Process Control, 3P4 Your name: _____

Tutorial 8 - Friday Student number: _____

This tutorial provides some practice for the next midterm, and makes sure you understand some concepts from this week's classes.

Question 1

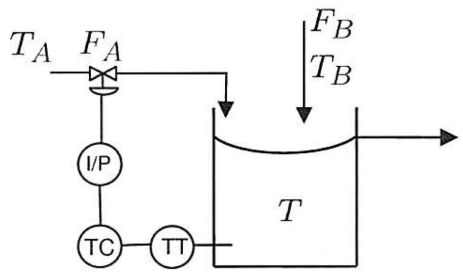
Calculate the controller tuning settings (K_c, T_I, T_D) for a PID controller that controls a process approximated by the following transfer function, $G_p = \dfrac{6e^{-12s}}{13s+1}$. Assume the controller is required to perform set point changes and disturbance rejection equally well.

Demonstrate mathematically that the final value of the controlled variable for a step change of 2 units in the set point will be offset free.

Over ...

From a previous midterm; this question is also in the next assignment.

In the process below it is desired to control the temperature of the fluid within the tank by manipulating the flow rate F_A. The temperature of stream B, T_B is expected to fluctuate. T_A and F_B, and the liquid volume in the tank are assumed constant.



An energy balance on the tank gives: $T'(s) = \dfrac{18}{2s+1}F'_A(s) + \dfrac{0.6}{2s+1}T'_B(s)$

where F_A is in L/min, T and T_B are in Kelvin, and the time constant is in minutes. The true tank temperature is not what is recorded by the sensor. In fact, the measured temperature, $T_m = 0.15T$, where T_m is a signal value in milliamps, mA.

It is this measured signal, in mA, that is used to feed back and send to the controller, `TC`. The controller has to send a signal to the valve to open or close it. It does this by sending a signal, in mA, to the valve. This signal travels at least 1000 m across the plant network to reach the valve, which is why an electrical signal is preferred.

At the valve is an I/P transducer (search the internet for what this term means), which converts the signal to a pressure, in psig. If the I/P transducer receives a 4mA signal, it creates a 3 psig output. If it receives a 20 mA signal, it provides a 20 psig output. This pressure counteracts a spring in the valve to open or close it. The 4mA and 20mA are the lowest and highest signals possible, corresponding to the valve being fully shut and open, respectively. All other valve positions are linearly between these points.

Finally, the pressure output causes the valve to slowly open or close (i.e. it is not instantly opened or closed). When the pressure is suddenly increased by 2mA, we notice that the response in the flow rate, F_A, is a first order output, with a final value of 1 L/min higher, taking about 0.5 minutes to completely reach this increased flow.

Use the above information and draw a block diagram of all the systems described here, clearly showing the manipulated variable, disturbance, and show blocks for the temperature sensor, I/P transducer and valve. Show all units on the lines connecting the blocks.