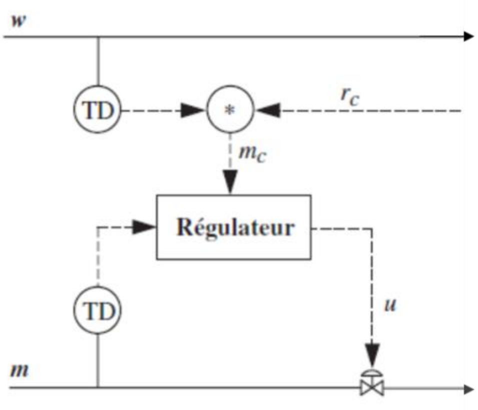
Series 12

Exercise 1

We consider a neutralization process where a flow rate w of acid A must be neutralized with a flow rate m of base B. The two flow rates are measured. If the pHs of both streams are known (constants or measured), a ratio control can be used to adjust bias flow B. However, the pHs of A and B are not precisely known because they are not measured and they vary slightly. On the other hand, the pH is measured at the outlet of the neutralization process. Draw a block diagram of a modification of the ratio command in the following figure which takes into account that the compositions of A and B are not constant.



Exercise 2

We want to use a numerical control for the following dynamic system:

$$K = \frac{2e^{-s}}{5s+1}$$

Calculate the numerical values of the control law $\Delta N_k = \alpha e_k + \beta e_{k-1} + \gamma e_{k-2}$ for P, PI and PID controllers.

Exercise 3

The dynamics of a reaction system is described by the equation

$$V\frac{dx(t)}{dt} = au(t) - kx^{2/3}(t)$$

where x represents the concentration in the reactor, u the feed concentration and where a, k and V are positive constants, $a = 1$ [L/min], $k = 2$ [mol$^{1/3}$ L$^{2/3}$/min], $V = 10$ [l].

a) For the operating point corresponding to $\bar{u} = 4$ [mol/L], determine the transfer function $X(s)/U(s)$.
b) We want to control the variable x by acting on u. Sizing a PID-type digital controller of minimum complexity to guarantee the absence of droop in x.
c) For the controller obtained in point *b)*, does the change in the operating point modifies the static and dynamic properties of the looped system?