Corrigé DS de S1, MPSI, PCSI, nov 21

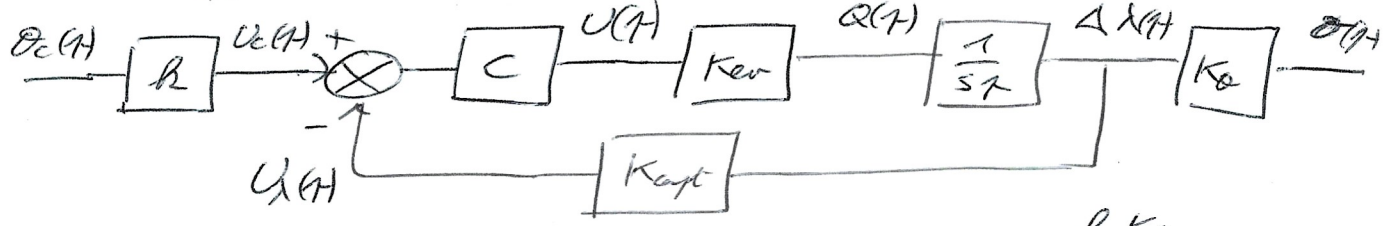
Exo 1 Régulation d'un CTA

(Q1) $K_\theta = \dfrac{\Delta\theta}{\Delta\lambda} = \dfrac{60 \times \frac{\pi}{180}}{9,550 - 9,82} = \dfrac{\pi}{3 \times 0,13} = 8$ rad/m

(Q2) $H_{ev}(p) = \dfrac{1}{Sp}$ (en $s.m^{-1}.m^{-2}$)

(Q3) $K_{capt} = \dfrac{2,5}{0,2} = 120\ V.m^{-1}$

(Q4)



(Q5) $H(p) = R\,\dfrac{C K_{ev}}{Sp + C K_{ev} K_{capt}} \times K_\theta = \dfrac{\frac{R K_\theta}{K_{capt}}}{1 + \frac{S}{C K_{ev} K_{capt}} p}$

$H(p) = \dfrac{K_1}{1 + \tau_1 p}$ (1er ordre) $\Rightarrow$ $\left| \begin{array}{l} K_1 = \dfrac{R K_\theta}{K_{capt}} \\ \tau_1 = \dfrac{S}{C K_{ev} K_{capt}} \end{array} \right.$

(Q6) On veut $K_1 = 1 \Rightarrow R = \dfrac{K_{capt}}{K_\theta}$

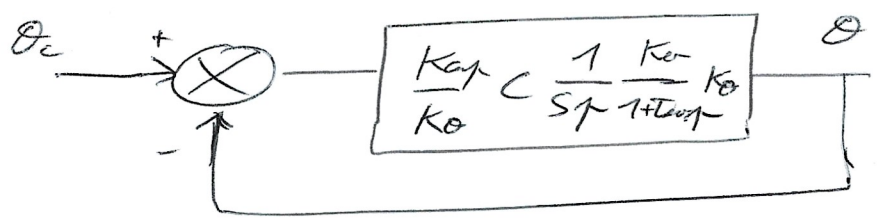
$K_1 = 1 \Rightarrow$ Asservissement précis.

(Q7) On veut $t_{5\%} = 3\tau_1 = 2\,s \Rightarrow C = \dfrac{3.S}{2\,K_{capt} K_{ev}}$

$C = 0,0125$ (sans unité).

(Q8) $H_{ev}(p) = \dfrac{K_{ev}}{1 + \tau_{ev} p}$ Identification $\Rightarrow$ $\left| \begin{array}{l} \tau_{ev} = 0,02\,s \\ K_{ev} = 0,0105 \\ (rad\,s^{-1}\,V^{-1}) \end{array} \right.$

(Q9)



(2)

$$H_2(p) = \frac{K_{opt} \, C \, K_{cv}}{5p(1+\tau_{cv} p)} = \frac{K_2}{p(1+\tau_{cv} p)} \; ; \; K_2 =$$

$$K_2 = \frac{K_{opt} \, C \, K_{cv}}{5}$$

(Q18) $$H_3(p) = \frac{126\,C}{p(1+0{,}02p)+126\,C} = \frac{1}{\frac{p^2}{50\times 126\,C} + \frac{p}{126\,C} + 1}$$

$K_3 = 1 \qquad \omega_n = \sqrt{50 \times 126\,C}$

$$\frac{2z}{\omega_n} = \frac{1}{126.C} \Rightarrow z = \frac{\sqrt{50}}{2\sqrt{126\,C}} = \frac{0{,}315}{\sqrt{C}}$$

on veut $z = 0{,}7 \Rightarrow C = 0{,}2$

Performances de l'asservissement :

Précis (car $K_3 = 1$)

Rapidité $t_{5\%} \cdot \omega_n = 3$ (Abaque) $\Rightarrow t_{5\%} = \frac{3}{\omega_n} = 0{,}08\ s$

Stable, dépassement de 5%.

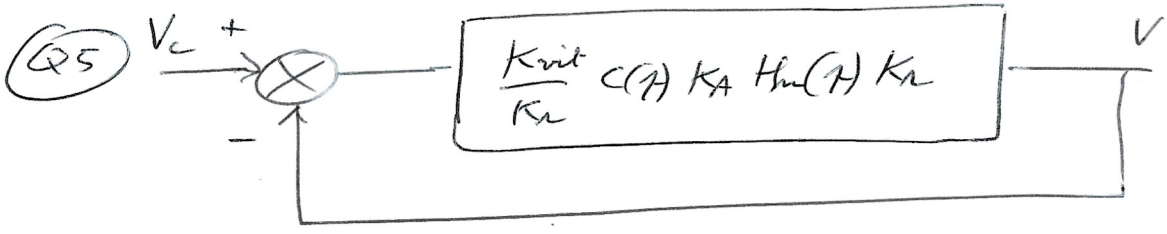
Exo 2 Imagerie médicale

(Q2) $$H_1(p) = \frac{K_e}{(R+Lp)Jp + K_c K_e} \; ; \; H_2(p) = \frac{R+Lp}{(R+Lp)Jp + K_c K_e}$$

(Q4) $$K_r = r \, k_1 \, k_2 = \frac{0{,}115}{4 \times 28{,}5} = 0{,}001 \quad m/rad$$

$$K_{conv} = \frac{K_{vit}}{K_r} = \frac{0{,}0014}{0{,}001} = 1{,}4 \quad V/rad\,s^{-1}$$

(Q5)



(3)

$$H_3(p) = \frac{K_{mt}\, C\, K_A\, K_m}{(1+\tau_1 p)(1+\tau_2 p)} \Rightarrow \left| \begin{array}{l} K_3 = K_{mt}\, C\, K_A\, K_m \\ K_3 = 9,8 \end{array} \right.$$

(Q6) $$H_4(p) = \frac{K_3}{(1+\tau_1 p)(1+\tau_2 p) + K_3} = \frac{\frac{K_3}{1+K_3}}{\frac{\tau_1 \tau_2}{1+K_3} p^2 + \frac{\tau_1+\tau_2}{1+K_3} p + 1}$$

$$K_4 = \frac{K_3}{1+K_3} = \frac{10}{11} = 0,9$$

$$\omega_n = \sqrt{\frac{1+K_3}{\tau_1 \tau_2}} = 20$$

$$\frac{2\xi}{\omega_n} = \frac{\tau_1+\tau_2}{1+K_3} \Rightarrow \xi = \frac{\tau_1+\tau_2}{2\sqrt{\tau_1\tau_2}\sqrt{1+K_3}} = 0,56.$$

(Q7) Performances :

$K_4 = 0,9 \Rightarrow$ Pas précis ($\varepsilon(\infty) = 0,1$ avec une entrée échelon unitaire)

$\varepsilon_x = 10\%$

Abaque $\Rightarrow t_{5\%}\, \omega_n = 5 \Rightarrow t_{5\%} = \frac{5}{\omega_n} = 0,012$ s

Stable, $\xi < 0,7 \Rightarrow$ dépassement, oscillations ...

(Q8) $$H_5(p) = \frac{K_{mt}\, B\, K_A\, K_m}{p(1+\tau_4 p)} \Rightarrow \left| \begin{array}{l} K_5 = K_{mt}\, B\, K_A\, K_m \\ K_5 = \end{array} \right.$$

(Q9) $$H_6(p) = \frac{0,1\, B}{p(1+\tau_1 p) + 0,1.B} = \frac{1}{\frac{10\tau_1}{B} p^2 + \frac{10}{B} p + 1}$$

$K_6 = 1$; $\omega_n = \sqrt{\frac{B}{10\tau_1}}$, $\frac{2\xi}{\omega_n} = \frac{10}{B} \Rightarrow \xi = \frac{\sqrt{10}}{2\sqrt{B\tau_1}} = \frac{9,6}{\sqrt{B}}$

$\omega_n = 1,92\sqrt{B}$

On veut $\xi = 1 \Rightarrow B = 92,6$ $\quad t_{5\%} = \frac{5}{\omega_n} = 0,27$ s.

(Abaque)

(1)

Performances :

$K_6 = 1 \Rightarrow$ Précis

Stable ; $\xi = 1 \Rightarrow$ pas de dépassement

Rapidité : $t_{5\%} = 0{,}22\ s$

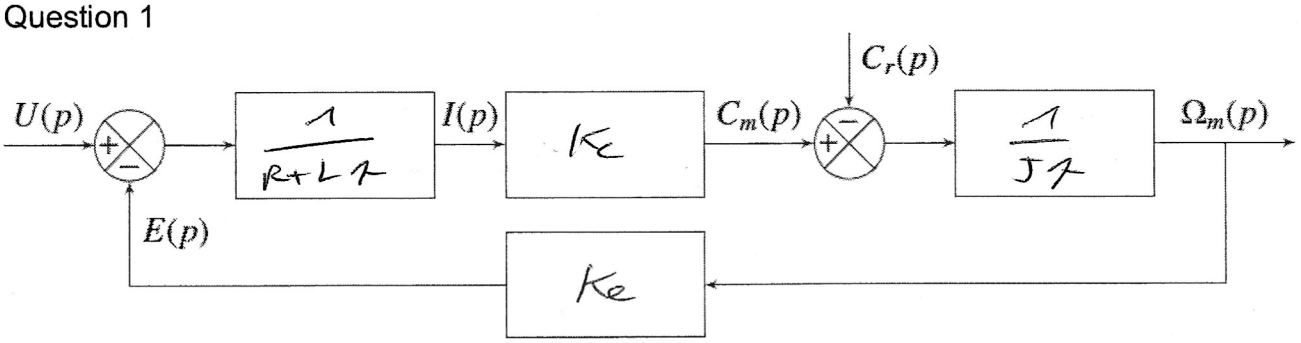
(Q11) Courbes

Précis dans les 2 cas, pas de dépassement.

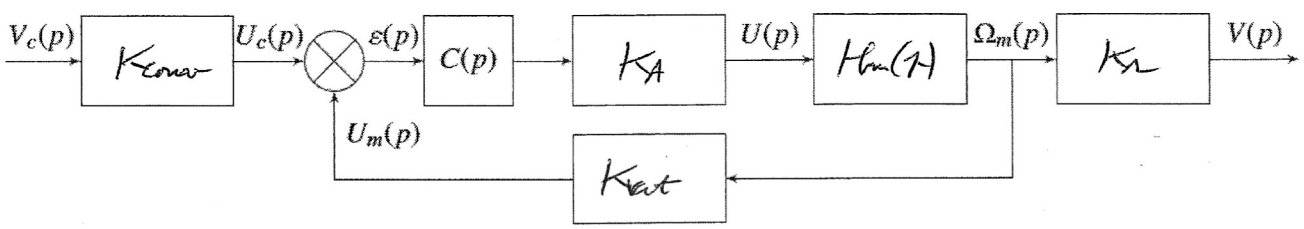
Système réel plus lent que le système simulé.

Exercice 3. Imagerie médicale (CCP MP 17)

Question 1



Question 3



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