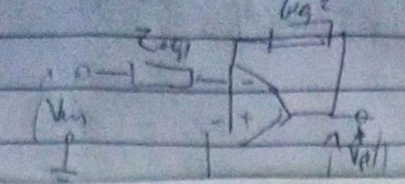
Prueba (1

a) $G = -\frac{R_2}{R_1} = \frac{V_o}{V_{in}}$




$$C_1 = 0{,}1 \cdot 10^{-3} \rightarrow \frac{1}{s \cdot 0{,}1 \cdot 10^{-3}} = \frac{10^4}{s} = \boxed{\frac{10 \cdot 10^3}{s}}$$

$$Z_{eq1} = \frac{(R_1 + C_1) \cdot R_2}{R_1 + C_1 + R_2} \qquad \frac{\left(2{,}4 \cdot 10^3 + \frac{10 \cdot 10^3}{s}\right) \cdot 1{,}6 \cdot \cancel{10^3}}{\left(2{,}4 + \frac{10}{s} + 1{,}6\right) \cdot \cancel{10^3}}$$

$$Z_{eq1} = \frac{1{,}6 \cdot 10^3 \cdot \left(2{,}4 + \frac{10}{s}\right)}{\left(4 + \frac{10}{s}\right)}$$

$$Z_{eq1} = \left(3{,}84 + \frac{16}{s}\right) \cdot 10^3 \cdot \left(\frac{s}{4s + 10}\right) = \frac{3840 s}{4s + 10} + \frac{16 \cdot 10^3 \cdot s}{s(4s + 10)}$$

$$Z_{eq1} = \frac{3840 s^{\cancel{2}} + 16 \cdot 10^3 \cancel{s}}{\cancel{s}(4s + 10)} = \boxed{\frac{3840 s + 16 \cdot 10^3}{4s + 10}}$$

$$Z_{eq2} = \frac{(R_3 + C_2) \cdot R_4}{R_3 + R_4 + C_2} \Rightarrow C_2 = 0{,}2 \cdot 10^{-3} \rightarrow 2 \cdot 10^{-4} \rightarrow \frac{10^4}{2s} = \boxed{\frac{5 \cdot 10^3}{s}}$$

$$\frac{\left(10^3 + \frac{5 \cdot 10^3}{s}\right) \cdot 6{,}8 \cdot \cancel{10^3}}{\cancel{10^3}\left(1 + 6{,}8 + \frac{5}{s}\right)} = \frac{6{,}8 \cdot 10^3 \left(1 + \frac{5}{s}\right)}{\left(7{,}8 + \frac{5}{s}\right)} = \frac{6{,}8 \cdot 10^3 \left(\frac{s + 5}{s}\right)}{\frac{7{,}8 s + 5}{s}}$$

$$6{,}8 \cdot 10^3 \left(\frac{s + 5}{\cancel{s}}\right) \cdot \frac{\cancel{s}}{7{,}8 s + 5} = \boxed{\frac{6{,}8 \cdot 10^3 s + 34 \cdot 10^3}{7{,}8 s + 5}}$$

$$-\frac{Z_{eq2}}{Z_{eq1}} = \frac{6{,}8 \cdot \cancel{10^3} s + 34 \cdot \cancel{10^3}}{(7{,}8 s + 5)} \cdot \frac{(4s + 10)}{3{,}84 s \cancel{10^3} + 16 \cdot \cancel{10^3}} = \frac{27{,}2 s^2 + 68 s + 136 s + 340}{29{,}95 s^2 + 124{,}8 s + 19{,}2 s + 80}$$

$$-\frac{Z_{eq2}}{Z_{eq1}} = \frac{27{,}2 s^2 + 204 s + 340}{29{,}95 s^2 + 144 s + 80}$$

dividiendo por 29,95 $\Rightarrow$

$$\boxed{-\frac{0{,}9 s^2 + 6{,}81 s + 11{,}35}{s^2 + 4{,}80 s + 2{,}67}}$$

$\left(3{,}84 + \frac{16}{5}\right) \cdot \left(7{,}4 + \frac{5}{5}\right)$ | 28,41

b) $-\frac{R_6}{R_5} = G = \frac{55\cancel{0}}{100\cancel{0}} = -0{,}55$

① ©

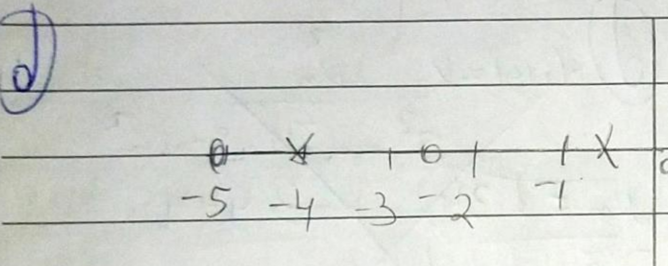
$$V_{in} \rightarrow \boxed{G_1} \rightarrow \boxed{G_2} \rightarrow V_{out}$$

$$V_{out} = V_{in} \cdot G_1 \cdot G_2 \qquad \frac{V_{out}}{V_{in}} = G_1 \cdot G_2$$

$$G_{Total} = 0{,}55 \cdot \frac{0{,}9s^2 + 6{,}81s + 11{,}35}{s^2 + 4{,}8s + 2{,}67}$$

$$G_T = \frac{0{,}495s^2 + 3{,}745s + 6{,}242}{s^2 + 4{,}8s + 2{,}67}$$

ⓓ




ⓔ $V_{in}(t) = 2\ [V]$

$$\frac{2}{s} \cdot G_T = V_{out}(s)$$

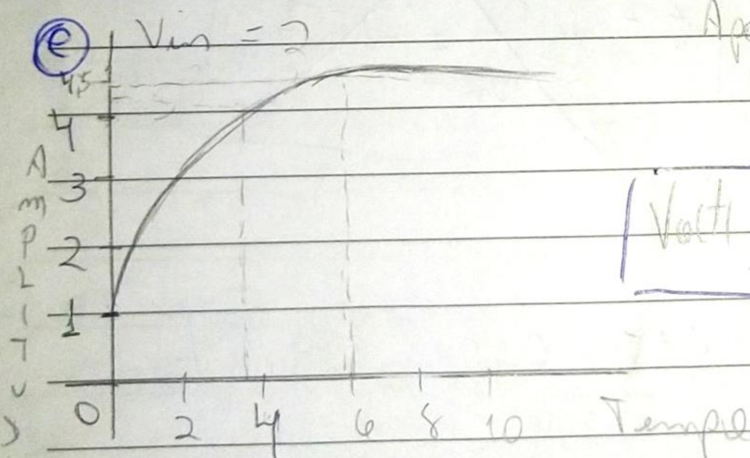
$$F(s) = \frac{2(0{,}495s^2 + 3{,}74s + 6{,}24)}{s(s^2 + 4{,}8s + 2{,}67)}$$

A partir do MATLAB

$$\frac{4{,}67}{s} - \frac{3{,}74s + 6{,}24}{1{,}00s^2 + 4{,}80s + 2{,}67}$$

$$\boxed{V_{out}(t) = 4{,}67 - 3{,}68e^{-2{,}4t}(\cosh(1{,}75t) + 0{,}94\,\mathrm{senh}\,t)}$$

ⓔ




ⓕ como tem $s^2$ ele é um de segunda ordem pela configuração dos polos, e olhando o gráfico eu classificaria como superamortecido.

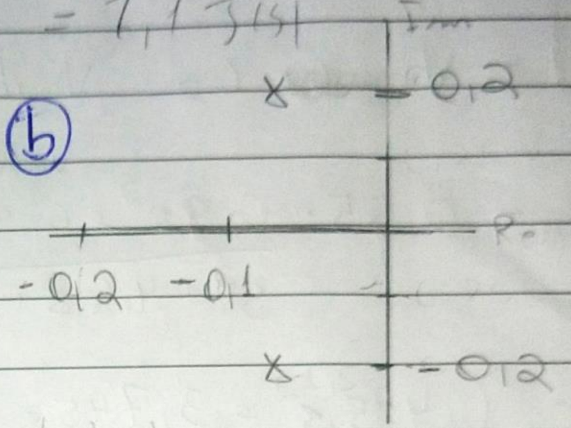
(a) $40{,}2\,\ddot{\theta}(t) + 6{,}1\,\dot{\theta}(t) + 1{,}4\,\theta(t) = 7{,}1\,T(t)$

a) $s^2\,40{,}2\,\Theta(s) + s\,6{,}1\,\Theta(s) + 1{,}4\,\Theta(s) = 7{,}1\,T(s)$

$\Theta(s)\,(s^2\,40{,}2 + s.\,6{,}1 + 1{,}4) = 7{,}1\,T(s)$

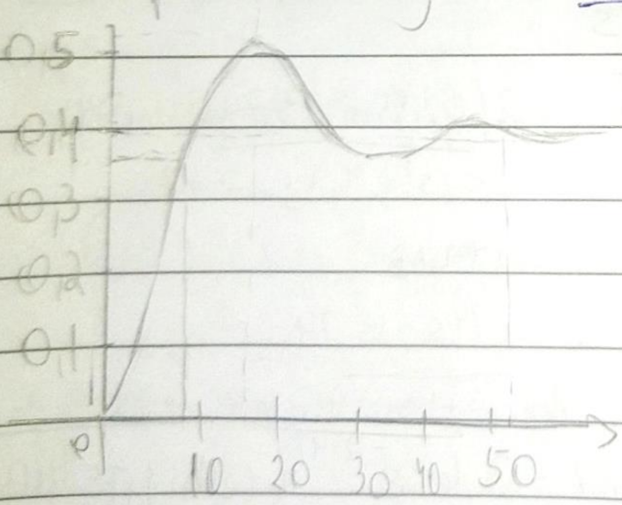
$$G = \frac{\Theta}{T} = \frac{7{,}1}{(s^2.\,40{,}2 + s.\,6{,}1 + 1{,}4)}$$

(b)




(c) Valor final $= \underline{0{,}394}$ , Instante de pico $= \underline{15{,}78} = T_p$

Tempo de acomodação $T_s = \underline{51{,}5\ s}$




(d) $G(s) = K \dfrac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$

$\omega_n = 1{,}34$ $\quad K = 3{,}944$

$2\zeta\omega_n s = 6{,}1\,s$

$\zeta = \dfrac{6{,}1}{2.\omega_n} = 2{,}27$

② d) $k = \frac{y(\infty)}{\text{amplitude}} \quad \frac{0,394}{0,1} = \boxed{3,94}$ $\quad Up = \frac{0,512 - 0,394}{0,394}$

$Up = 30\%$

$\ln 0,3 = \ln e^{\frac{-\xi\pi}{\sqrt{1-\xi^2}}}$ $\quad \ln(0,3) = \frac{-\xi\pi}{\sqrt{1-\xi^2}} \Rightarrow 1,2^2 = \left(\frac{-\xi\pi}{\sqrt{1-\xi^2}}\right)^2$

$1,45(1-\xi^2) = \xi^2\pi^2$

$1,45 = 11,3\,\xi^2$

$\xi^2 = 0,128$

$\boxed{\xi = 0,357}$

$T_p = \frac{\pi}{\omega_n\sqrt{1-\xi^2}}$

$\omega_n = \frac{\pi}{15,78}\cdot\frac{1}{\sqrt{1-\xi^2}} = 0,213$ [w/s]

2 e) não atendem

$\ln 0,05 = \ln e^{\frac{-\xi\pi}{\sqrt{1-\xi^2}}}$

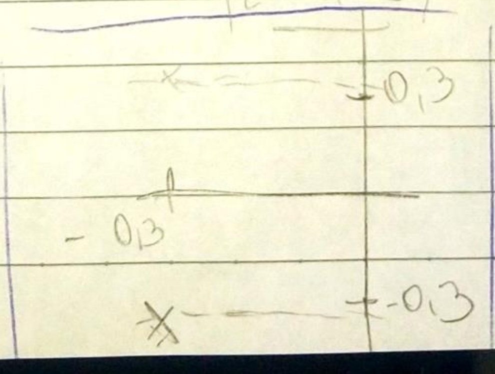
$-3 = -\frac{\xi\pi}{\sqrt{1-\xi^2}} \Rightarrow 9 = \frac{\xi^2\pi^2}{1-\xi^2} \Rightarrow 9(1-\xi^2) = \xi^2\pi^2 \therefore 9 - 9\xi^2 = \xi^2\pi^2$

$\frac{9}{18,86} = \xi^2$

$\boxed{\xi = 0,69}$

$T_p = 10 = \frac{\pi}{\omega_n\sqrt{1-\xi^2}}$

$\omega_n = \frac{\pi}{10\sqrt{1-\xi^2}} = \boxed{0,43}$



Q.1 ~~Sxx~~ Eu consideraria um sobremetal máximo admissível de 0,1%, pois visto que a precisão é muito importante por qualquer milímetro ser fatal, é bom ser cada vez mais próximo de zero