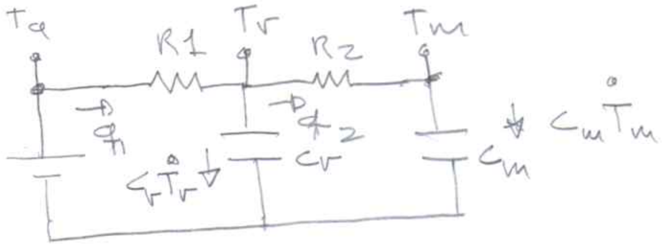
termometo

easy



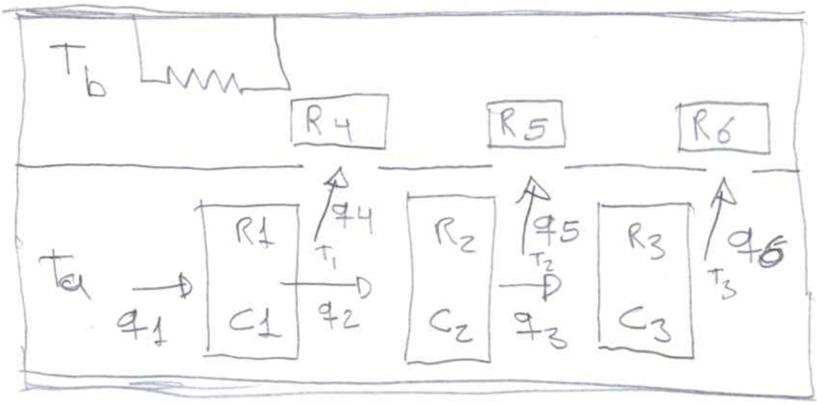
$$q_1 = q_2 + c_v \dot{T}_a \; ; \quad q_2 = \frac{T_v - T_m}{R_2} \; ; \quad q_1 = \frac{T_a - T_v}{R_1}$$

$$q_2 = c_m \dot{T}_m$$

15 Julho 2019

1020881

2.



c - capacidade térmica

R - resistência térmica

q - fluxo de calor

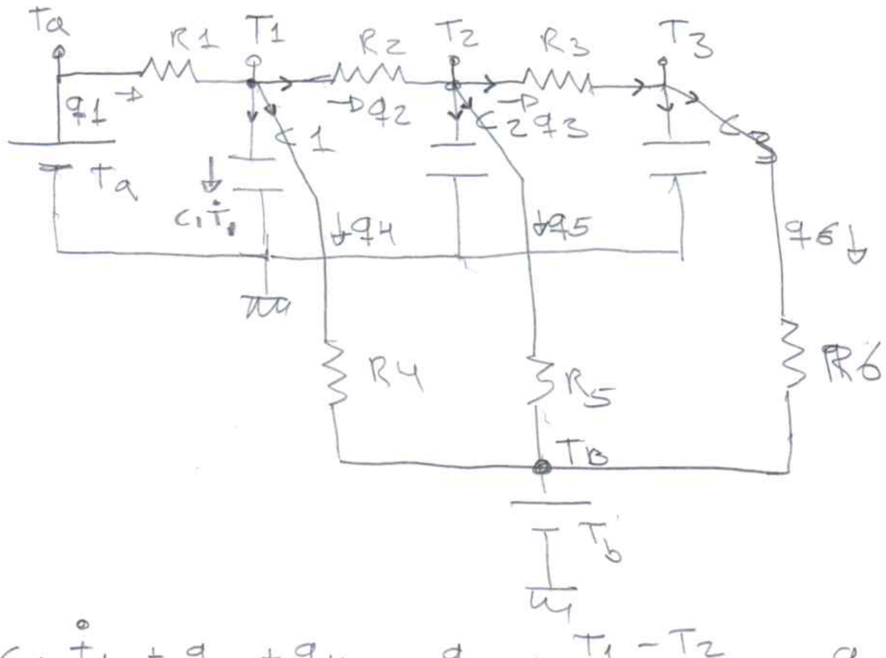
T - temperaturas.

A) $q_1 + q_2 + q_3 = 0$

B) $q_1 = C_1 \dot{T}_1 - q_2 + q_3$

C) $q_1 = C_1 \dot{T}_1 + q_2$

D) outro resultado $\boxed{D}$



$$q_1 = C_1 \dot{T}_1 + q_2 + q_4 \quad , \quad q_2 = \frac{T_1 - T_2}{R_2} \quad , \quad q_1 = \frac{T_a - T_1}{R_1}$$

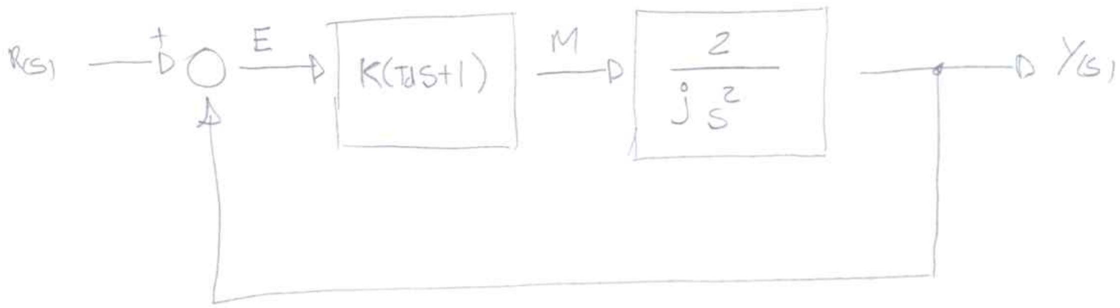
$$q_2 = C_2 \dot{T}_2 + q_3 + q_6 \quad , \quad q_3 = \frac{T_2 - T_3}{R_3}$$

$$q_3 = C_3 \dot{T}_3 + q_6 \quad , \quad q_4 = \frac{T_1 - T_b}{R_4} \quad , \quad q_5 = \frac{T_2 - T_b}{R_5}$$

$$q_6 = \frac{T_3 - T_b}{R_6}$$

5.

3 Fev 2004



Td = ? de modo $\xi = 0{,}6$

A) $Td = 2\sqrt{\frac{J}{2K}}$

B) $Td = 1{,}2\sqrt{\frac{2K}{J}}$

C) $Td = 2\sqrt{\frac{2K}{J}}$

D) $Td = 1{,}2\sqrt{\frac{J}{2K}}$ ✓

$$GH(s) = \frac{K(Td\,s+1) \cdot 2}{j\,s^2}$$

$$D(s)\Big|_{FTMF} = j s^2 + 2K(Td\,s+1)$$

$$j s^2 + 2K\,Td\,s + 2K = \varnothing \qquad \times \frac{1}{2K}$$

$$\underbrace{j s^2 + 2K} + 2K\,Td\,s = 0$$

$$1 + \frac{2K\,Td\,s}{j s^2 + 2K} = 0$$

$$j s^2 + 2K\,Td\,s + 2K = 0$$

$$s^2 + \frac{2K}{J}Td\,s + \frac{2K}{J} = 0$$

$$\omega_n^2 = \frac{2K}{j}$$

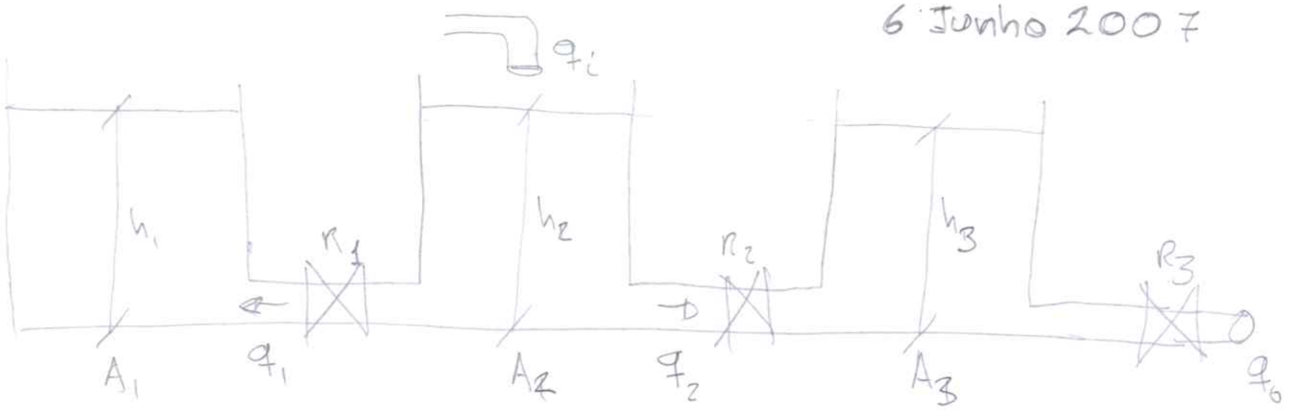
$$1{,}2\,\omega_n = \omega_n^2\,Td$$

$$1{,}2\,\frac{1}{\omega_n} = Td$$

$$1{,}2\,\frac{1}{\sqrt{\frac{2K}{j}}} = Td$$

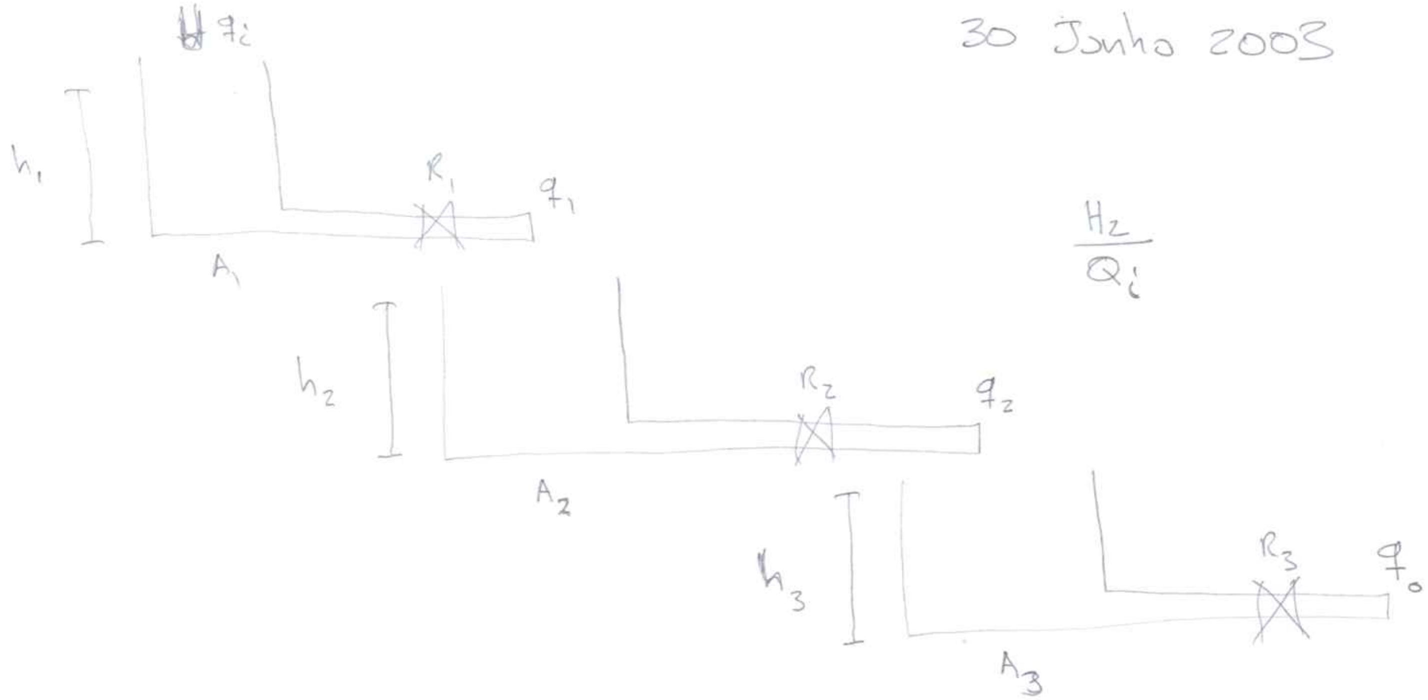
$$\boxed{1{,}2\sqrt{\frac{j}{2K}} = Td}$$

6 Junho 2007



$$\begin{cases} Q_i = SA_2H_2 + Q_1 + Q_2 \\ Q_1 = SA_1H_1 \\ Q_2 = SA_3H_3 + Q_0 \end{cases} \qquad \begin{cases} Q_1 = \dfrac{H_2 - H_1}{R_1} \\ Q_2 = \dfrac{H_2 - H_3}{R_2} \\ Q_0 = \dfrac{H_3}{R_3} \end{cases}$$

30 Junho 2003



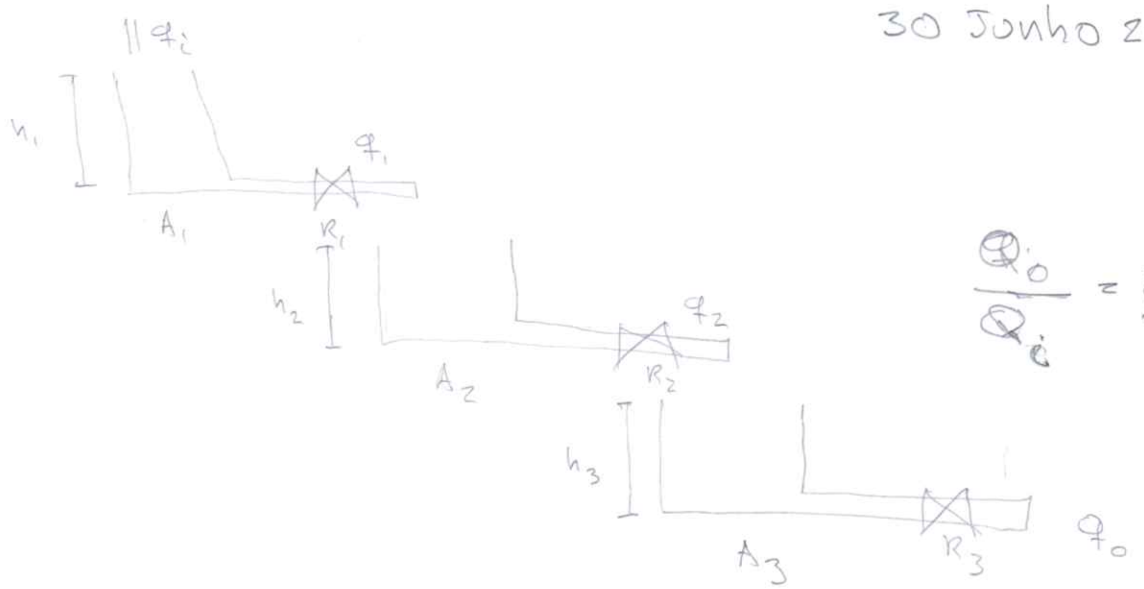
$$\frac{H_2}{Q_i}$$

$$\begin{cases} Q_i = s H_1 A_1 + \dfrac{H_1}{R_1} \\ Q_1 = s H_2 A_2 + \dfrac{H_2}{R_2} \end{cases} \qquad \begin{cases} Q_i = \left(sA_1 + \dfrac{1}{R_1}\right) H_1 \\ \dfrac{H_1}{R_1} = \left(sA_2 + \dfrac{1}{R_2}\right) H_2 \end{cases}$$

$$Q_i = \left(sA_1 + \frac{1}{R_1}\right)\left(sA_2 + \frac{1}{R_2}\right) H_2 \cdot R_1$$

$$\frac{H_2}{Q_i} = \frac{1}{\left(sA_1 + \frac{1}{R_1}\right)\left(sA_2 + \frac{1}{R_2}\right) \cdot R_1}$$

30 Junho 2003



$$\frac{Q_0}{Q_i} = ?$$

Por em evidência

$$\begin{cases} q_i = A_1 \frac{d}{dt} h_1 + q_1 & q_1 = \frac{h_1}{R_1} \\ q_1 = A_1 \frac{d}{dt} h_2 + q_2 & q_2 = \frac{h_2}{R_2} \\ q_2 = A_3 \frac{d}{dt} h_3 + q_0 & q_0 = \frac{h_3}{R_3} \end{cases}$$

$$\begin{cases} Q_i = S H_1 A_1 + Q_1 \; ; \; Q_1 = \frac{H_1}{R_1} \Rightarrow Q_1 R_1 = H_1 \\ Q_1 = S H_2 A_2 + Q_2 \; ; \; Q_2 = \frac{H_2}{R_2} \Rightarrow Q_2 R_2 = H_2 \\ Q_2 = S H_3 A_3 + Q_0 \; ; \; Q_0 = \frac{H_3}{R_3} \Rightarrow Q_0 R_3 = H_3 \end{cases}$$

$$\begin{cases} Q_i = S Q_1 R_1 A_1 + Q_1 \\ Q_1 = S Q_2 R_2 A_2 + Q_2 \\ Q_2 = S Q_0 R_3 A_3 + Q_0 \end{cases} \quad \begin{cases} Q_i = (S R_1 A_1 + 1) Q_1 \\ Q_1 = (S R_2 A_2 + 1) Q_2 \\ Q_2 = (S R_3 A_3 + 1) Q_0 \end{cases}$$

$$Q_i = (S R_1 A_1 + 1)(S R_2 A_2 + 1)(S R_3 A_3 + 1) \cdot Q_0$$

$$\frac{Q_0}{Q_i} = \frac{1}{(S R_1 A_1 + 1)(S R_2 A_2 + 1)(S R_3 A_3 + 1)}$$

2 Fev 1999

3.

4	1	3	K
3	2	4	0
2	1	K	0
1	4-2K	0	
0	K		

$$6-4$$

$$\frac{2\times 3-4}{2}=1$$

$$\frac{2K-0}{2}=2K$$

$$\frac{4-2K}{1}$$

$$\frac{\cancel{(4-2K)}K-0}{\cancel{4-2K}}$$

$$4-2K>0$$

$$-2K>-4$$

$$K<2$$

$$K>0$$

$$0<K<2$$

4.

calc MP $\left(y(t_p)=1{,}163;\ y(\infty)=1 \right)=0{,}163$

$M_p=0{,}163 \Rightarrow \xi \simeq 0{,}5 \Rightarrow \omega_n=9.$

5.

$$K_p=\frac{10\times 2}{3\times 5}=1{,}33^{\circ}$$

$G(s) \rightarrow K_p$ tipo sistema e sinal

$\Downarrow$

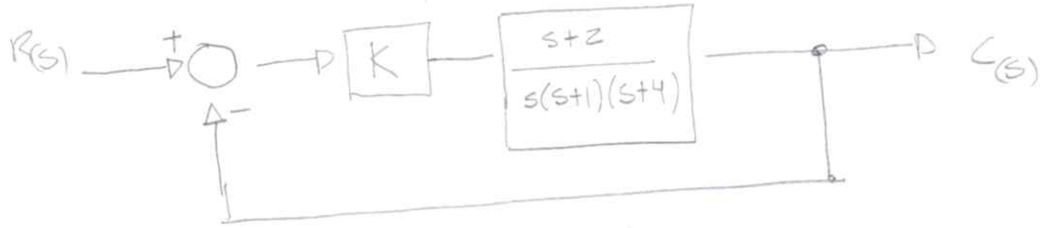
e_{ss}

$$e_{ss}=\frac{1}{1+K_p}=0{,}428$$

6.

2 Fev 1999

2ª parte



$K>0$

$$FTMF = \frac{K\frac{s+2}{s(s+1)(s+4)}}{1+\boxed{K\frac{s+2}{s(s+1)(s+4)}}}$$

↓

FTLG

1a) $K>0$ = ? estável.

1b) $K=?$ se $e_{ss}=0{,}1$ e $R(s)=\frac{1}{s^2}$

1c) lugar Geométrico de raízes

1d) diagrama de Bode da Amplitude

a)

$s(s+1)(s+4)+K(s+2)$

$(s^2+s)(s+4)+K(s+2)$

$s^3+4s^2+s^2+4s+Ks+2K$

$s^3+5s^2+(K+4)s+2K$

FTTMF → D-Routh Hurwitz

3	1	K+4
2	5	2K
1	$\frac{3K+20}{5}$	0
0	2K	

$$\frac{5K+20-2K}{5} = \frac{3K+20}{5}$$

b)

FTMA → $b=1 \wedge e_{ss}$

$$\begin{cases}\frac{3K+20}{5}>0\\ 2K>0\end{cases} \quad \begin{cases}3K+20>0\\ \underline{K>0}\end{cases} \quad \begin{cases}3K>-20\\ \end{cases} \quad \begin{cases}K>\frac{-20}{3}\\ \end{cases}$$

$$b=1 \Rightarrow \lim_{s\to 0} \cancel{s}\cdot\frac{K(s+2)}{\cancel{s}(s+1)(s+4)} = \lim_{s\to 0}\frac{K\,2\left(\frac{s}{2}+1\right)}{(s+1)\,4\left(\frac{s}{4}+1\right)}$$

$$K_v = \frac{1}{2}K$$

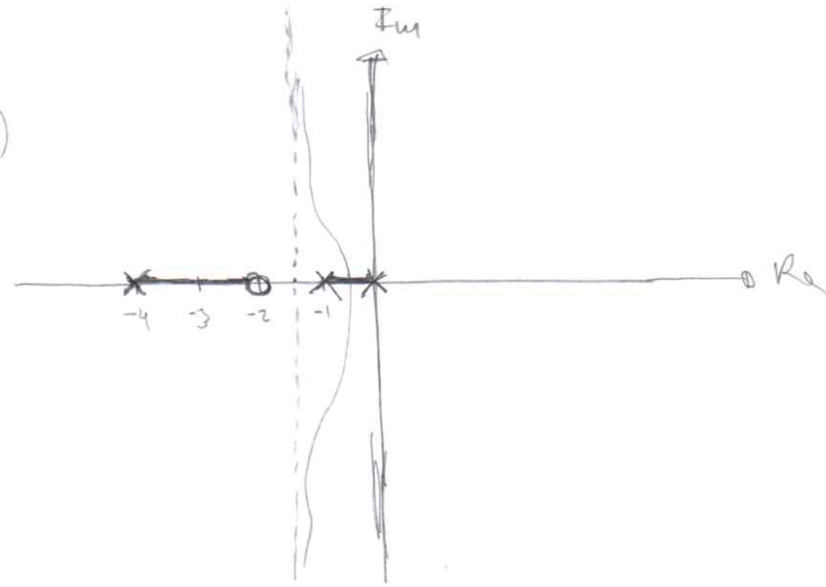
$$e_{ss} = \frac{1}{K_v} = \frac{1}{\frac{K}{2}} = \boxed{\frac{2}{K}} = 0{,}1$$

$$K = \frac{2}{0{,}1} = 20$$

c) FTMA → LGR

{ Zeros, Polos, Angl

$$K \cdot \frac{s+2}{s(s+1)(s+4)}$$



3 Branches

2 Asymptotes

90°

270

-1,5

$$s^3+5s^2+(K+4)s+2K=0$$

$$s^3+5s^2+Ks+4s+2K=0$$

$$s^3+5s^2+(s+2)K+4s=0$$

$$(s+2)K=-(s^3+5s^2+4s)$$

$$K=\frac{-(s^3+5s^2+4s)}{(s+2)}$$

$$\frac{d}{dt}K=0 \qquad 0=-\left[(3s^2+10s+4)(s+2)-(s^3+5s^2+4s)\right]$$

$$+20s+4s$$

$$3s^3+6s^2+10s^2+8-s^3-5s^2-4s=0$$

$$2s^3+11s^2+20s+8=0$$

$$x=-0{,}549$$

d)

Exame

19 Julho 2016

consider a system with the T.F $G(s)$ the closed loop T.F include P.I.D controller and a unity feed back loop. tune the controller by the method zeigler-nichols open-loop.

$$G(s) = \frac{5 \cdot e^{-1,5s}}{s}$$

$$\left[\begin{array}{l} K'p = 5 \\ T = 1,5 \end{array}\right]$$

$$\omega_2 = \frac{K'p \cdot e^{-st}}{s}$$

Applying the formulas from the table:

$$K = \frac{1,2}{T \cdot K'_p} \Leftrightarrow K = 0,16$$

$$T_i = 2T \Leftrightarrow T_i = 3$$

$$T_d = 0,5T \Rightarrow T_d = 0,75$$

— // —

2 Julho 2012

consider a open loop transfer function $G(s)$ tune the P.I.D controller by the method cohen-coon.

cohen-coon use Model 1 ω_1

$$\omega_1 = \frac{K_p \cdot e^{-st}}{s\tau + 1} \qquad G(s) = \frac{7 e^{-3s}}{5s+1}$$

$K_p = 7$

$T = 3$

$\tau = 5$

Applying the formulas from the table:

$$K \to \frac{\tau}{T K_p}\left(1,35 + 0,27 \frac{T}{5}\right) \Rightarrow K = 0,36$$

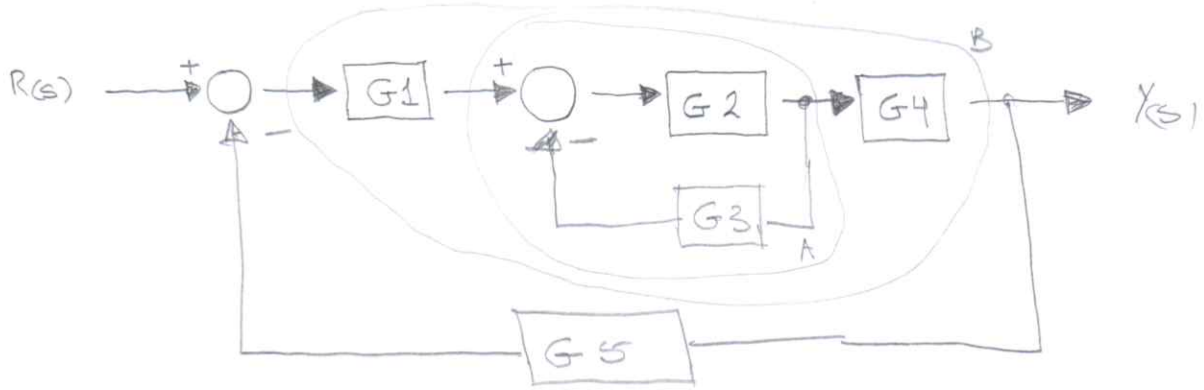
$$T_i \to T \left(\frac{2,5 + 0,5 T/\tau}{1 + 0,6 T/\tau}\right) \Rightarrow T_i = 6,176$$

$$T_d \to T\left(\frac{0,37}{1 + 0,2 T/\tau}\right) \Rightarrow T_d = 0,991$$

tesis practica.

29 Junho 2019

1.



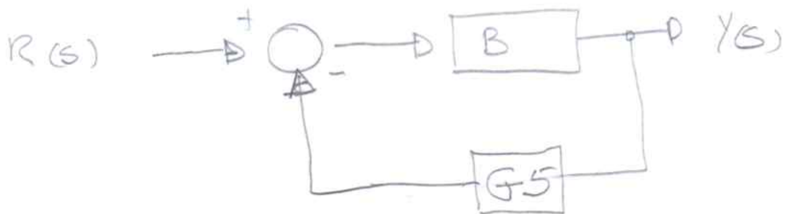
1. simplify feedback loop:

$$A = \frac{G2}{1+G2G3}$$

2. simplify block in cascade:

$$B = G1 \cdot \frac{G2}{1+G2G3} \cdot G4 = \frac{G1G2G4}{1+G2G3}$$

3. simplify feedback loop:



$$\frac{Y(s)}{R(s)} = \frac{B}{1+B.G5} = \frac{\frac{G1G2G4}{1+G2G3}}{1+\frac{G1G2G4}{1+G2G3} \cdot G5}$$

$$= \frac{G1G2G4}{1+G2G3+G1G2G4G5} = \frac{G1.G2G4}{1+G2(G3+G1.G4G5)}$$

C

2. teste prática 29 Junho 2019

TANK 1
①

$$\begin{cases} q_i = q_0 + q_1 + A_1 \frac{d}{dt} h_1 \\ q_1 = \frac{h_1 - h_2}{R_1} \\ q_0 = \frac{h_1}{R_0} \end{cases}$$

TANK 2
②

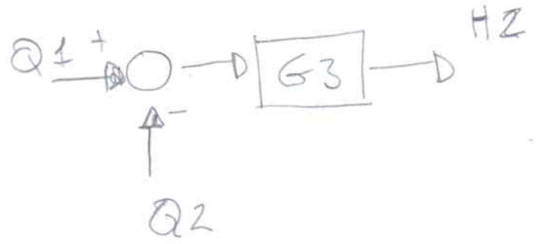
$$\begin{cases} q1 = q2 + A_2 \frac{d}{dt} h_2 \\ q2 = \frac{h_2 - h_3}{R_2} \end{cases}$$

TANK 3
③

$$\begin{cases} q2 = q3 + A_3 \frac{d}{dt} h_3 \\ q3 = \frac{h_3}{R_3} \end{cases}$$

$\boxed{D}$

3.



$$G3 = \frac{H2(s)}{Q_1(s) - Q_2(s)}$$

$$\therefore \quad q1 - q2 = A2 \frac{d}{dt} h_2$$

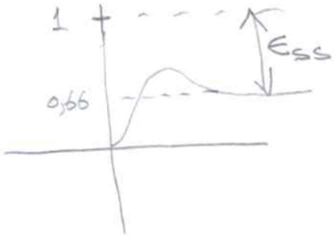
$$Q_1(s) - Q_2(s) = A_2 \, s \, H_2(s)$$

$$\boxed{\frac{1}{A_2 s}} = \frac{H2(s)}{Q_1(s) - Q_2(s)}$$

$\boxed{A}$

tesis pracdica 29 Junho 2019

4.



$E_{ss} = 1 - \frac{2}{3}$

$= \frac{1}{3}$

estável em 0,66

sistema tipo 1 e Diagrama unitario

$E_{ss} = \phi \Rightarrow \cancel{\boxed{B}}$ não pode ser

$\boxed{\text{ver tabela}}$

sistema tipo ϕ e Diagrama unitario

caso $\boxed{A}$ $K_p = \frac{4}{(s+1)(s+2)} = 2 \Rightarrow \frac{1}{1+2} = \boxed{\frac{1}{3}}$

caso $\boxed{B}$ $K_p = \frac{2}{(s+1)(s+3)} = 0,5 \Rightarrow \frac{1}{1+0,5} = \frac{2}{3}$

logo é a $\boxed{A}$

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

$e_{ss} = \lim_{s \to 0} \frac{\cancel{s}}{1 + G(s)} \cdot \frac{1}{\cancel{s}}$

$= \frac{1}{1 + \underbrace{\lim_{s \to 0} G(s)}_{K_p}}$

$\frac{\frac{4}{\cancel{(s+1)(s+2)}}}{\frac{(s+1)(s+2) + 4}{\cancel{(s+1)(s+2)}}}$

0,0877

$4 \times x = 6$

1,5

$\frac{4}{x} = 6$

$\frac{4}{(s+1)(s+2)+4} = \frac{\frac{4}{6} \times 6}{s^2+2s+s+2+4}$

$\sqrt{6}$

$2 \cdot \xi \omega_n = 3$ $\quad s^2 + 3s + 6$ 0,612

11,2%

tesis practica 29 Junho 2019.

5) $t_p = 1{,}6223$ seg

$x(t_p) = 0{,}1444$

$$x(t_p) = K\left(1 + e^{-\pi \xi / \sqrt{1-\xi^2}}\right)$$

$\Downarrow$

$0{,}1 \Rightarrow \xi = 0{,}25 \Rightarrow \omega_n = 2$

$\Downarrow$

$0{,}15 \Rightarrow \xi = 0{,}35 \Rightarrow \omega_n = 1$

$\Downarrow$

$0{,}2 \Rightarrow \xi = 0{,}15 \Rightarrow \omega_n = 3$

$$t_p = \frac{\pi}{\omega_n \cdot \sqrt{1+\xi^2}}$$

$$0{,}1444 = 0{,}1\left(1 + e^{-\pi \xi / \sqrt{1-\xi^2}}\right)$$

$$1{,}444 = 1 + e^{-\pi \xi / \sqrt{1-\xi^2}}$$

$$0{,}444 = e^{-\pi \xi / \sqrt{1-\xi^2}}$$

$\Downarrow$

$M_p \Rightarrow \xi = 0{,}25 \Rightarrow \omega_n = 2$

logo $0{,}1 \Rightarrow 0{,}25 \Rightarrow 2$ ✓

$\boxed{A}$

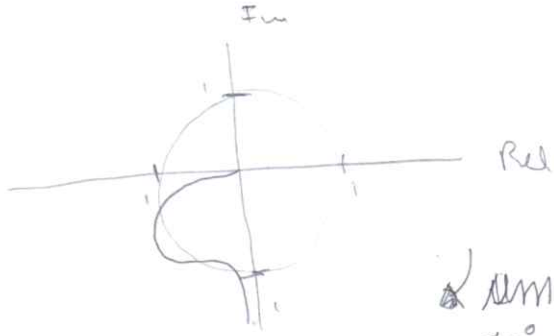
test $\boxed{B}$

$\boxed{\text{Mp da negativo}}$ X

tesis practica. 29 Junho 2019.

6.

caso A $\frac{1}{s(s+1)}$

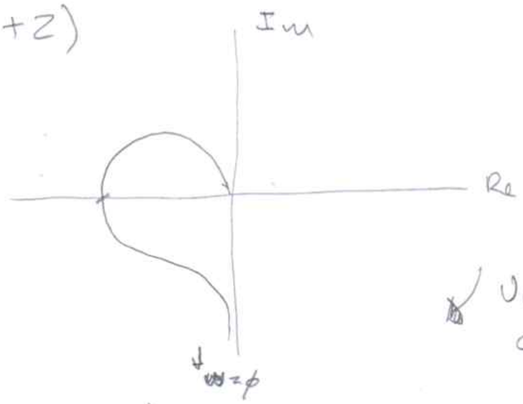


Não tem Margem de fase logo não pode ser

Um s 90°

Um (s+1) 90° curvatura

caso B $\frac{1}{s(s+1)(s+2)}$



Um s 90°

Dois (s+1) e (s+2) Duas curvaturas 90°

fazer contas.

MF calc

$s = x$

$$\text{solve}\left(\frac{1}{x \cdot \sqrt{x^2+1} \cdot \sqrt{x^2+2^2}} = 1, x\right)$$

$\boxed{|G(j\omega)| = 1}$ Low

$\Rightarrow 0{,}4457$ ✓ $0{,}4457 \rightarrow \omega$

$$MF = 180° + \text{Arg}\left(\frac{1}{Wj \times (Wj+1)(Wj+2)}\right)\Bigg|_{\omega = 0{,}4457}$$

$= 53{,}410°$ ✓

MG calc

$\boxed{\text{Arg}[G(j\omega)] = -\pi}$ Low

$\boxed{B}$ ✓

$$\text{solve}\left(-90 - tg^{-1}(\omega) - tg^{-1}\left(\frac{\omega}{2}\right) = -180°\right) \Rightarrow W = 1{,}414$$

$$GM = \frac{1}{|G(j\omega)|}$$

$\omega \cdot \sqrt{\omega^2+1} \cdot \sqrt{\omega^2+2} = 5{,}998$

$GM_{dB} = 20 \log GM$

$= 20 \log 5{,}998$

$= 15{,}56\, dB$