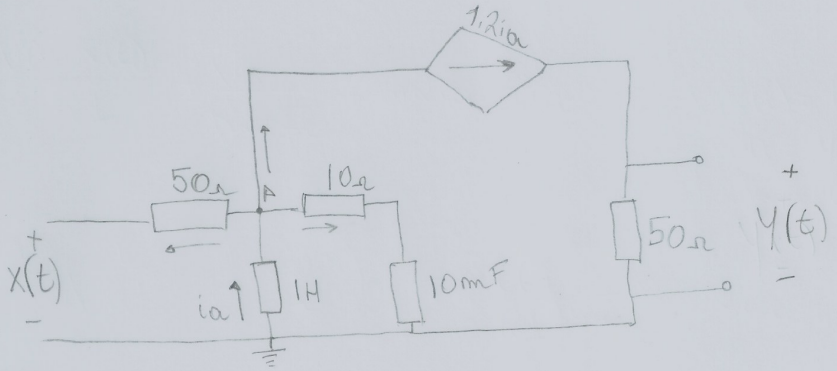
SEGUNDA ORDEM
2 POLOS E 1 ZERO
TIPO 1
INSTÁVEL

①



$$\frac{V_A - x(t)}{R1} + \frac{V_A}{R2+Z_C} + 1{,}2ia = ia \quad ; \quad y(t) = 1{,}2 \cdot ia \cdot 50$$

$$ia = \frac{y(t)}{60}$$

$$V_A\left(\frac{1}{R1} + \frac{1}{R2+Z_C}\right) - \frac{x(t)}{R1} = 0{,}2ia$$

$$V_A\left(\frac{1}{R1} + \frac{1}{R2+Z_C}\right) + 0{,}2ia = \frac{x(t)}{R1}$$

$$V_A = -ia\,Z_L$$

$$V_A = \frac{-y(t).Z_L}{60}$$

$$\frac{-y(t).Z_L}{60}\left(\frac{1}{R1} + \frac{1}{R2+Z_C}\right) + \frac{0{,}2y(t)}{60} = \frac{x(t)}{R1}$$

$$\frac{-y(t)}{60}\left(\frac{Z_L}{R1} + \frac{Z_L}{R2+Z_C}\right) + \frac{0{,}2y(t)}{60} = \frac{x(t)}{R1}$$

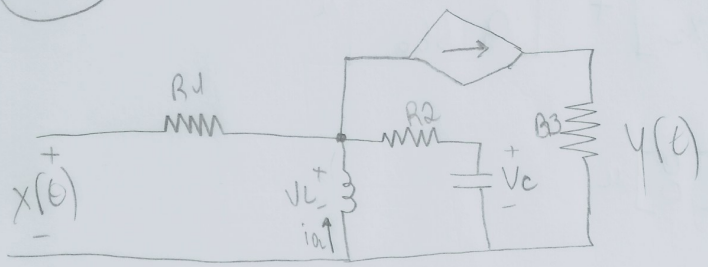
$$\frac{y(t)}{60}\left(\frac{-Z_L}{R1} - \frac{Z_L}{R2+Z_C} + 0{,}2\right) = \frac{x(t)}{R1}$$

$$\frac{y(t)}{x(t)} = \frac{\frac{-60}{R1}}{Z_L/R1 + Z_L/R2+Z_C - 0{,}2} \Rightarrow \frac{y(s)}{x(s)} = \frac{-1{,}2}{s/50 + \frac{s}{10+\frac{1}{10ms}} - 0{,}2}$$

$$\frac{y(s)}{x(s)} = \frac{-1{,}2}{s/50 + \frac{10ms^2}{100ms+1} - 0{,}2} = \frac{-1{,}2}{\frac{100ms^2+s+500ms^2-s-10}{50(100ms+1)}}$$

$$\frac{y(s)}{x(s)} = \frac{-1{,}2}{600ms^2-10} \cdot \frac{5000ms+50}{1} = \frac{-6s-60}{0{,}6s^2-10}$$

1.7



$x_1 = V_c \rightarrow$ VARIÁVEL DE ESTADO

$x_2 = I_L \rightarrow$ VARIÁVEL DE ESTADO

$y = 60\, i_Q = -60\, i_L = -60 I_L$

$x = u$

$V_C = V_L - I_C R2 \quad (1)$

$I_L + I_C - 1{,}2 I_L + \frac{V_L - x(t)}{R1} = 0 \quad (*0)$

$I_L \rightarrow$ VARIÁVEL x2

$I_C = C \frac{dV_C}{dt} \dot{x}_1$

$I_C = C \dot{x}_1$

$V_L = L \frac{di}{dt} \dot{x}_2$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} A & b \\ C & d \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Utilizar (1) para escrever V_L em termos de V_C

$$x_2 + \dot{x}_1 C - 1{,}2 x_2 + x_1 + \frac{\dot{x}_1 C R2}{R1} - \frac{u}{R1} = 0$$

$$\dot{x}_1 \left[\frac{C R2}{R1} + C \right] = 0.2\, x_2 + \frac{u}{R1} - \frac{x_1}{R1}$$

$$\dot{x}_1 \cdot 0{,}012 = 0{,}2 x_2 + \frac{u}{50} - \frac{x_1}{50}$$

$$\boxed{\dot{x}_1 = 16{,}6666 x_2 - 1{,}666 x_1 + 1{,}1666 u}$$

$$I_L + \frac{V_L - V_C}{R2} - 1{,}2 I_L + \frac{V_L - u}{R1} = 0 \quad \text{(Utilizando *0)}$$

$$x_2 + \frac{\dot{x}_2 L - x_1}{R2} - 1{,}2 x_2 + \frac{\dot{x}_2 L - u}{R1} = 0$$

$$\dot{x}_2 \left[\frac{1}{R2} + \frac{1}{R1} \right] = 0{,}2 x_2 + \frac{x_1}{R2} + \frac{u}{50}$$

$$\boxed{\dot{x}_2 = 1{,}6666 x_2 + 0{,}83333 x_1 + 0{,}16666 u}$$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1,6666 & 16,6666 \\ 0,83333 & 1,6666 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1,6666 \\ 0,1666 \end{bmatrix} u$$

$$y = \begin{bmatrix} 0 & -60 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} u$$