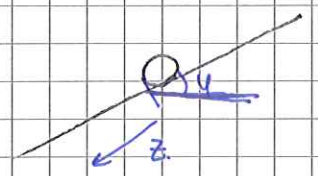
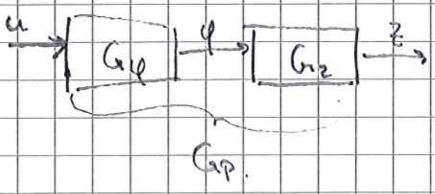
22/2-2012

(14)

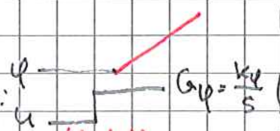
"KULAN PÅ BOMMEN"





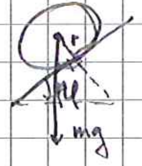
1) Modellbygge

G_p Stegsvarsexperiment: $G_\varphi = \frac{k_\varphi}{s}$



Bodediagram ger $k_\varphi = 4{,}5$. Modellen är giltig för $\omega < 10$ rad/s

G_z



Momentekvationen:

$M = J\cdot\dot{\omega}$

$M = mg\cdot r\sin\varphi$

$J = \frac{7}{5} m r^2$

$\dot{\omega} = \frac{M}{J} = \frac{5mgr\sin\varphi}{7mr^2} = \frac{5g\sin\varphi}{7r}$

$\dot{z} = r\omega$

$\ddot{z} = r\dot{\omega} = \frac{5g\sin\varphi}{7} \approx 7\varphi$

$s^2 Z = 7\Phi$

$\Rightarrow G_z = \frac{7}{s^2}$

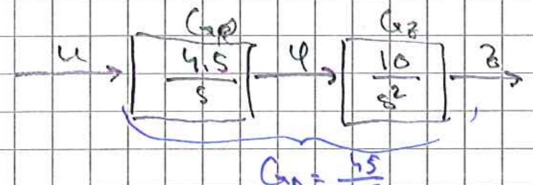
$\frac{k_z}{s^2} = 1 \Rightarrow \omega \approx 3s$

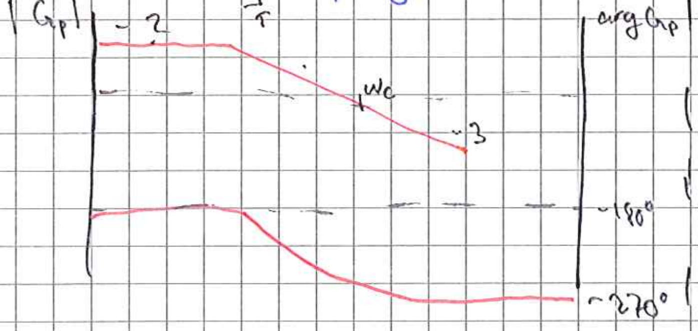
$\frac{k_z}{3s^2} = 1 \Rightarrow k_z \approx 10$

Bodediagram ger $G_z = \frac{10}{s^2}$

Modellen gäller för $\omega < 5$ rad/s.

∴ Modell:





Vinkelregleringen

$G_\varphi = \frac{4{,}5}{s}$

$G_{R2} = K_2$

$G_{R2} = K_2$

$\therefore \Phi = \frac{4{,}5}{s} K_2 (R - \Phi)$

$\left(1 + \frac{4{,}5K_2}{s}\right)\Phi = \frac{4{,}5K_2}{s} R$

$\Phi = \frac{\frac{4{,}5K_2}{s}}{1 + \frac{4{,}5K_2}{s}} R = \frac{4{,}5K_2}{s + 4{,}5K_2} R$ (G_2)

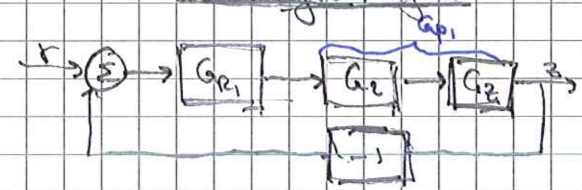
$G_0(i\omega) = \frac{4{,}5K_2}{i\omega}$

$|G_0(i\omega_c)| = |G_0(i\cdot 10)| = \frac{4{,}5K_2}{10} = 1 \Rightarrow$

$\Rightarrow K_2 = \frac{10}{4{,}5} = 2{,}2$

$G_2 = \frac{10}{s+10} = \frac{1}{1+0{,}1s} = \frac{1}{1+sT_2} \Rightarrow T_2 = 0{,}1$

Kulregleringen



$G_{p1} = G_2 \cdot G_z = \frac{1}{1+sT_2}\cdot\frac{10}{s^2}$

$G_{R1}' = K'\left(1 + \frac{1}{sT_i'}\right)\frac{1+sT_i'}{1+sT_i'/10}$

$1 + \frac{1}{sT_i'} = \frac{sT_i'+1}{sT_i'} = \frac{s + 1/T_i'}{s} = \frac{s+a}{s+a/M}$

$a = \frac{1}{T_i'}$ $M \to \infty$

$K'\frac{1+sT_d'}{1+sT_d'/N} = K'\frac{1+s/b}{1+s/(bN)}$

$b = \frac{1}{T_d'}$ $N = 10$

$\arg G_{R1}'(i\omega_c) = -6° + 55° = 49°$

$\arg G_{p1}(i\omega_c) = -\arctan(\omega_c T_2) - 180° = -\arctan(0{,}1\omega_c) - 180°$

$\varphi_m = 180° + \arg G_{p1}(i\omega_c) + \arg G_{R1}(i\omega_c) = 180 + 49 - \arctan(0{,}1\omega_c) - 180° =$

$= 49° - \arctan(0{,}1\omega_c)$

Väljer: $\omega_c = 2$ rad/s $\Rightarrow \varphi_m = 38°$

$a = 0{,}1\omega_c \Rightarrow$ $a = 0{,}2 \Rightarrow T_i' = 5$ s

$b\sqrt{N} = \omega_c \Rightarrow b = \frac{\omega_c}{\sqrt{10}} = \frac{2}{\sqrt{10}}$

$T_d' = \frac{1}{b} = \frac{\sqrt{10}}{2} \approx 1{,}6$ s

$|G_{R1}(i\omega_c)|\cdot|G_{p1}(i\omega_c)| = 1 \Rightarrow K' \approx 0{,}3$

$|G_{R_1}'(i\omega_d)| \cdot |G_{P_1}(i\omega_d)| = 1 \Rightarrow k' = 0{,}13$