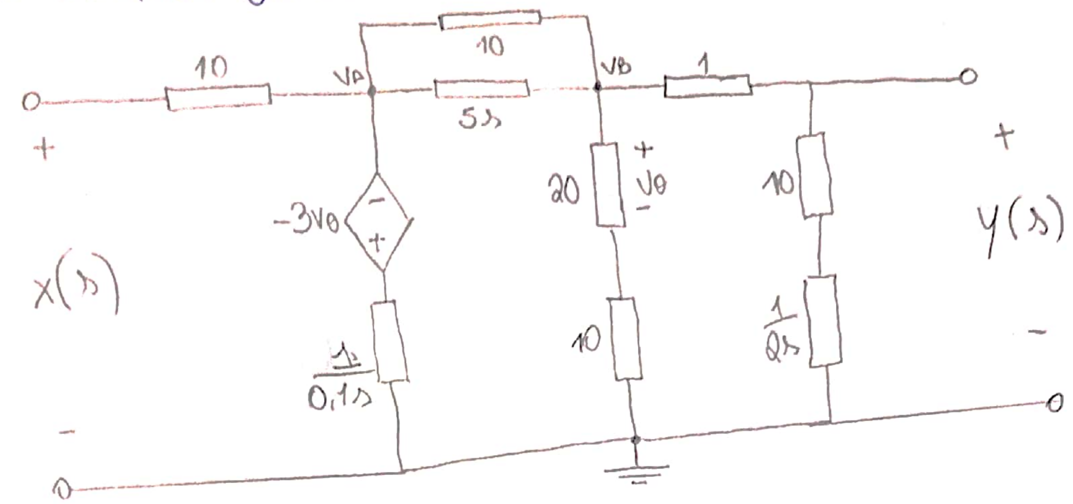
Moiron Schmeider Cardoso



$$\frac{V_A - X(s)}{10} + \frac{V_A - V_B}{10+5s} + \frac{V_A - V_B}{\frac{1}{0{,}1s}} = 0$$

EQ DE CORRENTE

(I) $V_A\left(\frac{1}{10} + \frac{1}{10} + \frac{1}{5s} + 0{,}1s\right) - V_B\left(\frac{1}{10} + \frac{1}{5s} + \frac{3 \cdot 20}{20+10} \cdot 0{,}1s\right) = \frac{1}{10}X(s)$

A, B, C

$$\frac{V_B - 0}{20+10} + \frac{V_B}{1+10+\frac{1}{2s}} + \frac{V_B - V_A}{10+5s} = 0$$

(II) $-V_A\left(\frac{1}{10} + \frac{1}{5s}\right) + V_B\left(\frac{1}{20+10} + \frac{1}{11+\frac{1}{2s}} + \frac{1}{10} + \frac{1}{5s}\right) = 0$

D, E

(III) $Y = V_B\left(\frac{10+\frac{1}{2s}}{11+\frac{1}{2s}}\right)$

F

$$\begin{cases} AV_A + BV_B = C \\ -V_A D + V_B E \\ Y = V_B \cdot F \end{cases} \rightsquigarrow \boxed{G = \frac{C \cdot F}{\frac{AE}{D} + B}}$$

MATLAB $\rightsquigarrow$

$$G = \frac{60s^2 + 123s + 6}{280s^3 + 636s^2 + 319s + 8}$$

Calculo do ER através do teorema do valor final com $\boxed{C = \frac{1}{s}}$

$$y(\infty) = \lim_{s\to\infty} \cancel{s} \cdot \frac{1}{\cancel{s}}\left(1 - \frac{60s^2+123s+6}{280s^4+636s^3+379s^2+131s+6}\right) = 1$$

$y(\infty) = 1 \rightarrow \frac{6}{6} = 1$

$E_{RP} = |1-1| = 0$

CRITÉRIO DE ESTABILIDADE

$$G(s) = \frac{60s^2+123s+6}{280s^3+636s^2+319s+8}$$

$$C = \frac{K(s+1)}{s}$$

$q(s) = s(280s^3+636s^2+319s+8) + K(s+1)(60s^2+123s+6)$

$q(s) = 280s^4 + 636s^3 + 319s^2 + 8s + 60Ks^3 + 123Ks^2 + 6Ks + 60Ks^2 + 123Ks + 6K$

$q(s) = 280s^4 + (636+60K)s^3 + (319+183K)s^2 + (8+126K)s + 6K$

s^4	280	319+183K	6K
s^3	636+60K	8+126K	0
s^2	b_1	b_2	0
s^1	c_1	0	0
s^0	d_1	0	0

$$b_1 = \frac{(636+60K)(319+183K) - 280(8+126)}{636+60K}$$

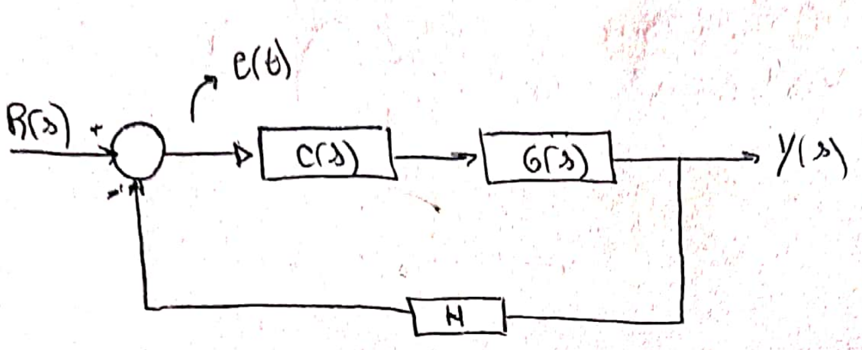
$$b_1 = \frac{2745K^2 + 25062K + 50161}{15K+159}$$

$d_1 = 6K \rightarrow \boxed{K>0}$

$$C_1 = \frac{340470K^3 + 3065292K^2 + 5914038K + 401288}{2745K^2 + 25062K + 50161}$$

$\boxed{K > -2{,}963}$

Método de construção prático do controlador



Através do cálculo do pid, temos que o controlador genérico tem a forma:

$$u(t) = K\left(e(t) + \frac{1}{T_i}\int_0^T e(\tau)\,d\tau + T_d \frac{de(t)}{dt}\right)$$

O controlador P-I é definido como

$$u(t) = K\,e(t) + \frac{K}{T_i}\int_0^t e(\tau)\,d\tau$$

Considerando um controlador igual à:

$$C(s) = 1 + \left(1 + \frac{1}{T_i \cdot s}\right)$$

$\downarrow$ $K_p = 1$ $\uparrow$ $K_i = 1$

$$V_c = V_{out} - V_{in} \cdot R_8$$

$$V_{in} = \frac{C \cdot dv}{dt}$$

$$V_{in} = -C\,\frac{d(V_{out} - V_{in} \cdot R_8)}{dt}$$

$$\frac{dt - V_{in} - dV_{in}}{C} R_8 = dV_{out}$$

$$= -\frac{1}{RC}\int V_{in} \cdot dt - \frac{R_2}{R_1} V_{in}$$