: Dionatas Santos Brito

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1.

1.a = 7

b = 3

c = $\frac{26}{8} = 3$

$\left.\begin{array}{l}\\\\\end{array}\right\}$ $\frac{C(s)}{R(s)} = \frac{K(s^2+as+b)}{s^2(s-c)+K(s^2+as+b)} = \frac{G(s)}{1+G(s)}$ ↘ em malha Fechado

1.1

$= \frac{K(s^2+as+b)}{s^3 - cs^2 + Ks^2 + Kas + Kb}$

$= \frac{K(s^2+as+b)}{s^3 + (K-c)s^2 + Kas + Kb}$

a_3 a_2 a_1 a_0

$\begin{bmatrix} a_{m-1} & a_{m-2} \\ a_{m-3} & a_{m-3} \end{bmatrix}$

$b_{m-1} = \begin{bmatrix} a_m & a_{m-2} \\ a_{m-1} & a_{m-3} \end{bmatrix}$

$b_{m-3} = \begin{bmatrix} a_m & a_{m-4} \\ a_{m-1} & a_{m-5} \end{bmatrix}$

c_{m-1} a_{m-1} a_{m-2} / b_{m-1} b_{m-3}

• Faixa de ganho K

$$\begin{bmatrix} s^3 & 1 & Ka \\ s^2 & K-c & Kb \\ s^1 & b_{m-1} & - \\ s^0 & c_{m-1} & - \end{bmatrix} \simeq \begin{bmatrix} s^3 & 1 & 7K \\ s^2 & K-3 & 3K \\ s^1 & \frac{7K^2+24K}{K-3} & \\ s^0 & 3K & \end{bmatrix} //$$

$b_{m-1} = \frac{-1}{a_{m-1}} \begin{bmatrix} a_m & a_{m-2} \\ a_{m-1} & a_{m-3} \end{bmatrix} = \frac{-1}{K-c} \begin{bmatrix} 1 & Ka \\ K-c & Kb \end{bmatrix} = \frac{-1}{K-c} \cdot \left[Kb - Ka(K-c) \right]$

$b_{m-1} = \frac{-1}{K-3}\left(3K - 7K(K-3)\right) = \frac{-1}{K-3}\left[3K - 7K^2 + 21K\right] = \frac{7K^2+24K}{K-3} //$

↳ $\frac{-3K}{K-3} + 7K$

$b_{m-3} = -$

$$m_{-1} = \frac{-1}{b_{m-1}} \begin{bmatrix} a_{m-1} & a_{m-3} \\ b_{m-1} & b_{m-3} \end{bmatrix} = \frac{-1}{b_{m-1}} \begin{bmatrix} K-c & Kb \\ b_{m-1} & 0 \end{bmatrix}$$

$$c_{m-1} = \frac{-1}{b_{m-1}} \begin{bmatrix} -Kb \cdot b_{m-1} \end{bmatrix}$$

$$c_{m-1} = Kb$$

$$c_{m-1} = 3K$$

$$\frac{-3K + 7K^2 - 21K}{K-3}$$

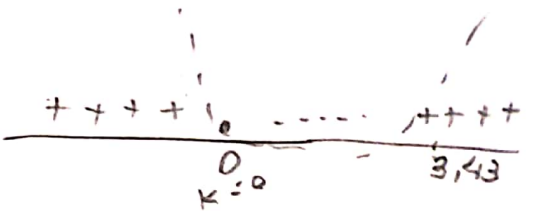
\# $K > 0$, $b_{m-1} > 0$

$$\frac{7K^2 - 24K}{K-3} \sim -3K^2 + 7K^2 - 21K = 0$$

$$7K^2 - 24K + 0 = 0 \rightarrow 0$$

$\rightarrow 3.43$

\# Logo $0 < K < 3.43$ → para que o sistema seja estável



- para ser marginalmente estável
uma linha inteiro deve ser nula

x: em b_{m-1}

$b_{m-1} \to 0 \rightarrow K = 0$

$\searrow 3.43 \rightarrow K = 3.43$

∴ $b_{m-1} = 7K^2 - 2K + 0$ } anula a linha s^1

$c_{m-1} \to K > 0 \rightarrow +$

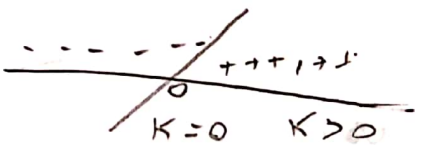
$\searrow K < 3 \rightarrow -$

$\searrow K > 3.43 \rightarrow +$

com $K = 3.43$

$b_{m-1} = 7.(3.43)^2 - 2.(3.43)$

$b_{m-1} = 0$



$P(D) = (K-3)D^2 + 3KD$

$\downarrow$ 0.43 $\quad$ $\downarrow$ 10.29

Logo é marginalmente estável quando

$b_{m-1} \to K = 0, K = 3.43$

$c_{m-1} \to K = 0, K > 0, K > 3.43$

1.3

Eq. característica

$D^3 + (K-c)D^2 + KaD + Kb = 0$

$D^3 + (K-3)D^2 + 7KD + 3K = 0$ } com $K = 3.43$

$(3.43-3)D^2 + (3 \cdot 3.43)D = 0$

$0.43D^2 + 10.29D = 0$

$D = \frac{-10.29}{0.43}$

$D = 23.93$

$q(D) = (K-3)D^2 + 3KD$ → se $D = 0$

→ se $D = 23.93$

Raízes

$D_1 = 0$

$D_2 = 23.93$

$D_3 =$

$D_4 =$

1.4

com $\begin{cases} c=3 \\ b=3 \\ a=7 \end{cases}$ $\left.\begin{matrix} \\ \\ \end{matrix}\right\} K = 3.43$

Degrau

$$E_{ss}^{\alpha} = \lim_{t \to \infty} e(t) = \lim_{s \to 0} s\,E(s) = \lim_{s \to 0} \frac{s \cdot R(s)}{1 + G(s)} = 0 \;//$$

$R(s) = \frac{1}{s}$

$$G(s) = \frac{K(s^2 + as + b)}{s^3 + \dots - cs^2 + \dots} = \infty \left\{ \text{Tem polo na origem} \right. \quad = 0 \;//$$

\# como $G(s)$ tem polo na origem e está no denominador do erro, o erro tende a zero // $e(\infty) = 0$

Rampa

$$G(s) = \frac{K(s^2 + as + b)}{s^3 - cs} \qquad R(s) = \frac{1}{s^2}$$

$$\lim_{t \to 0} s\,E(s) = \lim_{s \to 0} \frac{s\,R(s)}{1 + G(s)}$$

$$\Rightarrow \frac{1}{s^2} \cdot \frac{1}{\frac{K(s^2 + as + b)}{s^2(s - c)}} = \lim_{s \to 0} \frac{1}{\frac{K \cdot 3}{0 \cdot (0 - 3)}} = \frac{3}{3.43.3} = 0{,}29 \;//$$

$e(\infty) = 0{,}29$