ChE-381: Process Dynamics and Control
Simulation Session 6

Problem statement

Consider the three noninteracting tanks in series shown in Figure 1 with feedback control.

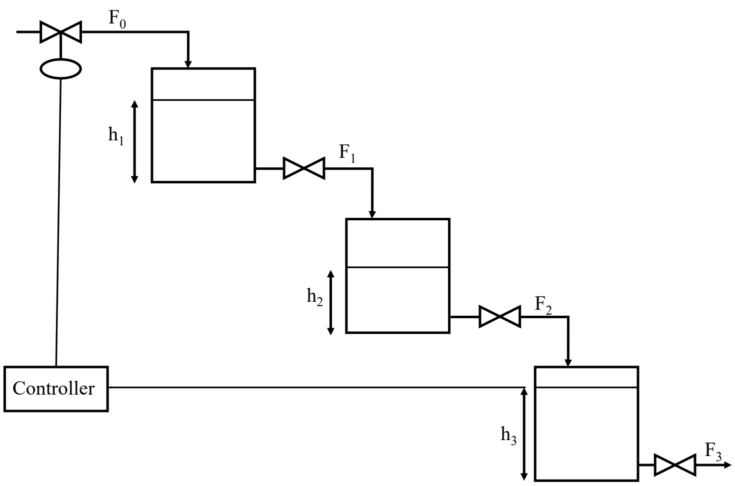

Figure 1. Three non-interacting tanks in series with feedback controller.

A linear model for the liquid level h_i of each tank will take the form:

$$A_1 \frac{dh_1}{dt} = F_0 - c_1 h_1$$

$$A_2 \frac{dh_2}{dt} = c_1 h_1 - c_2 h_2$$

$$A_3 \frac{dh_3}{dt} = c_2 h_2 - c_3 h_3$$

where A_i and c_i represent the cross-section area and the outlet valve discharge constant for each tank. Defining deviation variables and taking Laplace transform, we get:

$$H_3'(s) = \frac{K}{(\tau_1 s + 1)(\tau_2 s + 1)(\tau_3 s + 1)} F_0'(s)$$

We observe that h_3 is measured and F_0 is adjusted by the controller. Assume that $K = 6, \tau_1 = 2, \tau_2 = 4$, and $\tau_3 = 6$.

a) Tune PI controller using the following methods: robust response time, Skogestad IMC, and Zeigler-Nichols step response. Compute your performance metric used in lab 5 for the tuned PI controller. Which method performs the best in terms of performance metrics?
b) Tune PI controller obtained using Skogestad IMC and Zeigler-Nichols further to reduce your performance metric while ensuring the poles of closed loop transfer function remains sufficiently in the left half plane.
c) Show the response plot with the PI controller obtained in (b) and PID parameters obtained in the previous lab in the **same figure.** Ensure that the figure is well labeled, and legend is clear.

Submit a zipped folder containing a .txt file containing the solution of parts (a) and (b), and the simulink file for part (c). Name the folder as your roll number.