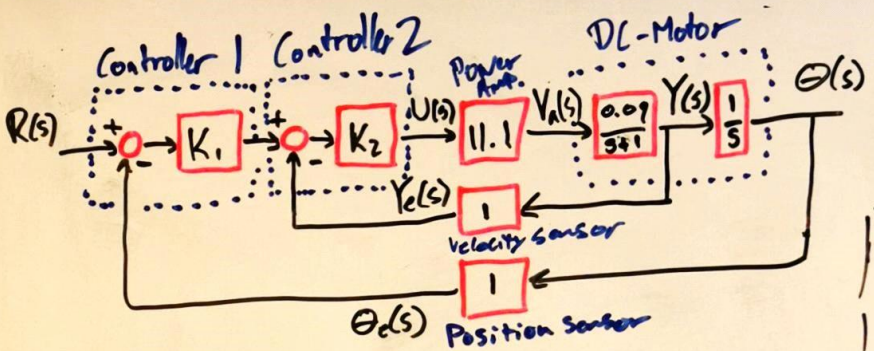
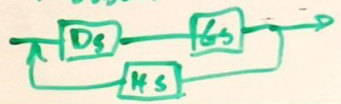
MM2 Ex. 2 – Time domain Analysis



$$\frac{\Theta(s)}{R(s)} = \frac{D(s)G(s)}{1+D(s)G(s)H(s)} = \frac{\text{direct term}}{1+\text{Open loop}}$$

Kan vara Y(s)



Golden formula

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① Step I: Reducer inner loop

$$T_i(s) = \frac{K_2 \frac{1}{1+s}}{1+K_2\frac{1}{1+s}} \Rightarrow \frac{K_2}{s+1+K_2}$$

Step II: Reducer whole system

$$T(s) = \frac{K_1 \cdot \frac{K_2}{s+1+K_2}\cdot\frac{1}{s}}{1+K_1\cdot\frac{K_2}{s+1+K_2}\cdot\frac{1}{s}} \Rightarrow \frac{K_1K_2}{s^2+(1+K_2)s+K_1K_2}$$

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② Find K1 K2

$$\%OS = 100MP = 100\,e^{\left(\frac{\pi\zeta}{\sqrt{1-\zeta^2}}\right)}$$

OR Read Graph

M_p (overshoot) = 20% ⇒ 0.45

$t_s = 1s$

Settling time% = 2%

$$t_s = \frac{-\ln(x)}{\zeta\omega_n} = \frac{-\ln(0.02)}{0.45\cdot\omega_n} = 1$$

Solve ω_n ⇒ $\omega_n = 8{,}7$ sek Hz???

$2\zeta\omega_n = 1+K_2$ Solve K_2 ⇒ 6.8

$\omega_n^2 = K_1K_2$ Solve K_1 ⇒ 11.1

Standard form

$$\frac{K\cdot\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}$$

Slide !! : Pdf

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③ Find rise time (t_r) of the system

$$t_r \approx \frac{1.8}{\omega_n} = \frac{1.8}{8.7} = 0.21 \text{ sekunder}$$

Formel är givet sådan.

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④ System type? Steady state errors for step, parabola and ramp?

System type from n poles in Open loop: $G(s) = \frac{K_1K_2}{s+K_2+1}\cdot\frac{1}{s}$; 1 pole i nul

System type 1

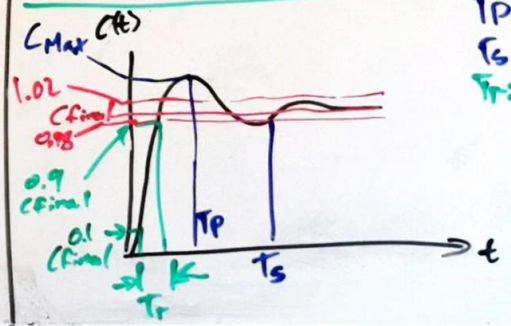
Vi vet $K_p = \infty$, error: 0 for step

$K_a = 0$, error: ∞ for parabola

K_v = constant, error $\frac{1}{K_v}$ for Ramp

$$\lim_{s\to 0}(sG(s)) = s\cdot\frac{K_1K_2}{s+K_2+1}\cdot\frac{1}{s} = 9.67$$

$$e_{ss} = \frac{1}{K_v} = 0.1$$



Tp = Peak time
Ts = Settling time
Tr = rise time typ 0.1→0.9