Homework #9: ECE 461/661

PLC Structured Text, Delays, z-Transform, s-to-z conversion

Structured Text

1) (20pt) Take your PLC program from homework #8 and convert it to a Pascal (structured text) program.

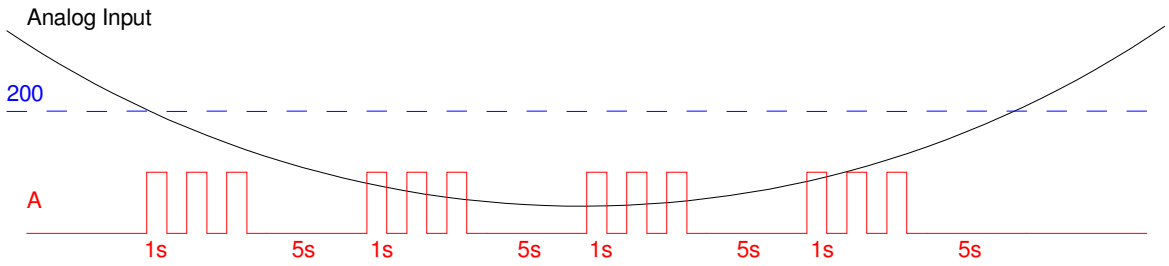
- If using PLC fiddle, just write the program. PLC Fiddle doesn't support Pascal programs

Irrigation System with an Analog Input:

- If the analog input is more than 200, nothing happens. Soil mosture is high enough.
- If the analog input is less than 200, the soil is too dry. Irrigation A turns on (1s on, 1s off three times)
- It then waits for five seconds.
- If the analog input is still less than 200, the process repeats.

For the analog input

- If using a Micro-810, use the analog inputs (0 = 0V, 1000 = 10V)
- If using PLC-Fiddle, use a number input.



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Systems with Delays:

Assume a 250ms delay is added to G(s):

$$G(s) = \left(\frac{2}{(s+1)(s+3)(s+7)(s+10)} \right) \cdot e^{-0.25s}$$

2) Design a PI compensator which results in 20% overshoot for the step response. For this K(s),

- Find the error constant, Kp
- Find the closed-loop poles
- Plot the step response of the closed-loop system

Unstable Systems

Assume an unstable system

$$G(s) = \left(\frac{2}{(s-1)(s+3)(s+7)(s+10)} \right)$$

3) Design a PI compensator which results in 20% overshoot for the step response. For this K(s),

- Find the error constant, Kp
- Find the closed-loop poles
- Plot the step response of the closed-loop system

z-Transforms

4) Assume X and Y are related by the following transfer function with a sampling rate of 10ms (T = 0.01)

$$Y = \left(\frac{0.05(z+0.8)}{(z-0.96)(z-0.9)} \right) X$$

a) Find the difference equation relating X and Y

b) Find y(t) assuming

$$x(t) = 2 + 3\sin(4t)$$

c) Find y(t) assuming

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

s-to-z Conversion

5) Find the discrete-time equivalent to G(s). Assume a sampling rate of 10ms (T = 0.01)

$$G(s) = \left(\frac{70(s+2)}{(s+1)(s+5)(s+20)} \right)$$

6) Find the discrete-time equivalent to G(s). Assume a sampling rate of 10ms (T = 0.01)

$$G(s) = \left(\frac{70(s-1)}{s(s+5+j20)(s+5-j20)} \right)$$