
- In1: Intermittant
- In2: Slow
- In3: Fast
- In4: Clean Windshield

Problem 1-4: (Due December 1st)

Problem 1: Write a PLC program to control a windshield wiper in intermittand mode

- When IN0 is pressed, the wipers turn off
- When IN1 is pressed, the wipers start a sequence
  - OUT2 = off (slow)
  - Forward for 2 seconds (OUT0 = 1, OUT1 = 0)
  - Reverse for 2 seconds (OUT0 = 0, OUT1 = 1)
  - Pause for 2 seconds (OUT0 = 0, OUT1 = 0)
  - Repeat

Problem 2: Add Slow mode

- When IN2 is pressed, the wipers start a sequence
  - OUT2 = off (slow)
  - Forward for 2 seconds
  - Reverse for 2 seconds
  - Repeat

Problem 3: Add fast mode

- When IN3 is pressed, the wipers start a sequance
  - OUT2 = on (fast)
  - Forward for 1 seconds
  - Reverse for 1 seconds
  - Repeat

Problem 4: Add a clean mode (assumes wipers were turned off)

- OUT3 remains on while IN4 is pressed (sprays cleaning fluid on the windshield)
- While IN4 is pressed, the wipers go back and forth in the slow mode (2 seconds forward, 2 seconds in reverse, repeat).
- When IN4 is released,
  - The spray turns off (OUT3 = off),
  - The wipers complete 3 more cycles (forward then reverse)
  - Then the wipers turn off

LaPlace Transforms (Due September 13th)

5) Assume X and Y are related by the following transfer function

$$Y = \left(\frac{10(s+3)}{(s+2)(s+5)(s+10)} \right) X$$

a) What is the differential equation relating X and Y?

b) Determine y(t) assuming

$$x(t) = 4\cos(3t) + 5\sin(3t)$$

c) Determine y(t) assuming x(t) is a unit step input

$$x(t) = u(t)$$

6) Assume X and Y are related by the following transfer function:

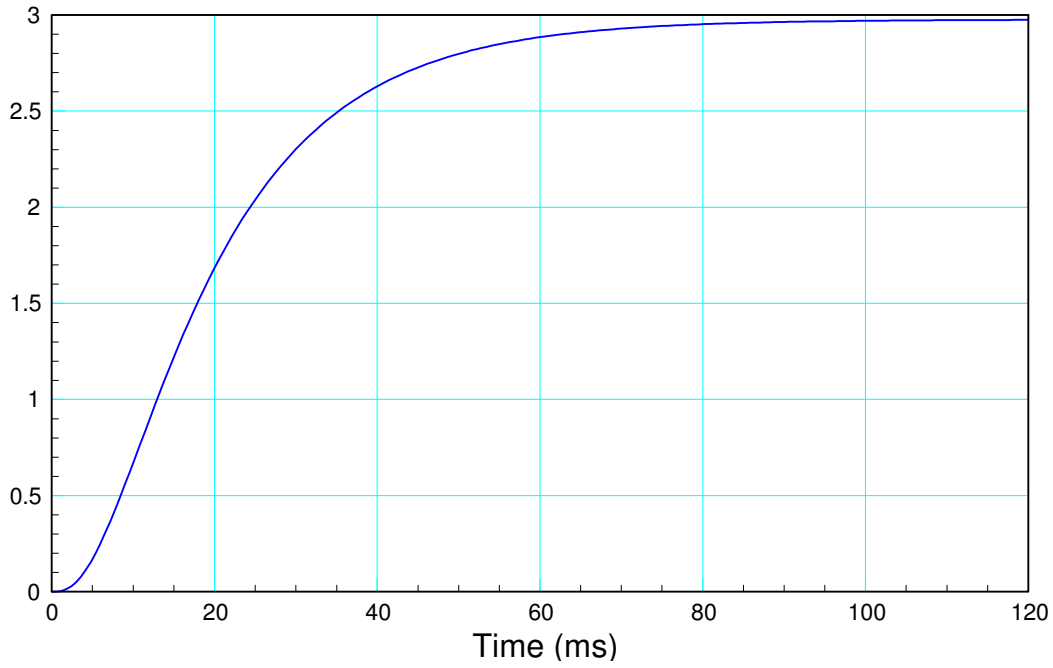
$$Y = \left(\frac{100}{(s+1+j5)(s+1-j5)(s+30)} \right) X$$

a) Use 2nd-order approximations to determine

- The 2% settling time
- The percent overshoot for a step input
- The steady-state output for a step input (x(t) = u(t))

b) Check your answers using the 3rd order model and Matlab, Simulink, of VisSim (your pick)

7) Determine the transfer function for a system with the following step response:



8) Determine the transfer function for a system with the following step response: