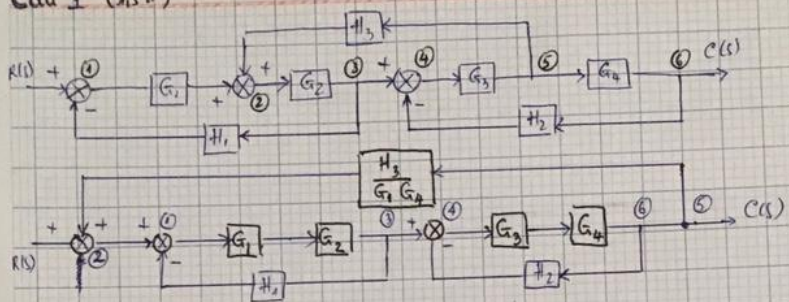
Đáp án HTĐKTĐ HK1, 2018 - 2019

Câu 1 (1,5đ)



$$G_A(s) = \frac{G_1 G_2}{1 + G_1 G_2 H_1}, \quad G_B(s) = \frac{G_3 G_4}{1 + G_3 G_4 H_2} \Rightarrow G_A \cdot G_B = \frac{G_1 G_2 G_3 G_4}{(1 + G_1 G_2 H_1)(1 + G_3 G_4 H_2)}$$

$$\frac{C(s)}{R(s)} = \frac{G_A \cdot G_B}{1 - G_A \cdot G_B \cdot \frac{H_3}{G_1 G_4}} = \frac{G_1 G_2 G_3 G_4 \cdot G_1 G_4}{(1 + G_1 G_2 H_1)(1 + G_3 G_4 H_2) G_1 G_4 - G_1 G_2 G_3 G_4 H_3}$$

1,0

$$= \frac{G_1 G_2 G_3 G_4}{(1 + G_1 G_2 H_1)(1 + G_3 G_4 H_2) - G_2 G_3 H_3}$$

0,5

Câu 2: (2đ)

a) (1,0) Phương trình đặc trưng

$$1 + D(s)G(s) = 0$$

$$\Leftrightarrow 1 + \frac{(s+a)}{s+1} \cdot \frac{K}{s(s+2)(s+5)} = 0$$

$$\Leftrightarrow s^4 + 8s^3 + 17s^2 + (10+K)s + aK = 0$$

Bảng Routh

s^4	1	17	aK
s^3	8	10 + K	
s^2	$17 - \frac{1}{8}(10+K) = \frac{126-K}{8}$	aK	
s^1	$(10+K) - \frac{64}{126-K} \cdot aK$		
s^0	aK		

$\alpha_3 = \frac{1}{8}$

$\alpha_4 = \frac{64}{126-K}$

0,5

Điều kiện để hệ thống ổn định

0,5

$$\begin{cases} 10 + K > 0 \\ aK > 0 \\ \frac{126 - K}{8} > 0 \\ (10+K) - \frac{64aK}{126-K} > 0 \end{cases} \Leftrightarrow \begin{cases} Ka > 0 \\ -10 < K < 126 \\ (10+K)(126-K) - 64aK > 0 \end{cases}$$

Câu 2 b (1đ)

$$K_v = \lim_{s\to 0} s\,D(s)\,G(s) = \lim_{s\to 0} s\cdot\frac{(s+a)\,K}{(s+1)(s+2)(s+5)\,s}$$ 0,5

$$= \frac{aK}{10}$$

để $e_{ss} \le 0{,}24 \Leftrightarrow$ [illegible]

$$\Leftrightarrow \frac{1}{K_v} \le 0{,}24 \Rightarrow \frac{10}{aK} \le 0{,}24 \Rightarrow aK \geqslant \frac{10}{0{,}24} = 41{,}7$$ 0,5

Câu 3 : (1,5đ)

Phương trình đặc trưng của hệ kín

$$(s^2 + 5{,}3s + 8{,}5354)(s^2 + 0{,}7s + 0{,}7625) = 0$$

$$\Rightarrow \left[\begin{array}{l} s_{1,2} = -\frac{53}{20} \pm \frac{123}{100}j = -2{,}65 \pm 1{,}23j \\ s_{3,4} = -\frac{7}{20} \pm \frac{4}{5}j = -0{,}35 \pm 0{,}8j \end{array}\right.$$

Cặp cực phức quyết định là cặp cực nằm gần trục ảo nhất 0,5

$$\Rightarrow s_{3,4} = -0{,}35 \pm j\,0{,}8 = -\xi\omega_n \pm j\omega_n\sqrt{1-\xi^2}$$

$$\Rightarrow \begin{cases} \xi\omega_n = 0{,}35 \\ \omega_n\sqrt{1-\xi^2} = 0{,}8 \end{cases}$$

$$t_{qđ}(2\%) = \frac{4}{\xi\omega_n} = \frac{4}{0{,}35} = 11{,}4$$ 0,5

$$POT = \left(e^{-\frac{\xi\pi}{\sqrt{1-\xi^2}}}\right)\times 100\% = \left(e^{-\frac{0{,}35\cdot\pi}{0{,}8}}\right)\times 100\% = 25{,}3\%$$ 0,5

$$N = \frac{2}{\xi\pi}\sqrt{1-\xi^2} = \frac{2\cdot 0{,}8}{\pi\cdot 0{,}35} = 1{,}46 \text{ lần}$$

Câu 4 :

a (2đ)

Vẽ QĐNS

PTĐT $\quad 1 + G(s) = 0 \Leftrightarrow 1 + \dfrac{K}{s^3+7s^2+12s+1} = 0 \quad (1)$

$$\Rightarrow s^3 + 7s^2 + 12s + 1 + K = 0 \quad (2)$$

$$\Rightarrow K = -s^3 + 7s^2 + 12s + 1 \quad (3)$$

Cực $p_1 = -0{,}088 \qquad p_2 = -2{,}714 \qquad p_3 = -4{,}199$

Tiệm cận có

$$OA = \frac{\sum \text{cực}}{3} = -2{,}333$$ 0,5

$$\alpha_1 = \frac{\pi}{3} \qquad \alpha_2 = -\frac{\pi}{3} \qquad \alpha_3 = \pi$$

Điểm tách nhập

$$\frac{dK}{ds} = 0 \Leftrightarrow 3s^2 + 14s + 12 = 0 \Leftrightarrow \begin{cases} s_1 = -1{,}13 \text{ (nhận)} \\ s_2 = -3{,}54 \text{ (loại)} \end{cases}$$ 0,5

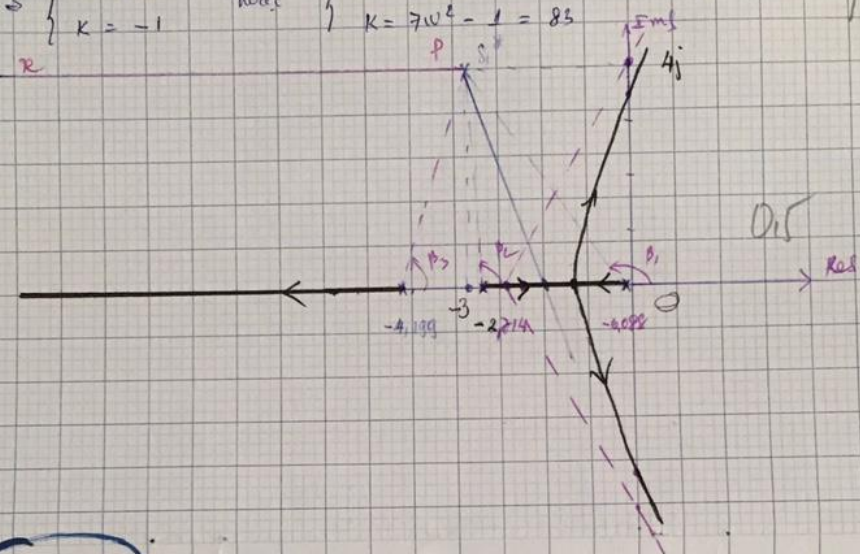
Giao điểm QĐNS và trục ảo

Thay $s = j\omega$ vào pt (3)

$-j\omega^3 - 7\omega^2 + 12j\omega + 1 + K = 0$

$\Leftrightarrow (1 + K - 7\omega^2) + j\omega(12 - \omega^2) = 0$

$\Rightarrow \begin{cases} \omega = 0 \\ K = -1 \end{cases}$ hoặc $\begin{cases} \omega = \pm\sqrt{12} \\ K = 7\omega^2 - 1 = 83 \end{cases}$ $\Rightarrow s = \pm\sqrt{12}j = 3{,}464$ 0,5



0,5

Câu 4b (3đ)

$POT = \left(e^{-\frac{\xi\pi}{\sqrt{1-\xi^2}}}\right) \times 100\% \leq 15\%$

$\Rightarrow -\frac{\xi\pi}{\sqrt{1-\xi^2}} \leq -1{,}897$

$\Rightarrow \xi^2\pi^2 \geq 1{,}897^2(1 - \xi^2)$

$\xi^2(\pi^2 + 1{,}897^2) \geq 1{,}897^2 \Leftrightarrow \xi^2 \geq 0{,}267$

$\Rightarrow 1 > \xi \geq 0{,}517$

Chọn $\xi = 0{,}6$

$t_{qđ}(2\%) = \frac{4}{\xi\omega_n} \leq 2 \Rightarrow \omega_n \geq \frac{4}{2\xi} = \frac{4}{2.0{,}6} = 3{,}33$

Chọn $\omega_n = 5$ (rad/s)

$s^*_{1,2} = -\xi\omega_n \pm j\omega_n\sqrt{1-\xi^2}$

$= -3 \pm 4j$ 0,6

Góc pha cần bù

0,6
$\phi^* = -180^\circ + (\beta_1 + \beta_2 + \beta_3)$

$= -180^\circ + \left(90^\circ + tg^{-1}\frac{3 - 0{,}088}{4} + 90^\circ + tg^{-1}\frac{3 - 2{,}214}{4} + tg^{-1}\frac{4}{4{,}199 - 3}\right)$

$= 113{,}5^\circ$

P^2 phân giác

$\widehat{OPx} = 90^\circ + tg^{-1}\frac{3}{4} = 126,9$

$OP = \sqrt{3^2+4^2} = 5$

$$OB = OP \frac{\sin\left(\frac{\widehat{OPx}}{2} + \frac{\phi^*}{2}\right)}{\sin\left(\frac{OPx}{2} - \frac{\phi^*}{2}\right)} = 5\,\frac{\sin\left(\frac{126,9+113,5}{2}\right)}{\sin\left(\frac{126,9-113,5}{2}\right)} = 37,0$$

1,2

$$OC = OP \frac{\sin\left(\frac{\widehat{OPx}}{2} - \frac{\phi^*}{2}\right)}{\sin\left(\frac{OPx}{2} - \frac{\phi^*}{2}\right)} = 0,67$$

$$\left|G_c(s)G(s)\right|_{s=s_1^*} = 1$$

$$\left|K_c \frac{s+0,67}{s+37,0} \cdot \frac{9}{s^3+17s^2+12s+1}\right|_{s=s_1^*} = 1$$

0,6

$$\left|K_c \frac{0,67-3+4j}{37-3+4j} \cdot \frac{9}{[(0,088-3)+4j][2,714-3+4j][4,199-3+4j]}\right| = 1$$

$K_c = 68,0$.

$$G_c(s) = 68,0 \cdot \frac{s+0,67}{s+37,0}$$