28/10/2021

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Turma: Engenharia da Computação 2018

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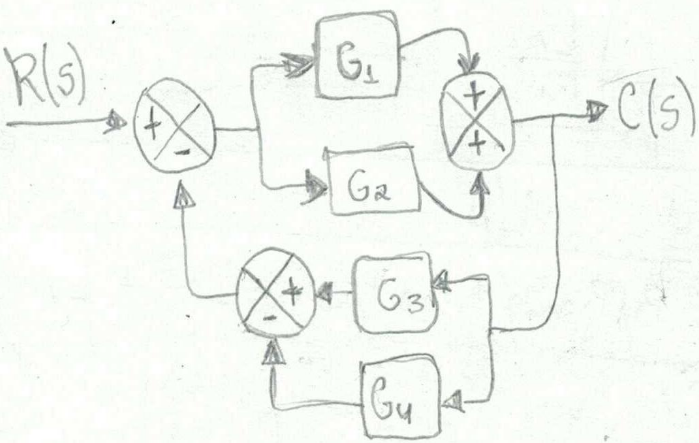
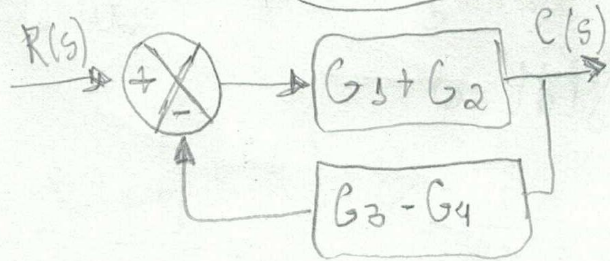
Disciplina: Sistema de Controle I

01) Resolução:

$$\frac{C(s)}{R(s)} = \boxed{\frac{G_1 + G_2}{1 + (G_3 - G_4)(G_1 + G_2)}}$$





02)

$$\ddot{y} + 3\dot{y} + 2y = u$$

$$\ddot{y} + \overset{3}{a_1}\dot{y} + \overset{2}{a_2}\, y = \overset{0}{b_0}\ddot{u} + \overset{0}{b_1}\dot{u} + \overset{1}{b_2}u$$

$$\begin{cases} \beta_0 = b_0 = 0 \\ \beta_1 = b_1 - a_1\beta_0 = 0 \\ \beta_2 = b_2 - a_1\beta_1 - a_2\beta_0 = 1 \\ \beta_3 = b_3 - a_1\beta_2 - a_2\beta_1 - a_3\beta_0 \\ \hookrightarrow = 0 - 3\cdot 1 = -3 \end{cases}$$

$$\begin{cases} x_1 = y - \beta_0 \overset{0}{u} = y \\ x_2 = \dot{y} - \beta_0 \overset{0}{\dot{u}} - \beta_1 \overset{0}{u} = \dot{y} - \beta_1 u \end{cases}$$

$$\begin{cases} \dot{x}_1 = -a_1x_1 + \beta_1 u = -3x_1 \\ \dot{x}_2 = -a_2x_1 - a_1x_2 + \beta_2 u \\ \hookrightarrow = -2x_1 - 3x_2 + u \end{cases}$$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -3 & 0 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \qquad y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

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03)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \overset{A}{\begin{bmatrix} -4 & -1 \\ 3 & -1 \end{bmatrix}} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \overset{B}{\begin{bmatrix} 1 \\ 1 \end{bmatrix}} u \qquad y = \overset{C}{\begin{bmatrix} 1 & 0 \end{bmatrix}} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$\dot{x} = Ax + Bu$$
$$y = Cx + Du$$

$$G(s) = C(s\underbrace{I}_{\text{Matriz identidade}} - A)^{-1}B \qquad \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$\frac{Y(s)}{U(s)} = \left[C(sI - A)^{-1}B + \overset{0}{D}\right]$$

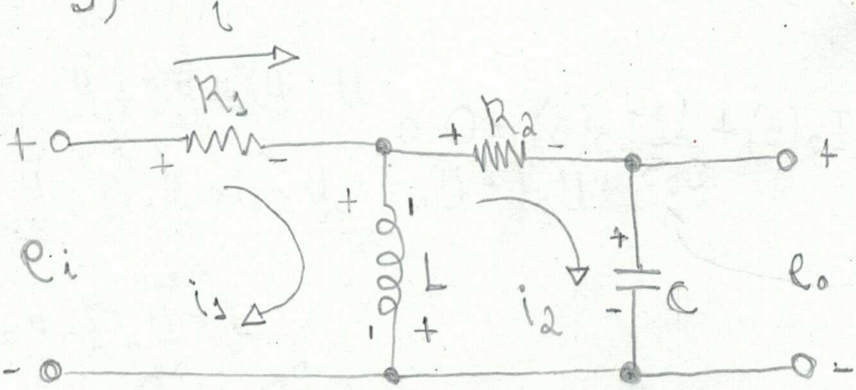
$$= \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} s+4 & s+1 \\ -3 & s+1 \end{bmatrix}^{-1} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

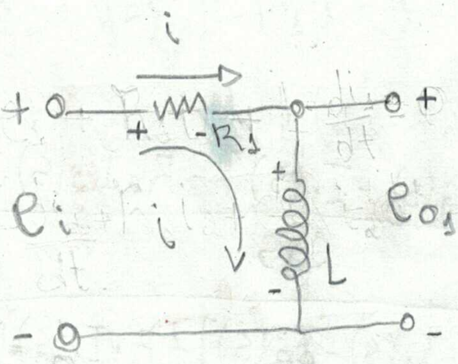
$$(sI - A)^{-1} = \frac{adj(sI - A)}{det(sI - A)}$$

$$= \begin{bmatrix} 1 & 0 \end{bmatrix} \frac{\begin{bmatrix} s+1 & -1 \\ 3 & s+4 \end{bmatrix}}{(s+1)(s+4) - 3} \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

$$= \frac{\begin{bmatrix} s \\ s+7 \end{bmatrix}}{(s+1)(s+4) - 3} \begin{bmatrix} 1 & 0 \end{bmatrix} \longrightarrow \boxed{\frac{s}{s^2 + 5s + 1}}$$

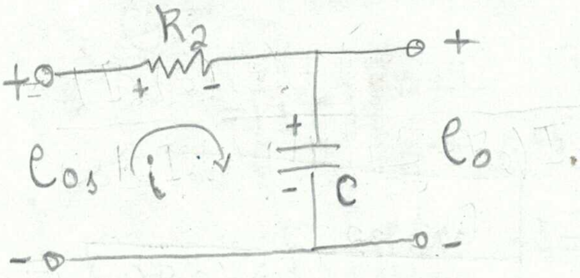
3)





$$\left.\begin{aligned} -e_i + iR_1 + L\frac{di}{dt} &= 0 \\ e_{o1} - L\frac{di}{dt} &= 0 \end{aligned}\right\} \mathcal{L} \longrightarrow \begin{aligned} I(s)R_1 + LsI(s) &= e_i \\ LsI(s) &= e_o \end{aligned}$$

$$\boxed{F.T._1 = \frac{e_o}{e_i} = \frac{Ls\cancel{I(s)}}{(R_1 + Ls)\cancel{I(s)}} = \frac{Ls}{R_1 + Ls}}$$

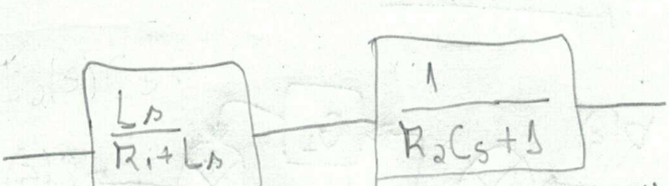


$$I(s)R_2 + \frac{1}{cs}I(s) = e_{o1}$$

$$\frac{1}{cs}I(s) = e_o$$

$$\left.\begin{aligned} -e_{o1} + iR_2 + \frac{1}{c}\int i\,dt &= 0 \\ e_o - \frac{1}{c}\int i\,dt &= 0 \end{aligned}\right\} \mathcal{L}$$

$$F.T_2 = \frac{e_{o1}}{e_o} = \frac{\frac{1}{cs}\cancel{I(s)}}{\left(R_2 + \frac{1}{cs}\right)\cancel{I(s)}} = \frac{1}{R_2Cs + 1}$$



$$\boxed{= \frac{Ls}{R_1R_2Cs + R_1 + LR_1Cs^2 + Ls}}$$