UPPLAGA 10/11. ("GAMLA")

3 Feedback Systems

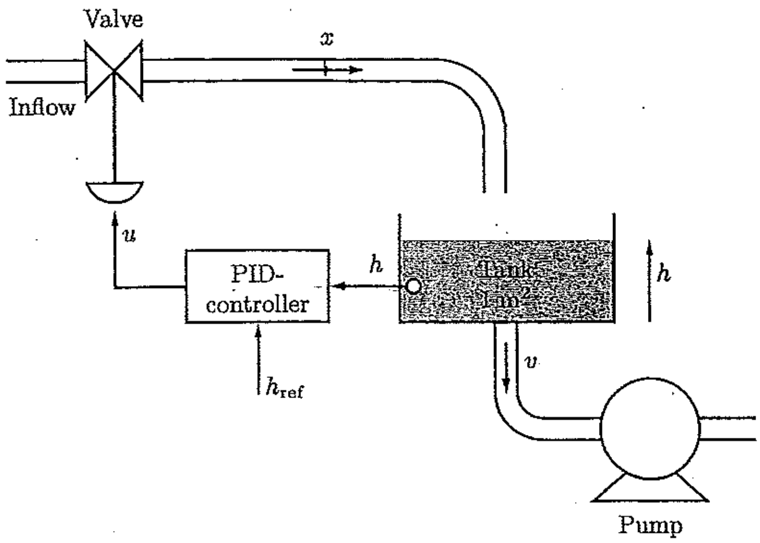

Figure 3.1a.

3.1 A feedback system for level control is shown in Figure 3.1a where all variables denote variations from a working point. The flow to the tank is given by the valve position and the outflow from the tank by the flow $v(t)$ via the pump. The transfer function from valve opening u to the flow x is denoted $G_v(s)$.

a) Determine the important signals of the system and draw a block diagram of the whole system. Use mass balance* to determine a transfer function for the tank.

b) The transfer function of the valve is

$$G_v(s) = \frac{k_v}{1+Ts}.$$

To find k_v and T a unit step change in u has been applied. The step response is shown in Figure 3.1b. Determine the constants k_v and T.

*That the change in tank level is proportional to the difference between inflow and outflow.

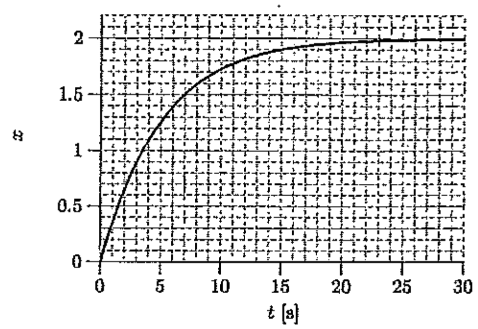

Figure 3.1b.

c) Compute the transfer functions from h_{ref} to h and from v to h and verify that they have the same poles.

d) Assume that we use proportional control, that is, $F(s) = K$. How large gain, K, can we select if we want all poles of the closed loop system to be in the area shown in Figure 3.1c?

e) Assume that a disturbance is introduced in the outflow v in the form of a unit step. How large will the level error due to the disturbance be in steady state with control according to d)?

f) How large will the steady state level error due to the disturbance be with a PI controller?

3.2 Consider the tank system in Problem 3.1.

a) Assume that proportional control with gain $K = 1$ has been selected. Which poles will the closed loop system have?

b) Consider a PD controller

$$u = -K_P h - K_D \frac{dh}{dt}$$

Assume that $K_P = 1$ and calculate a value of K_D so the damping ratio of the closed loop poles will be greater than $1/\sqrt{2}$. This corresponds to the