OKS Vizesi 2010 — Çözümleri — KON 317 Bahar Dönemi

(1) a) $GH(s) = G_e(s) \Rightarrow 1 + G_e(s) = 1 + \dfrac{K(1+2s)(1+4s)}{s^2(s^2+s+1)} = 0$

$q(s) = s^4 + s^3 + (8K+1)s^2 + 6Ks + K = 0$ ($n=4$)

RT:

s^4	1	$8K+1$	K
s^3	1	$6K$	
s^2	$2K+1$	K	
s^1	$\dfrac{K(12K+5)}{2K+1}$		
s^0	K		

$8K+1>0 \rightarrow K > -1/8 \rightarrow K>0$

$6K>0$

$K>0$

([redacted] Gerek koşuldan)

$2K+1>0 \rightarrow K>-1/2 \rightarrow K>0$

$K(12K+5)>0 \rightarrow K>0$

$K>0$ } $K>0$ (yeter koşul)

Sistemin asimptotik kararlılık aralığı : $K>0$

$K(12K+5)=0 \rightarrow K=0$ için $s^2(2K+1)+K = 0$

$\rightarrow s_1=0, s_2=0$ $K=0$

$K=0$ için sanal eksen üzerinde $s=0$'da sistem kutupları var. (s_1, s_2)

b) $K_p = \lim_{s\to 0} G_e(s) = \infty$, $K_v = \lim_{s\to 0} s\,G_e(s) = \infty$, $K_a = \lim_{s\to 0} s^2 G_e(s) = K$

c) [redacted] $e_{ss} = R/1+K_p = 0$, $K_v = R/K_v = 0$, $K_a = R/K_a = R/K$

(2) a) $T(s) = \dfrac{G_e(s)}{1+G_e(s)} = \dfrac{\dfrac{10K_1}{s[s+(5+10K_2)]}}{1+\dfrac{10K_1}{s[s+(5+10K_2)]}} = \dfrac{10K_1}{s^2+(5+10K_2)s+10K_1}$

b) $e_{ss} = \dfrac{R}{K_v} = \dfrac{1}{K_v} = 0{,}1 \rightarrow K_v = 10$

$K_v = \lim_{s\to 0} s\,G_e(s) = \dfrac{10K_1}{5+10K_2} = 10 \rightarrow K_1 = 5+10K_2$

$s^2+(5+10K_2)s+10K_1 = s^2 + 2\zeta\omega_n s + \omega_n^2$

$5+10K_2 = 2\zeta\omega_n = 20 \rightarrow K_2 = 1{,}5$ ($2\zeta\omega_n = 10$)

$\dfrac{5+10K_2}{1{,}5} = K_1 \rightarrow K_1 = 20$

c) $\omega_n^2 = 10K_1 = 10(20) \rightarrow \omega_n = 10\sqrt{2}$

[redacted] $2\zeta\omega_n = 10 \rightarrow \zeta = \dfrac{10}{2\omega_n} = \dfrac{10}{10\sqrt{2}} = \sqrt{2}/2 = 0{,}707$ ($0<\zeta<1$) (sönümlü salınımlı bir davranış)

(3) $\%M_p = 4{,}32(\%) \rightarrow \xi = \frac{-\ln(4{,}32/100)}{\sqrt{\pi^2 + \ln^2(4{,}32/100)}} = 0{,}707$

$0{,}0432$

$T_r \approx \frac{1 - 0{,}416\xi + 2{,}917\xi^2}{\omega_n}\Big|_{\xi=0{,}707} = 0{,}306 \rightarrow \omega_n = 7{,}07 \left[\text{rad/sn}\right]$

$1 + G_e(s) = 0 \qquad 1 + (K_1 + K_2 s)\frac{10^4}{s^2(s+10.2)} = 0 \rightarrow$

$q(s) = s^3 + (10.2)s + 10^4 K_2 s + 10^4 K_1 = 0$

$q_1(s) = (s+p_3)(s^2 + 2\xi\omega_n s + \omega_n^2) = s^3 + (p_3+10)s^2 + (10p_3+50)s + 50p_3 = 0$

$q(s) = q_1(s) \Rightarrow \begin{cases} p_3 + 10 = 10.2 \\ 10^4 K_2 = 10p_3 + 50 \\ 10^4 K_1 = 50 p_3 \end{cases} \Rightarrow \begin{cases} p_3 = 0{,}2 \\ K_2 = 52\cdot 10^{-4} \\ K_1 = 10^{-3} \end{cases}$

$G_{PI}(s) = K_1 + K_2 s = 10^{-3} + (52)10^{-4} s$, $p_3 = 0{,}2$

(4) a) $G_1(s) = K_p + K_d s$, $G_2(s) = \frac{10^3}{0{,}1s+1} = \frac{10^4}{s+10}$

$G_3(s) = \frac{1}{Ms} = \frac{1}{(50\cdot 10^3)s} = \frac{1}{(5\cdot 10^4)s}$

b) $T(s) = \frac{V_c(s)}{V_r(s)} = \frac{G_1(s)\,G_2(s)\,G_3(s)}{1 + K_t\,G_1(s)\,G_2(s)\,G_3(s)}$

$T(s) = \frac{(50+50s)\frac{10^4}{s+10}\frac{1}{5\cdot 10^4 s}}{1 + 0{,}1(50+50s)\frac{10^4}{s+10}\frac{1}{5\cdot 10^4 s}} = \frac{10^2(s+0{,}1)}{s^2+20s+1}$

c) $V_{c\,sen} = \lim_{s\to 0} s\,V_c(s) = \lim_{s\to 0} s\,T(s)\frac{V_r}{s} = T(0)V_r = 20$

$\rightarrow V_r = 20/T(0) = \frac{20}{\frac{10^2(0{,}1)}{1}} = \frac{20}{10} = 2\,[V]$