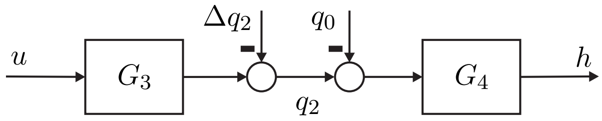
Exercise Sheet 14: Control Architectures

Problem 28:

We consider a different *one-tank* system that has the same structure as the one-tank system in Problem 18 except for an additional disturbance that can act on the inflow of the tank. The block diagram of this tank system is shown in the following figure, where q_2 is the inflow, Δq_2 is the inflow disturbance and q_0 is the outflow of the tank. The transfer functions are $G_3(s) = \dfrac{K_3}{1 + sT_3}$ and $G_4(s) = \dfrac{1}{A_4 s}$ ($A_4 = .5\,\mathrm{m}^2$, $T_3 = 3\,\mathrm{sec}$ and $K_3 = 0.03\,\mathrm{m}^3/\mathrm{sec}/\mathrm{V}$).



1. We assume that the inflow q_2 is measurable. Sketch the block diagram of a cascade control of the tank system. The inner loop is supposed to control the inflow q_2, while the outer loop should control the water level h of the tank.
2. Perform the controller design for the inner loop using pole placement. It is desired to achieve closed-loop poles at $s = -1\,\mathrm{rad/sec}$ and zero steady-state error for disturbance steps of Δq_2
3. Design a controller for the outer loop using Youla parametrization. Assume that the inner loop is designed as in **b.** Again, we want closed-loop poles at $s = -1\,\mathrm{rad/sec}$ and zero steady-state error for reference tracking
4. Explain why the controller designed in **c.** does not have an integrator. What do you expect for disturbance steps of q_0?
5. Simulate the disturbance step response for a disturbance step of $\Delta q_2 = 0.01\,\mathrm{m}^3/\mathrm{sec}$
6. Simulate the reference step response for a reference step of $r = 30\,\mathrm{cm}$
7. Simulate the disturbance step response for a disturbance step of $q_0 = 0.01\,\mathrm{m}^3/\mathrm{sec}$. How can you explain the different result from **e.**?