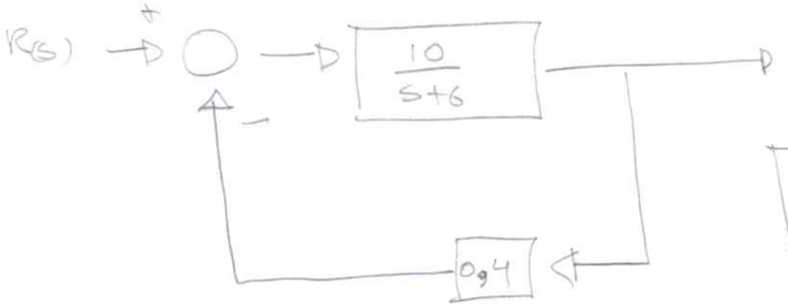
1 b)

Practico



$$\boxed{K = \lim_{s \to 0} \frac{Y(s)}{R(s)}}$$

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

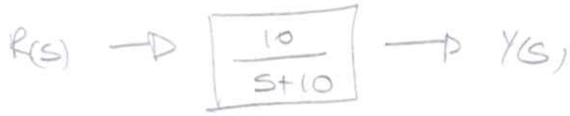
$$\frac{\frac{10}{s+6}}{1 + \frac{10}{s+6} \cdot 0{,}4} = \frac{\frac{10}{\cancel{s+6}}}{\frac{(s+6) + 10 \cdot 0{,}4}{\cancel{(s+6)}}}$$

$$GH(s) = \frac{4}{s+6} \to F(s) = s+6+4$$

1+LG

$$= \frac{10}{(s+6)+4}$$

$$= \frac{10}{s+10}$$



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

$$Y(s) = \frac{1}{s} \cdot \frac{10}{s+10} = \frac{A}{s} + \frac{B}{s+10}$$

$$A = \frac{10}{\cancel{s}(s+10)} \cancel{s} \Big|_{s=0} = 1 \qquad \Rightarrow Y(s) = \frac{1}{s} - \frac{1}{s+10}$$

$$B = \frac{10}{s\cancel{(s+10)}} \cancel{(s+10)} \Big|_{s=-10} = -1$$

$$K = \lim_{s \to 0} \frac{10}{10(1+\frac{s}{10})} = 1$$

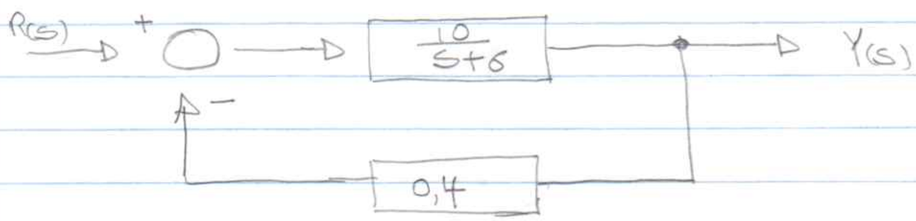
$\tau = \frac{1}{10}$

$T_r = 0{,}219$ seg

$T_s = 0{,}4$

$$Y_t = 1(1 - e^{-10t})$$

1 b)



- transfer function:

$$\frac{Y(s)}{R(s)} = \frac{\frac{10}{s+6}}{1+0{,}4 \cdot \frac{10}{s+6}} = \frac{10}{(s+6)+4} = \frac{10}{s+10}$$

c.a)

$$\frac{Y(s)}{R(s)} = \frac{10}{10(0{,}1s+1)} = \frac{1}{0{,}1s+1} \Rightarrow \begin{matrix} K=1 \\ \tau = 0{,}1 \text{ seg} \end{matrix}$$

- step response:

$$R(s) = \frac{1}{s} \Rightarrow Y(s) = \frac{1}{s} \cdot \frac{10}{s+10} = \frac{10}{s(s+10)}$$

- Expand into partial fraction:

$$Y(s) = \frac{A}{s} + \frac{B}{s+10}$$

A: $\left[\cancel{s} \frac{10}{\cancel{s}(s+10)} \right]_{s=0} = \frac{10}{10} = 1$

B: $\left[(s+10) \cdot \frac{10}{s(s+10)} \right]_{\substack{s+10=0 \\ s=-10}} = -\frac{10}{10} = -1$

$$Y(s) = \frac{1}{s} - \frac{1}{s+10}$$

- Applying inverse Laplace transform:

$$y(t) = \mathcal{L}^{-1}\left\{\frac{1}{s}\right\} - \mathcal{L}^{-1}\left\{\frac{1}{s+10}\right\}$$

$$= 1 - e^{-10t}, \quad t \geq 0$$

1 b) continuação

- DC Gain (K):

$$K = \lim_{s \to 0} \frac{Y(s)}{R(s)} = \lim_{s \to 0} \frac{10}{s+10} = 1$$

- system time constant (τ):

$$y(t)\Big|_{t=\tau} = 0,632 \Rightarrow 1 - e^{-10t} = 0,632$$
$$0,368 = e^{-10\tau}$$
$$\ln(0,368) = \ln(e^{-10\tau})$$
$$\ln(0,368) = -10\tau$$
$$\tau = 0,1 \text{ sec}$$

or Direct from T.F. (transfer function) Pole
$(s+10)$: $\tau = \frac{1}{a} = \frac{1}{10} = 0,1$ sec

- Rise time (t_r): from 10% to 90%

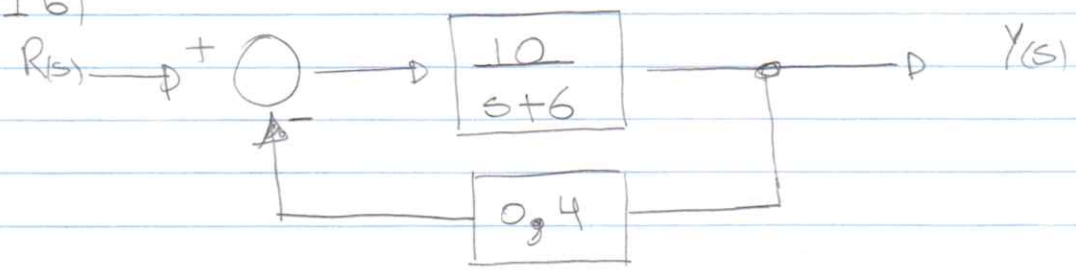
$$Y(t_1) = 0,1 \Rightarrow 1 - e^{-10t} = 0,1 \Rightarrow t_1 = 0,011 \text{ sec}$$
$$Y(t_2) = 0,9 \Rightarrow 1 - e^{-10t} = 0,9 \Rightarrow t_2 = 0,230 \text{ sec}$$

$$t_r = t_2 - t_1 = 0,230 - 0,011$$
$$= 0,219$$

- settling time (t_s):

$$\boxed{t_s = 4 \times \tau} = 4 \times 0,1 = 0,4 \text{ sec.}$$

1b)



1. Determinar a resposta ao degrau unitário:

1. − Determinar a função de transferência [F.T]

$$\frac{Y(s)}{R(s)} = \frac{\frac{10}{s+6}}{1+\frac{10}{s+6}\cdot 0{,}4} = \frac{10}{s+10}$$

$$R(s) = \frac{1}{s} \Rightarrow Y(s) = \frac{10}{s+10}\cdot\frac{1}{s}$$

$$= \frac{10}{s(s+10)}$$

$$= \frac{a}{s} + \frac{b}{s+10}$$

$$a = \left.\frac{10}{s+10}\right|_{s=0} \Leftrightarrow a = 1$$

$$b = \left.\frac{10}{s}\right|_{s=-10} \Leftrightarrow b = -1$$

$$Y(s) = \frac{1}{s} - \frac{1}{s+10} \quad \mathcal{L}^{-1} \quad Y(t) = 1 - e^{-10t}$$

- constante de tempo, τ

$$Y(t)\Big|_{t=\tau} = 0{,}632 \Leftrightarrow 1 - e^{-10t} = 0{,}632$$

$$-10\tau = \ln(0{,}632)$$

$$\tau = 0{,}09 \cong 0{,}1$$

ou

$$\tau = \frac{1}{a} \Leftrightarrow \tau = \frac{1}{10} = 0{,}1$$

- tempo de subida, t_r

$$\begin{cases} Y(t_1) = 0{,}1 \\ Y(t_2) = 0{,}9 \end{cases} \Leftrightarrow \begin{cases} 1 - e^{-10t_1} = 0{,}1 \\ 1 - e^{-10t_2} = 0{,}9 \end{cases} \Leftrightarrow \begin{cases} t_1 = 0{,}01 \text{ sec} \\ t_2 = 0{,}23 \text{ sec} \end{cases}$$

1b) continuação

$$t_r = t_2 - t_1 = 0,23 - 0,01 = 0,22 \text{ sec}$$

- tempo de estabilidade t_s

$$|Y(t_s) - 1| = 0,02 \qquad [2\%]$$

$$|1 - e^{-10t_s} - 1| = 0,02$$

$$e^{-10t_s} = 0,02 \Leftrightarrow t_s = 0,39 \text{ sec.}$$

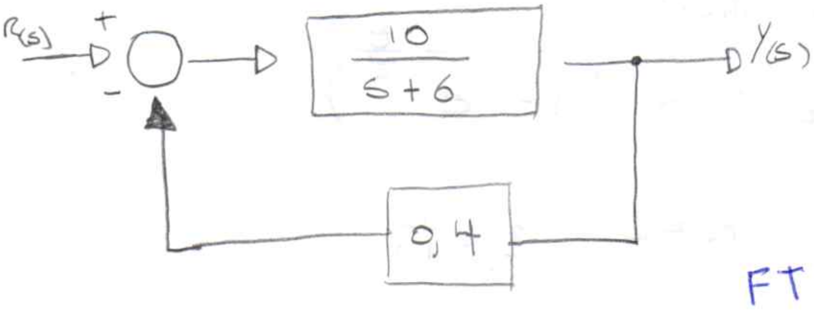
ou

$$t_s = 4\tau \cong 0,4 \text{ sec}$$

teseio

1

b)



FTMF

Jump out.

$$\frac{Y(s)}{R(s)} = \frac{\frac{10}{s+6}}{1 + \frac{4}{10}\cdot\frac{10}{s+6}} = \frac{10}{s+6} \cdot \frac{1}{1+\frac{4}{10}\cdot\frac{10}{s+6}}$$

10×1

$$(s+6)\left(1+\frac{4}{10}\cdot\frac{10}{s+6}\right) = (s+6) + \frac{4 \cdot \cancel{10} \cdot \cancel{(s+6)}}{\cancel{10}\,\cancel{(s+6)}}$$

$$= (s+6) + 4$$

$$\therefore \quad \frac{10}{s+10} = \frac{Y(s)}{R(s)}$$

se $R(t) = u(t) \Rightarrow R(s) = \frac{1}{s}$

$$Y(s) = \frac{1}{s} \cdot \frac{10}{s+10} = \frac{10}{s(s+10)} = 10 \times \frac{1}{s(s+10)}$$

$$10 \times \frac{1}{s(s+10)}$$

$$\frac{1}{s(s+10)} = \frac{A}{s} + \frac{B}{s+10}$$

$$A = \frac{1}{s+10}\Bigg|_{0} = \frac{1}{10} \qquad \therefore \left(\frac{\frac{1}{10}}{s} + \frac{-\frac{1}{10}}{s+10}\right) \times 10$$

$$B = \frac{1}{s}\Bigg|_{-10} = -\frac{1}{10} \qquad = \frac{1}{s} - \frac{1}{s+10}$$

$$\Rightarrow \quad Y(t) = 1 - e^{-10t} \qquad t > 0$$

$$y_{(t)} = 1 - e^{-10t}$$

canonico

$$y_{(t)} = K\left(1 - e^{-\frac{t}{\tau}}\right)$$

$\therefore \quad K = 1 \qquad \tau = \frac{1}{10}$

$$t_s|_{2\%} = 4 \times \tau = \frac{4}{10} = 0{,}4$$

$$t_r = (y_{(t)} = 0{,}9) - (y_{(t)} = 0{,}1)$$

$0{,}9 = 1 - e^{-10t} \Rightarrow t = 0{,}23$

$0{,}1 = 1 - e^{-10t} \Rightarrow t = 0{,}01$

$$t_r = 0{,}23 - 0{,}01 = 0{,}22$$

$\therefore$

$K = 1 \;;\; \tau = \frac{1}{10} \;;\; t_r = 0{,}22 \;,\; t_s = 0{,}4$