

CPN321: T5 First and second order systems

2019

1 Mixing system

Consider the mixing system analysed in T3 (remember that a simulation is available on the GitHub repository).

1. Find transfer functions relating the flow rate of A and the heights of each tank. Remember you will have to use deviation variables, Laplace transform and manipulate the equations to have the output on the left hand side of the equation.
2. Write the transfer functions in gain and time constant form.
3. Use these transfer functions to replicate the figures in the notebook showing the step response of each transfer function.

2 Second order relationships

Derive expressions for the following response characteristics of the underdamped second-order system:

- The time to the first peak t_p
- The fraction overshoot
- The decay ratio
- The settling time t_s . Can a *single* expression be used for t_s over the full range of ζ , $0 < \zeta < 1$?

3 TClab

Execute a step change in the first heater output. Record the output using the tclab historian and subsequently produce a graph showing your best estimate of a first order and second order system response fitted to the measured values of temperature 1. Which of the responses is more like the one you observe?