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Data: 9/3/2021   P1 - ELT 330

① Considerando o movimento vertical, temos: (Desconsiderando x_c)

Sobre o movimento de M_C:

$$\begin{cases} M_C \dfrac{d x_C}{dt} + K_S\int_0^t x_C - x_R\,dt + B_S(x_C - x_R) \Rightarrow \\ (M_C S^2 + B_S S + K_S)X_C + (-B_S - K_S)X_R = F - F = 0 \end{cases}$$

$$\begin{cases} a)\ FT = \dfrac{X_C}{F} \\ b)\ FT = \dfrac{X_R}{F} \end{cases}$$

Sobre o movimento de M_R:

$$\begin{cases} M_R \dfrac{dX_R}{dt} + B_S(X_R - X_C) + K_R\int_0^t (X_R - X_e)dt + K_S\int_0^t (X_R - X_C)\,dt \Rightarrow \\ (M_R S^2 + B_S S + (K_R + K_S))X_R + (-B_S - K_S)X_C + (-K_R)X_e = F - F \end{cases}$$

$$\begin{bmatrix} (M_C S^2 + B_S S + K_S) & (-B_S - K_S) \\ (-B_S S - K_S) & (M_R S^2 + B_S S + K_R + K_S) \end{bmatrix} \begin{bmatrix} X_C \\ X_R \end{bmatrix} = \begin{bmatrix} 0 \\ X_e \end{bmatrix} \quad \Big\{ \det A = \Delta$$

$$\underbrace{\begin{bmatrix} (253S^2 + 1145S + 8090) & (-1145S - 8090) \\ (-1145S - 8090) & (26S^2 + 1145S + 110090) \end{bmatrix}}_{A} \begin{bmatrix} X_C \\ X_R \end{bmatrix} = \begin{bmatrix} 0 \\ 102000X_e \end{bmatrix}$$

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a) $$\frac{\Delta_1}{\Delta} = \frac{102000(-1145S - 8090)X_e}{\det A} \Rightarrow FT = \frac{X_C}{X_e} = \frac{102000(-1145S - 8090)}{\det A}$$

b) $$\frac{\Delta_2}{\Delta} = \frac{102000X_e(253S^2 + 1145S + 8090)}{\det A} \Rightarrow FT = \frac{X_R}{X_e} = \frac{102000(253S^2 + 1145S + 8090)}{\det A}$$

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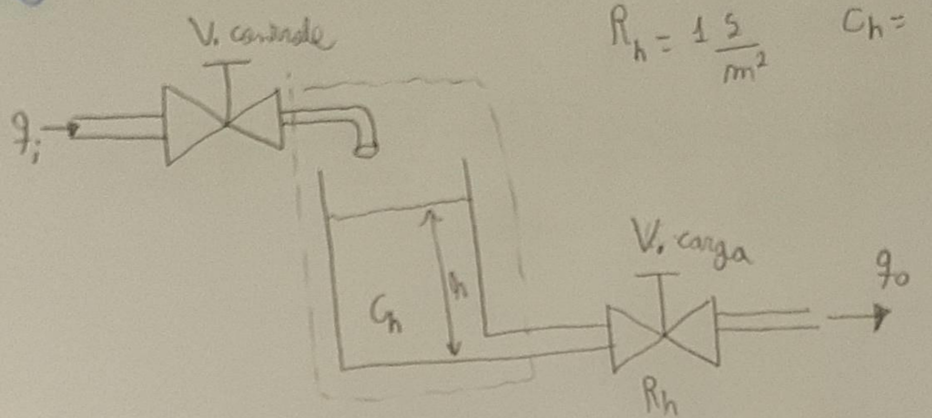
②

$R_h = 1 \frac{s}{m^2}$ $C_h = 1\ m^2$



a) $\boxed{q_i = C_h \frac{dh}{dt} + q_o}$ (1)

$q_o = \frac{h}{R_h} \Rightarrow \boxed{h = q_o \cdot R_h}$ (2)

• Aplicando Laplace em (1) e (2):

(3) $\Rightarrow Q_i = C_h S H + Q_o$

(4) $\Rightarrow H = Q_o R_h$

Substituindo (4) em (3): $Q_i = C_h R_h S Q_o + Q_o = Q_o \left[C_h R_h S + 1 \right]$

$FT = \frac{Q_o}{Q_i} = \frac{1}{C_h R_h S + 1} \Rightarrow \boxed{FT = \frac{1}{S+1}}$

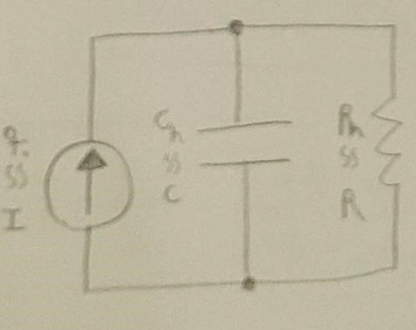
* $\int \frac{1}{A-x}\, dx = -\ln|A-x|$

b) Em $t = 0^-$ tem-se $h = 0$.

$q_i = C_h \frac{dh}{dt} + \frac{h}{R_h} \Rightarrow \frac{dh}{dt} = \frac{R_h q_i - h}{R_h C_h} \Rightarrow \frac{dh}{R_h q_i - h} = \frac{dt}{R_h C_h} \overset{*}{\Rightarrow} \ln|R_h q_i - h| = -\frac{t}{R_h C_h} \Rightarrow$

$\Rightarrow e^{-\frac{t}{R_h C_h}} = R_h q_i - h \Rightarrow \boxed{h = R_h q_i - e^{-\frac{t}{R_h C_h}}} \Rightarrow h = 1 - e^{-3} \cong 0.95\ m$

c) $q \sim I$



$q_i = 1 \frac{m^3}{s}$

$C_h = 1 m^2$

$R_h = 1 \frac{s}{m^2}$

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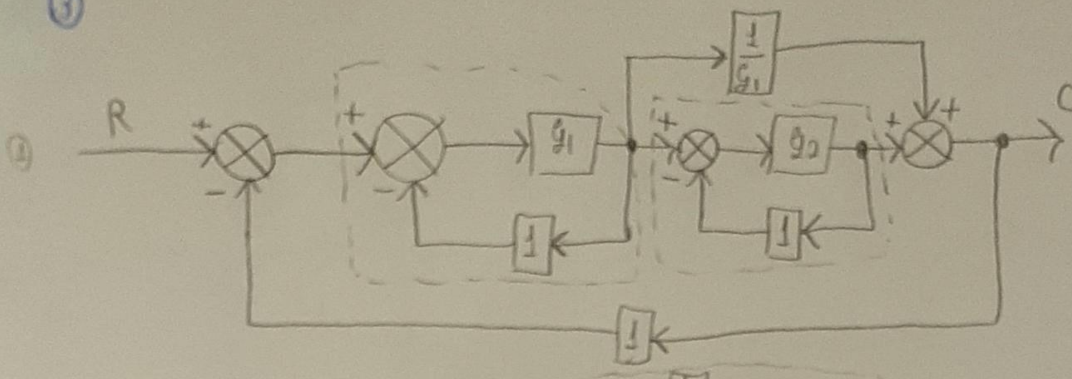
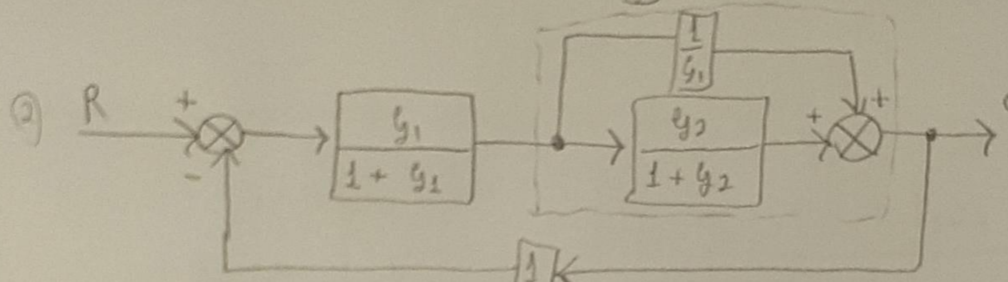
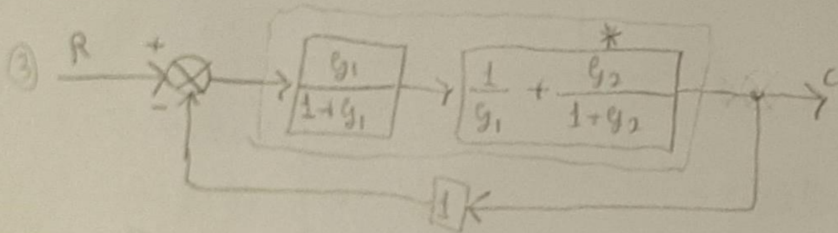
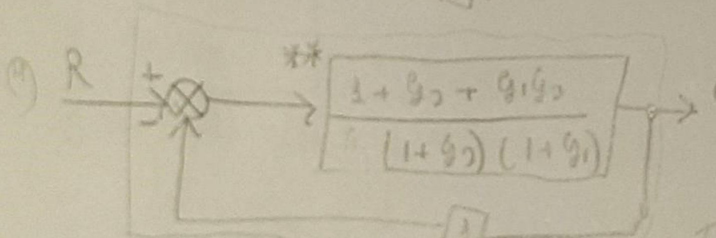
1 

2 

3 

$$* \quad \frac{1+g_2+g_1g_2}{g_1(1+g_2)}$$

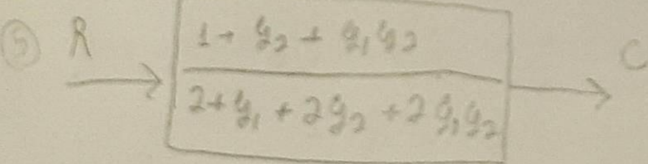
4 

$$** \quad \frac{1+g_2+g_1g_2}{\cancel{g_1}(1+g_2)} \cdot \frac{\cancel{g_1}}{1+g_1}$$

$$\frac{1+g_2+g_1g_2}{(1+g_2)(1+g_1)}$$

$$\frac{1+g_2+g_1g_2}{(1+g_1)(1+g_2)} \cdot \frac{1}{1+\frac{1+g_2+g_1g_2}{(1+g_1)(1+g_2)}}$$

$$\frac{1+g_2+g_1g_2}{1+g_1+g_2+g_1g_2+1+g_2+g_1g_2}$$

5 

$$\boxed{FT = \frac{C}{R} = \frac{1+g_2+g_1g_2}{2+g_1+2g_2+2g_1g_2}}$$

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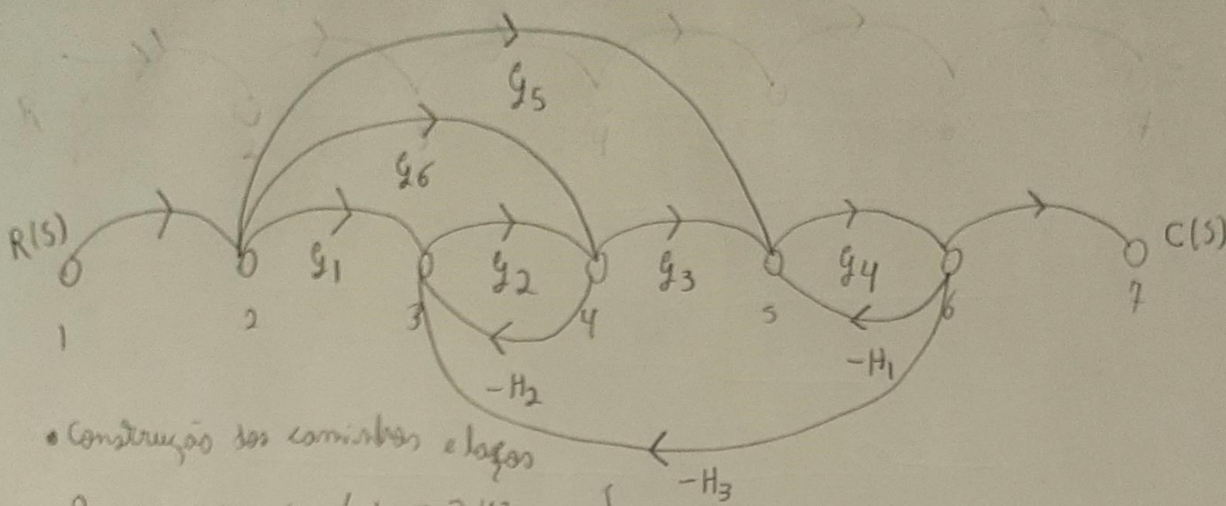

• Construção dos caminhos e laços

$P_1 = 1, 2, 3, 4, 5, 6, 7$	$L_1 = 3, 4, 3$	$F = \dfrac{P_1\Delta_1 + P_2\Delta_2 + P_3\Delta_3}{\Delta}$
$P_2 = 1, 2, 4, 5, 6, 7$	$L_2 = 5, 6, 5$	
$P_3 = 1, 2, 5, 6, 7$	$L_3 = 3, 4, 5, 6, 3$	

$P_1 = g_1 g_2 g_3 g_4$	$L_1 = -g_2 H_2$	$L_a = -g_2 H_2 - g_4 H_1 - g_2 g_3 g_4 H_3$
$P_2 = g_6 g_3 g_4$	$L_2 = -g_4 H_1$	$L_b L_c = g_2 H_2 g_4 H_1$
$P_3 = g_5 g_4$	$L_3 = -g_2 g_3 g_4 H_3$	$L_d L_e L_f = 0$

$$\Delta = 1 - L_a + L_b L_c = 1 + g_2 H_2 + g_4 H_1 + g_2 g_3 g_4 H_3 + g_2 H_2 g_4 H_1$$

$\Delta_1 = 1$, $\Delta_2 = 1$, $\Delta_3 = 1 + g_2 H_2 +$

$$\boxed{FT = \frac{C(S)}{R(S)} = \frac{g_1 g_2 g_3 g_4 + g_6 g_3 g_4 + g_5 g_4 (1 + g_2 H_2)}{1 + g_2 H_2 + g_4 H_1 + g_2 g_3 g_4 H_3 + g_2 H_2 g_4 H_1}}$$