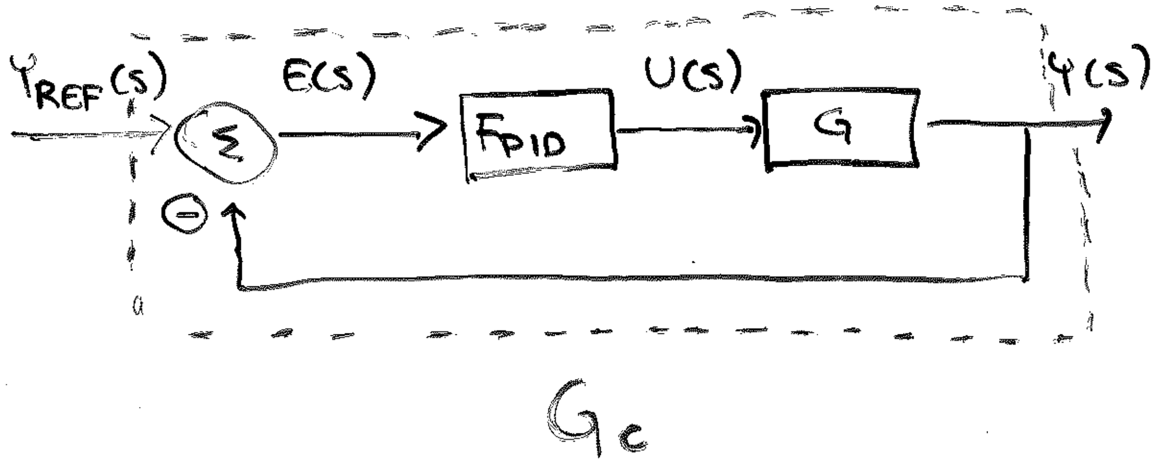
ÖVNING 2: · PID-REGULATORN

UPPGIFTER: 3.25, 3.1

TEORI:

BLOCKSCHEMA:



ÖVERFÖRINGSFUNKTIONER:

G: Processen vi vill reglera $u \to y$

F_{PID}: Regulatorn $e \to u$

G_c: Återkopplade systemet $y_{ref} \to y$

PID-REGULATORN:

I LAPLACE-RYMDEN:

$E(s) \rightarrow U(s)$ där $E(s) = Y_{REF}(s) - Y(s)$

$$U(s) = F_{PID}\, E(s) = \left(K_P + K_I \cdot \frac{1}{s} + K_D \cdot s\right) E(s)$$

Proportionell Integrerande Deriverande

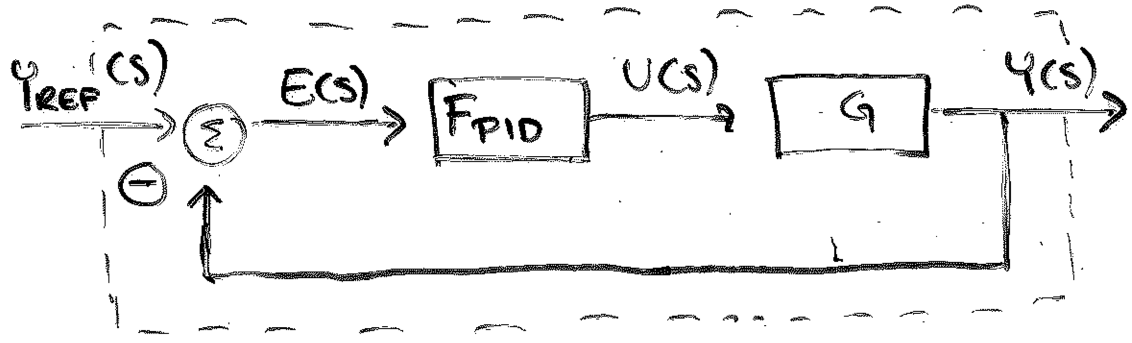
K_P, K_I och K_D är konstanter

I TIDSRYMDEN:

$e(t) \rightarrow u(t)$ där $e(t) = y_{ref}(t) - y(t)$

$$u(t) = K_P\, e(t) + K_I \int_0^t e(\tau)\, d\tau + K_D \frac{d}{dt} e(t)$$

DET ÅTERKOPPLADE SYSTEMET, G_c



G_c

$$Y(s) = \underbrace{\frac{G(s)\,F_{PID}(s)}{1 + G(s)\,F_{PID}(s)}}_{G_c(s)} \cdot Y_{REF}(s)$$

$$\therefore \quad G_c(s) = \frac{G(s)\,F_{PID}(s)}{1 + G(s)\,F_{PID}(s)}$$

PID-REGULATORNS OLIKA DELAR

P-DELEN

- Tittar på nuet
- styrsignalen U(s) är proportionell mot reglerfelet E(s)

Inverkan vid reglering:

- Om K_p är för stort kan man göra systemet instabilt.
- Risk för statiskt fel.

I-DELEN

- Tittar bakåt
- Styrsignalen U(s) är proportionell mot integralen av reglerfelet E(s).

Inverkan vid reglering:

- Eliminerar det statiska felet.
- Risk för svängigt system, kan bli instabilt.

D-DELEN

- Tittar framåt
- styrsignalen U(s) är proportionell mot derivatan av reglerfelet E(s).

Inverkan vid reglering:

- Minskar svängighet.
- Risk för bestående fel p.g.a. introducerat nollställe.
- Mycket känslig för brus i utsignalen Y(s).

3.25 A system is controlled by a PID controller,

$$U(s) = (K_P + K_I \frac{1}{s} + K_D s)E(s)$$

In Figure 3.25a four step responses from a unit step for the parameter triples

$$\begin{array}{llll}
1\ i) & K_P = 1 & K_I = 0 & K_D = 0 \\
2\ ii) & K_P = 1 & K_I = 1 & K_D = 0 \\
3\ iii) & K_P = 1 & K_I = 0 & K_D = 1 \\
4\ iv) & K_P = 1 & K_I = 1 & K_D = 1
\end{array}$$

are shown. Match each one of the parameter triples to one of the step responses. Justify your answer!

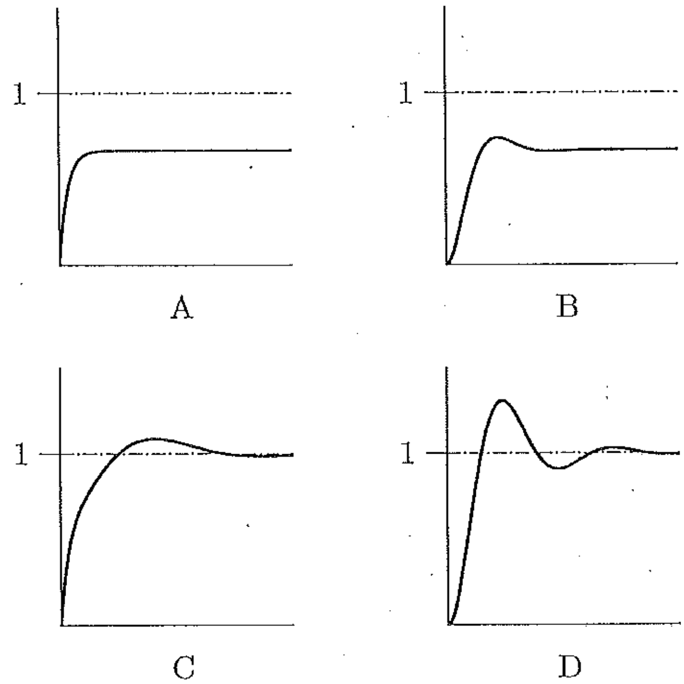


Figure 3.25a. Four step responses. All comparable axes have equal scaling.

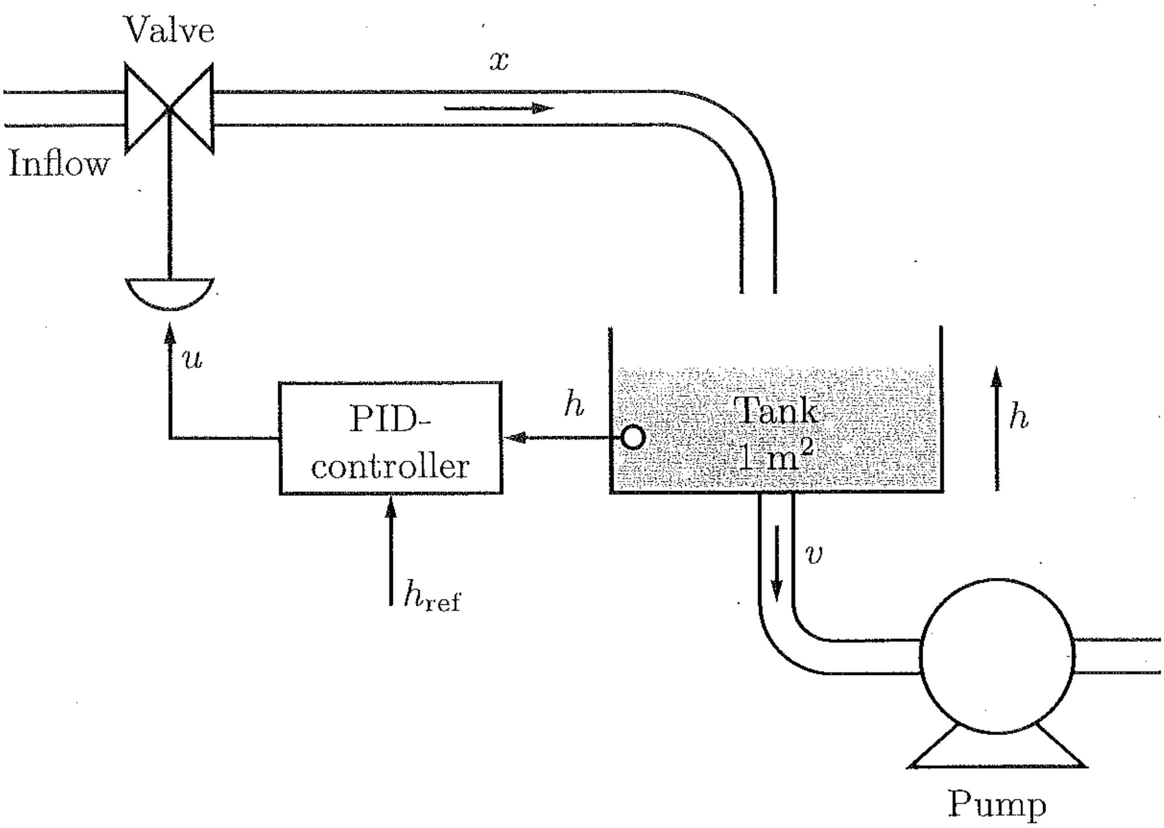


Figure 3.1a

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 $G_{\mathrm{v}}(s)$..

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.

3.1.b

STEGSVAR TILL VENTILEN.

$$X(s) = G_v(s)\,U(s) = \frac{k_v}{1+Ts}\,U(s)$$

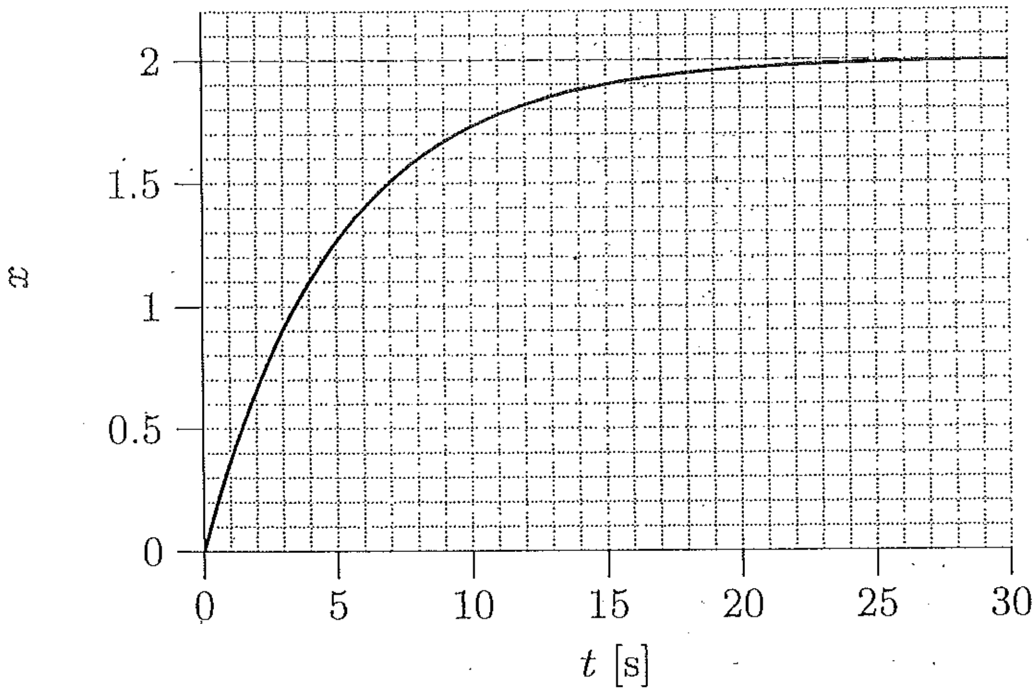


Figure 3.1b.

BESTÄM k_v OCH T.

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?

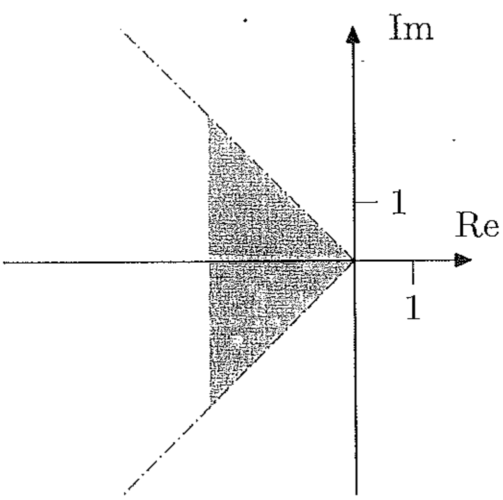


Figure 3.1c

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?