Reguleringsteknik 1

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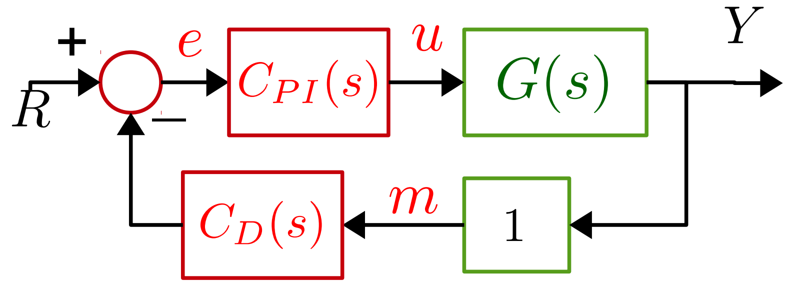
Kursusuge 6

Plan

- Stabilitetsmargin
  - Begreber (igen)
  - Nyquist plot
- PID design ud fra frekvensanalyse
  - P- regulator
  - PI regulator
  - P-Lead regulator
- Grupperegningsopgaver
  - PI-Lead
  - Multiple choice

DTU Electrical Engineering
Department of Electrical Engineering

Grupperegning
Lektion 6



1. Design en PI-Lead regulator til et system G1

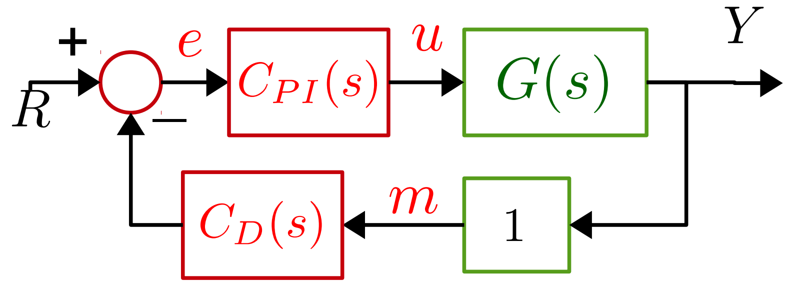
$$G_1 = \frac{9000}{(100s+1)(s^2+60s+900)}$$

a) Design en PI-Lead regulator, når der vælges:

$$N_i = 2,\ \alpha = 0.1 \text{ og } \gamma_M = 70^o$$

2. Multible choice opgaver på campusnet

Grupperegning



1. Design en PI-Lead regulator til et system $G_1 = \dfrac{9000}{(100s+1)(s^2+60s+900)}$

a) Design en PI-Lead regulator, når der vælges: $N_i = 2,\ \alpha = 0.1 \text{ og } \gamma_M = 70^o$

Udregn fasedrejning for G1, hvor krydsfrekvensen skal ligge.

$$\varphi_i = -\arctan\frac{1}{N_i} = -26.6^o \qquad \varphi_m = \arcsin\frac{1-\alpha}{1+\alpha} = 55^o$$

$$\angle G_1(\omega = \omega_c) = -180 + \gamma_M - \varphi_i - \varphi_m = -138^o$$

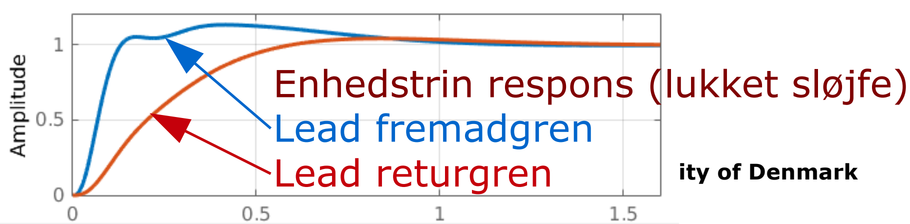
$$\omega_c = 13.4 \text{ rad/sek}$$

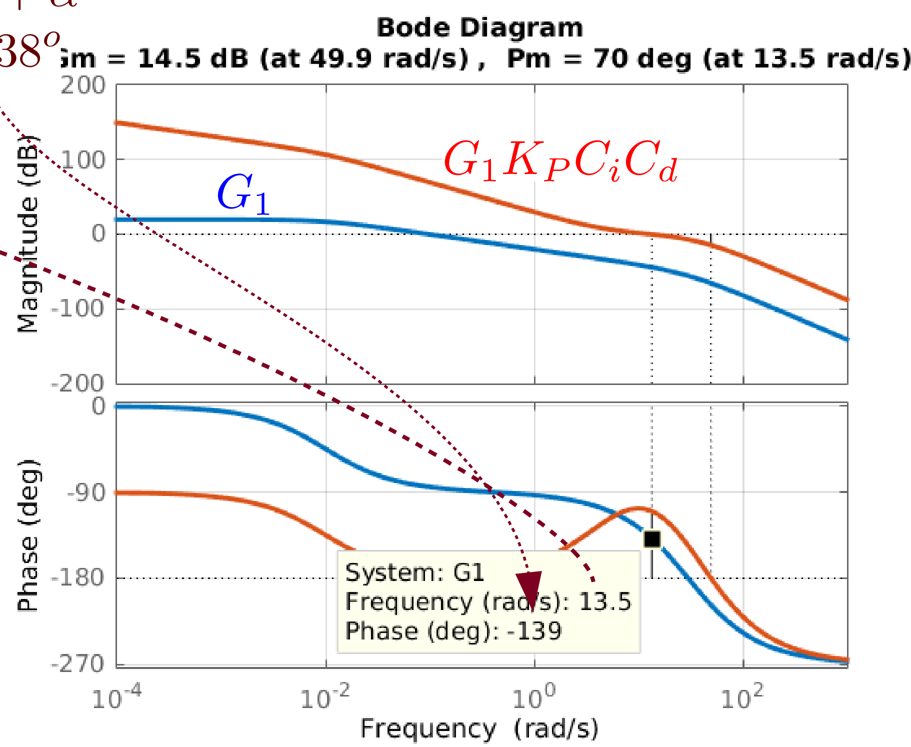
$$C_i = \frac{\tau_i s + 1}{\tau_i s} \qquad C_d = \frac{\tau_d s + 1}{\alpha \tau_d s + 1}$$

Find gain ved ω_c for åben sløjfe uden *Kp*

$$|G_å(\omega_c)| = |G_1 C_i C_d|_{s=j\omega_c}$$

$$|G_å(\omega_c)|_{dB} = -33.2dB \Rightarrow K_P = 45.8$$

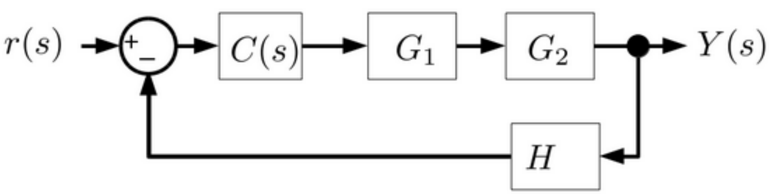




Multiple choice – lektion 6

Lektion 06 supplerende opgaver

Et system kan beskrives som



Hvor G1 og G2 beskriver systemets dynamik og H beskriver målesystemets dynamik.

Der skal designes regulatorer C(s), med det formål at Y(s) følger referencen r(s).

Spørgsmål 1

Et system er modelleret med en integrator således:

$$G_1 = \frac{2.2}{0.4s+1}$$

$$G_2 = \frac{1}{s}$$

$$H = \frac{1}{0.02s+1}$$

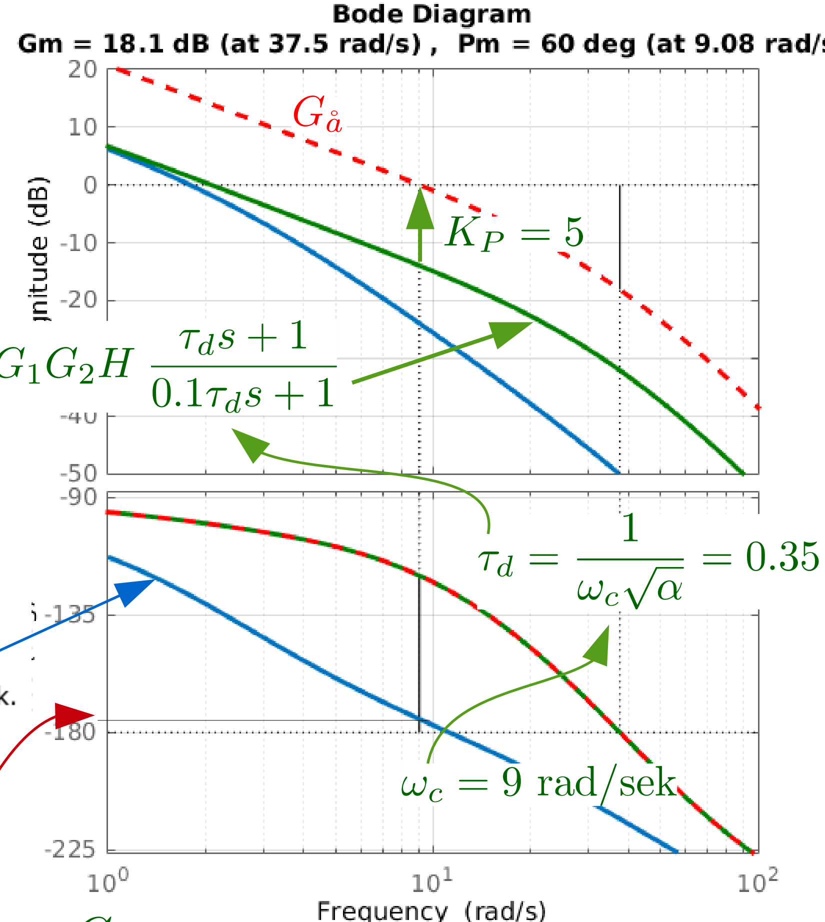
Design en P-Lead regulator til dette system med:

$$\gamma_M = 60^o$$

$$\alpha = 0.1$$

$$\angle(G_1G_2H) = -180 + \gamma_M - \varphi_d = -175^o$$

Hvad bliver indsvingningstiden (ca.) for et enhedstrin på referenceinput, hvis Lead-leddet placeres henholdsvis i fremadgrenen og i tilbagegrenen?



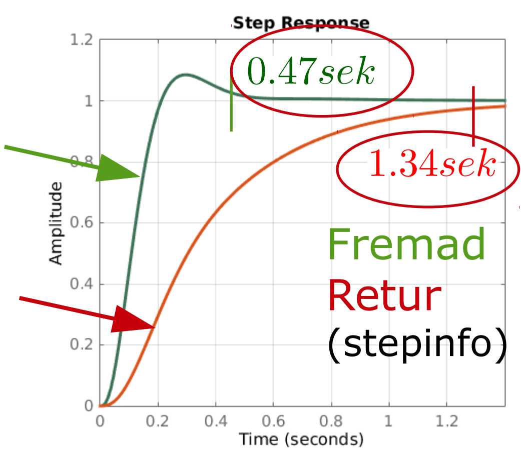
$$G_{Kp} = G_1G_2H\,\frac{\tau_d s + 1}{0.1\tau_d s + 1}$$

$$\tau_d = \frac{1}{\omega_c\sqrt{\alpha}} = 0.35$$

$$\omega_c = 9\ \mathrm{rad/sek}$$

$$G_{cl} = \frac{\overbrace{K_P C_d}^{C} G_1G_2}{1+G_å}$$

$$G_{cl} = \frac{K_P G_1G_2}{1+G_å}$$



Multiple choice - lektion 6

Spørgsmål 2

En model af et andet system er beskrevet med:

$$G_1 = \frac{120}{0.01s + 1}$$

$$G_2 = \frac{1}{0.0025s^2 + 0.04s + 1}$$

$$H = \frac{1}{0.001s + 1}$$

Design en PI-Lead regulator til dette system med

$$\gamma_M = 50^o$$

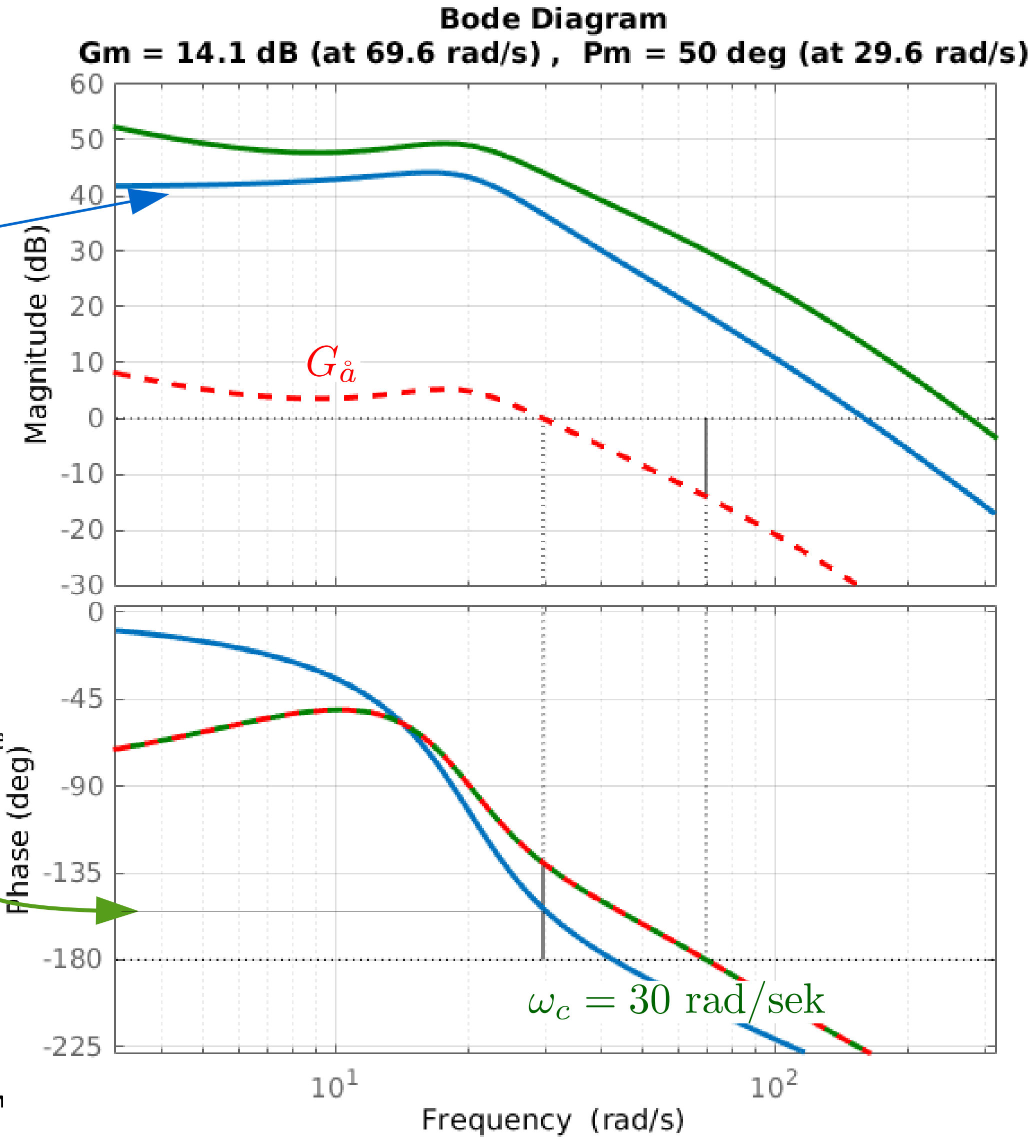
$$N_i = 3$$

$$\alpha = 0.2$$

Hvad bliver åben sløjfe krydsfrekvensen (ca.) for systeme

$$\angle(G_a G_{2H}) = -180 + \gamma_M - \varphi_i - \varphi_d = -153^o$$

$$\omega_c = 30 \text{ rad/sek}$$



Multiple choice
- lektion 6

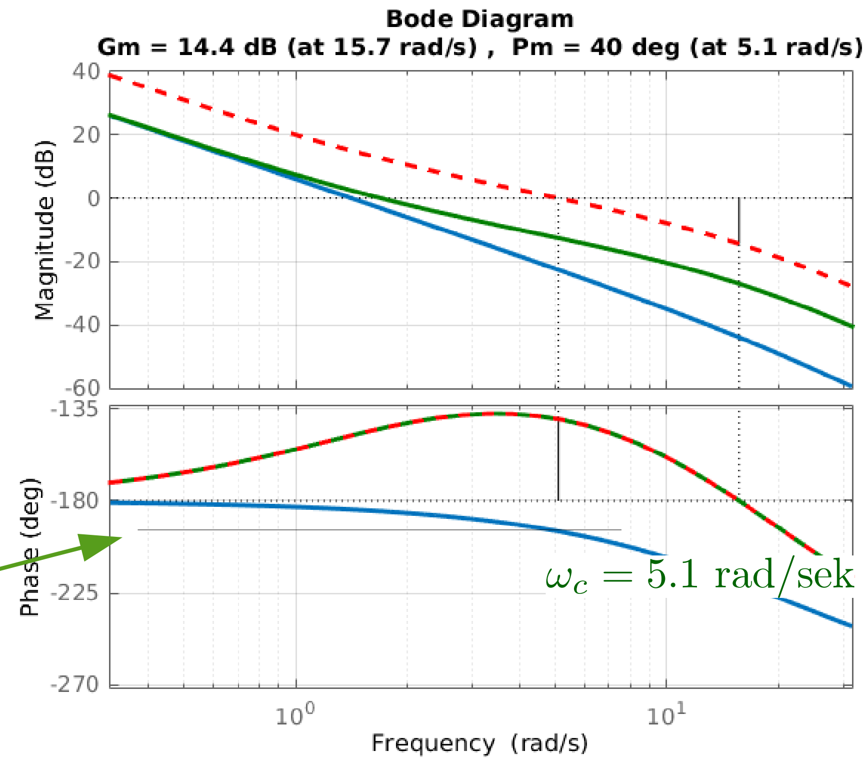
Spørgsmål 3

I en model med 2 integratorer (det kunne positionsstyring af være en

$$G_1 = \frac{2}{0.05s+1}$$

$$G_2 = \frac{1}{s^2}$$

$$H = \frac{1}{0.002s+1}$$



Design en P-Lead regulator med:

$\gamma_M = 40^o$

$\alpha = 0.1$

$$\angle G(\omega_c) = -194^o$$

Hvor meget oversving (ca.) giver et enhedsstep på reference-indgang,

- Oversving: 120%
- Oversving: 70%
- Oversving: 40%
- Oversving: 10%
- Oversving: 0%

$$\tau_d = 0.62\text{sek} \qquad K_P = 4.25$$

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