

TTK4105 Øving 6

Christian Le

1 a) $F_{\text{hori},i}(t) = F_p \cdot \sin(\theta(t)) \quad (1)$

$$F_{\text{vert}} = F_G = F_p \cdot \cos(\theta(t)) \quad (2)$$

Sætter F_p i (2) inn i (1)

$$F_{\text{hori},i}(t) = F_G \tan(\theta(t))$$

b) $\ddot{\lambda} = F_{\text{hori},i}(t) a = F_G \frac{\sin(\theta(t))}{\cos(\theta(t))} a$

När $\lim_{\theta \rightarrow 0}$ så er $\sin(\theta) \approx \theta$
 $\cos(\theta) \approx 1$

$$\ddot{\lambda} = F_G \theta a \quad (\text{Bruker Laplace})$$

$$s \dot{\lambda} = F_G \theta(s) a$$

$$\dot{\lambda}(s) = \frac{a F_G}{s J_1} \theta(s) = G_2(s) \theta(s)$$

c) Referer til likning (3):

$$\Theta(s) = G_1(s) u(s)$$

og gir likning (4) til et uttrykk
for $\lambda(s)$:

$$\lambda(s) = \frac{k_2}{s^2} \Theta(s) = \frac{k_1 k_2}{s^4(\tau s + 1)} u(s)$$

$$G(s) = \frac{\lambda(s)}{u(s)} = \frac{k_1 k_2}{s^4(\tau s + 1)}$$

Vi har en pol av multipelitet 4, som betyr
4-orders system

2

a) $\dot{\lambda}(ss) = G_2(s) \Theta(ss)$ (4)

$$\Theta(ss) \approx \Theta_r(s) \approx k_{p,1} (\lambda_r(s) - \lambda(ss))$$

$$s \frac{\dot{\lambda}(ss)}{k_2} = k_{p,1} (\lambda_r(s) - \lambda(ss))$$

$$s \dot{\lambda}(ss) = k_2 k_{p,1} (\lambda_r(s) - \lambda(ss))$$

$$\ddot{\lambda}(t) = k_2 k_{p,1} (\lambda_r(t) - \lambda(t))$$

$$k_{p,1} = \frac{k_1}{k_2}$$

$$K_{p,\lambda} = \frac{k_x j_\lambda}{a F g}$$

$$\Theta(s) \approx \Theta_r(s)$$

$$h(s) = \frac{\dot{j}(s)}{\dot{j}_r(s)} = \frac{(k_z/s) \Theta(s)}{(\Theta_r(s)/k_{p,\lambda}) + (\dot{j}(s))}$$

$$\dot{j}(s) = \frac{k_z}{s} \Theta(s)$$

$$\dot{j}_r(s) = \frac{\Theta_r(s)}{1/k_{p,\lambda}} + \dot{j}(s)$$

$$\frac{(k_z/s)}{(1/k_{p,\lambda}) + (\dot{j}(s)/\Theta(s))} = \frac{(k_z/s)}{(1/k_{p,\lambda}) + (k_z/s)}$$

$$\frac{k_z}{((s/k_{p,\lambda}) + k_z)} = \frac{k_z/k_{p,\lambda}}{s + k_z/k_{p,\lambda}}$$

$$b) k_z/k_{p,\lambda} = \frac{1}{\tau} = 1$$

Sprach wechselt

Vi. nur rechtsverdrängt!

c) Vi opererer fukt sam i forrige oppgave, men istedent har $\theta(s) \approx \theta_r(s)$

$$\dot{\theta}(s) = G_3(s) \theta_r(s)$$

$$\dot{i}(s) = G_2(s) \dot{\theta}(s)$$

$$\dot{i}(s) = G_2(s) G_3(s) \theta_r(s)$$

Sætter inn denne i (a)

$$\dot{\lambda}_r(s) = \frac{\theta_r(s)}{K_{p,\lambda}} + \dot{i}(s)$$

$$T(s) = \frac{G_2(s) G_3(s) \theta_r(s)}{\frac{\theta_r(s)}{K_{p,\lambda}} + \dot{i}(s)} = \frac{G_2 G_3}{\left(1/K_{p,\lambda}\right) + \frac{\dot{i}(s)}{\theta_r(s)}}$$

$$= \frac{G_2 G_3}{1/K_{p,\lambda} + G_2 G_3} = \frac{K_{p,\lambda} G_2 G_3}{1 + K_{p,\lambda} G_2 G_3}$$

$$K_{p1} G_2 G_3 = K_{p1} \frac{K_2}{s} G_3(s)$$

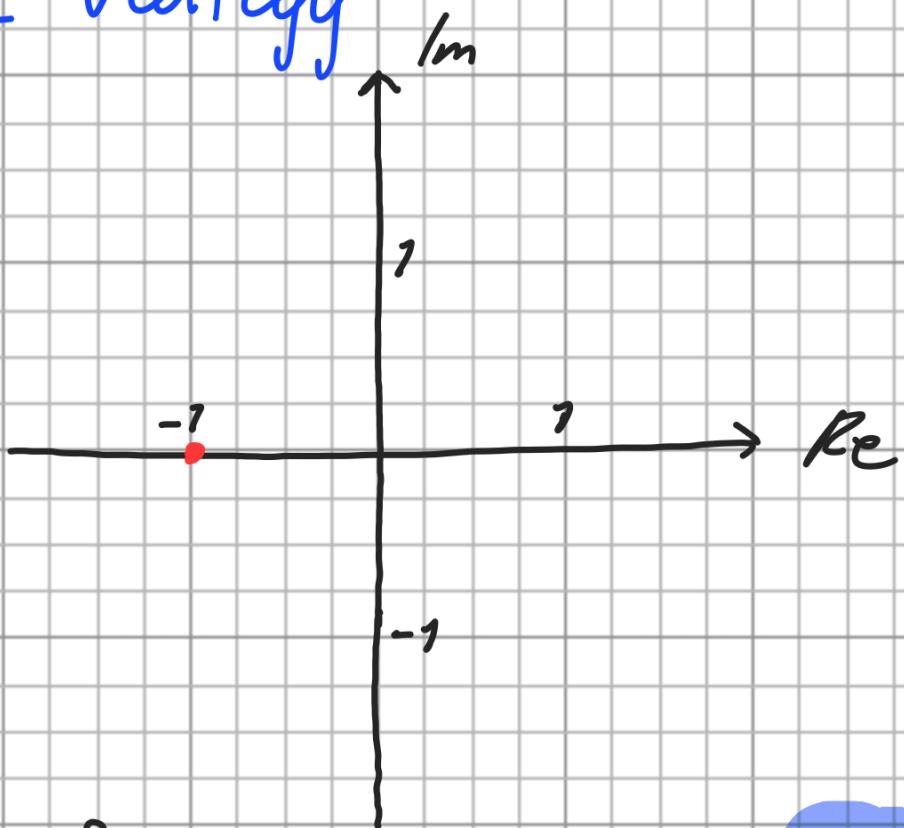
$$L_{CSJ} = \left(s - \frac{\omega_n^2}{s(\tau s^2 + s^2 + 2\zeta\omega_n s + \omega_n^2)} \right) K_1$$

d) Vedlegg viser at system blir ustabil

for $K_1 > 1,8$ (Altså stabilt ved $K_1 = 1,8$)

e) Spektrum vedlegg

3 a)

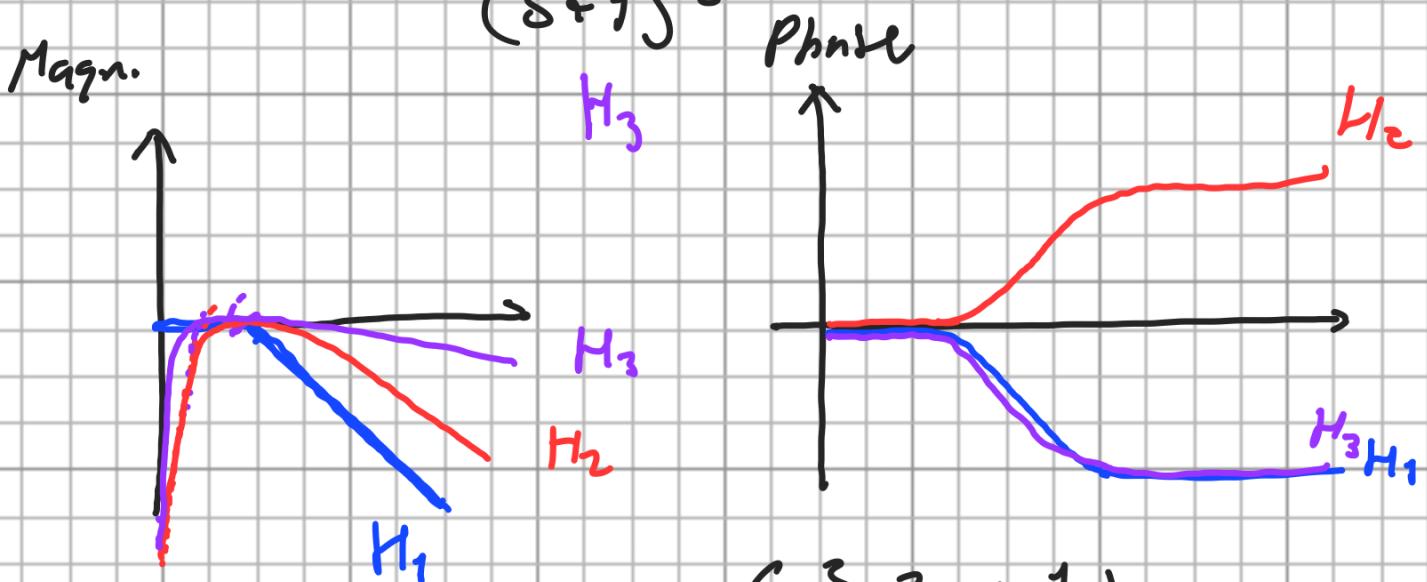


Alle tre filter har pol ved $s = -1$

$$b) H_1(s) = \frac{1}{s^2 + 2s + 1} = \frac{1}{(s+1)^2}$$

$$H_2(s) = \frac{2s}{(s+1)^2}$$

$$H_3(s) = \frac{s^2}{(s+1)^2}$$



$$c) H(s) = \frac{Y(s)}{U(s)} = \left(\frac{s^2 + 2s + 1}{s^2 + 2s + 1} \right) = 1$$

d) A - h - 2

B - h - 3

C - l - 2

D - h - 1

E - l - 3

F - l - 1

G - h - 2

H - m - 3 I - m - 2