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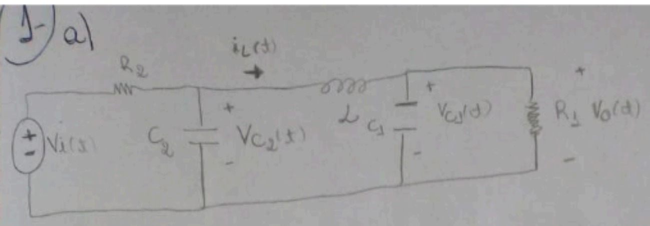
Questões com desenvolvimento teórico:

1 - a)

1-) a)



$x_1 = V_{C_1}(t)$

$x_2 = V_{C_2}(t)$

$x_3 = i_L(t)$

$y = V_0(t) = V_{C_1}(t) = x_1 \qquad u = V_i(t)$

$i_L(t) = i_{C_1}(t) + i_{L_1}(t)$

$$i_L(t) = C_1 \frac{dV_{C_1}(t)}{dt} + \frac{V_{C_1}(t)}{R_1}$$

$$C_1 \frac{dV_{C_1}(t)}{dt} = -\frac{V_{C_1}(t)}{R_1 C_1} + \frac{i_L(t)}{C_1}$$

$$\dot{x}_1 = -\frac{1}{R_1 C_1} x_1 + \frac{1}{C_1} x_3$$

$i_{R_2}(t) = i_{C_2}(t) + i_L(t)$

$$\frac{V_i(t) - V_{C_2}(t)}{R_2} = C_2 \frac{dV_{C_2}(t)}{dt} + i_L(t)$$

$$C_2 \frac{dV_{C_2}(t)}{dt} = -\frac{V_{C_2}}{R_2} - i_L(t) + \frac{V_i(t)}{R_2}$$

$$\frac{dV_{C_2}(t)}{dt} = -\frac{V_{C_2}(t)}{R_2 C_2} - \frac{i_L(t)}{C_2} + \frac{V_i(t)}{R_2 C_2}$$

$$\dot{x}_2 = -\frac{1}{R_2 C_2} x_2 - \frac{1}{C_2} x_3 + \frac{1}{R_2 C_2} u$$

$V_L(t) = V_{C_2}(t) - V_{C_1}(t)$

$$L \frac{di_L(t)}{dt} = -V_{C_1}(t) + V_{C_2}(t)$$

$$\frac{di_L(t)}{dt} = -\frac{V_{C_1}(t)}{L} + \frac{V_{C_2}(t)}{L}$$

$$\dot{x}_3 = -\frac{1}{L} x_1 + \frac{1}{L} x_2$$

$$\dot{X} = \begin{bmatrix} -\frac{1}{R_1 C_1} & 0 & \frac{1}{C_1} \\ 0 & -\frac{1}{R_2 C_2} & -\frac{1}{C_2} \\ -\frac{1}{L} & \frac{1}{L} & 0 \end{bmatrix} \cdot \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{1}{R_2 C_2} \\ 0 \end{bmatrix} u$$

$Y = Cx + Du$

$Y = [1 \;\; 0 \;\; 0]\, x + 0 \cdot u$

$Y = [1 \;\; 0 \;\; 0]\, x$

1-e)

$$\zeta = 0{,}7$$

$$\omega_n = 500\, rad/s$$

$$S_{1,2} = -\zeta.\omega_n \pm j\omega_n\sqrt{1-\zeta^2} = -350 \pm 357{,}07j$$

Para encontrar os polos s3 e s4 foi utilizado um valor 10 vezes maior que a parte real do polo s1, sendo:

$$S_{3,4} = -3500$$

1-f)

Encontrando os valores teóricos de simulação:

$$Mp = e^{-\frac{\pi\zeta}{\sqrt{1-\zeta^2}}} = 0{,}045988 = 4.5988\%$$

$$tp = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} = 8.7982\, ms$$