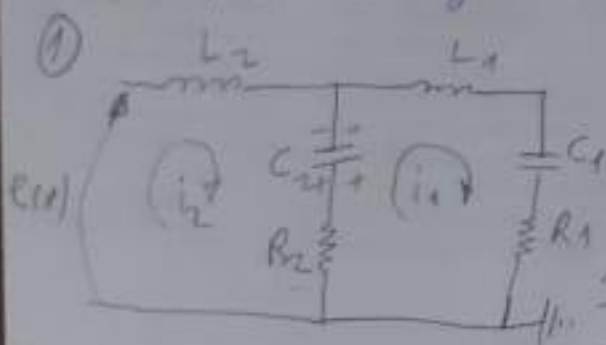


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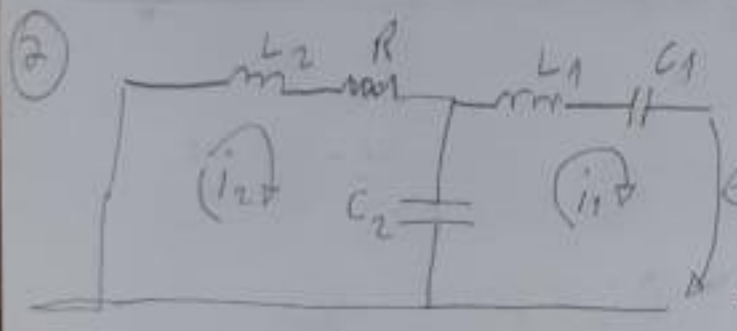


malha 2:  $e(t) = L_2 D i_1 + \left(\frac{1}{C_2 D}\right) (i_2 - i_1) + R_1 (i_2 - i_1)$

malha 1:  $0 = L_1 D i_1 + \left(\frac{1}{C_1 D}\right) i_1 + R_1 i_1 + \left(\frac{1}{C_2 D}\right) (i_1 - i_2) + (R_2)(i_1 - i_2)$

$$m_2 \ddot{x}_2 + K_2(x_2 - x_1) + b_2(\dot{x}_2 - \dot{x}_1) = f(t)$$

$$m_1 \ddot{x}_1 + K_1 x_1 + b_1 \dot{x}_1 + K_2(x_1 - x_2) + b(\dot{x}_1 - \dot{x}_2) = 0$$

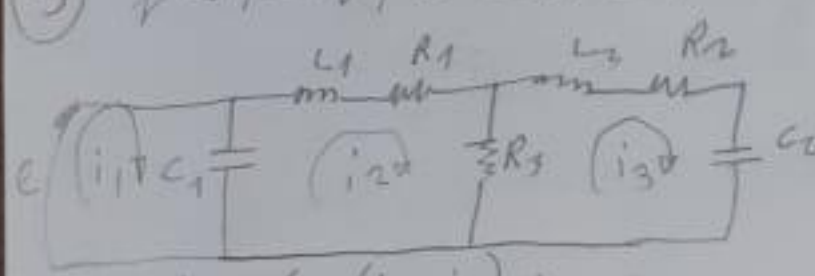


malha 2:  $L_2 D i_2 + R i_2 + \left(\frac{1}{C_2 D}\right) (i_2 - i_1) = 0$

malha 1:  $e(t) = L_1 D i_1 + \left(\frac{1}{C_1 D}\right) i_2 + \left(\frac{1}{C_2 D}\right) (i_1 - i_2)$

$$m_2 \ddot{x}_2 + B \dot{x}_2 + K_2(x_2 - x_1) = 0 \quad \text{e} \quad m_1 \ddot{x}_1 + K_1 x_1 + K_2(x_1 - x_2) = f_1(t)$$

3)  $f \rightarrow T \rightarrow V, v \rightarrow w \rightarrow i$



$$e(t) = \frac{1}{C_1 D} (i_1 - i_2)$$

$$(L_1 D + R_1) i_2 + \frac{1}{C_1 D} (i_2 - i_1) + R_3 (i_2 - i_3) = 0$$

$$(L_2 D + R_2 + \frac{1}{C_2 D}) i_3 + R_3 (i_3 - i_2) = 0$$

Relo analógico Tipo 1

$$T(t) = \frac{K_2}{D} (w_1 - w_2)$$

$$L_2(T(t) = K_1(\theta_1 - \theta_2))$$

$$(J_1 D + B_1) \dot{w}_2 + \frac{K_1}{D} (w_2 - w_1) + B_2 (\dot{w}_2 - \dot{w}_3) = 0$$

$$L_2 J_1 \ddot{\theta}_2 + (B_1 + B_3) \dot{\theta}_2 + K_1 \theta_2 = K_1 \theta_1 + B_3 \dot{\theta}_3$$

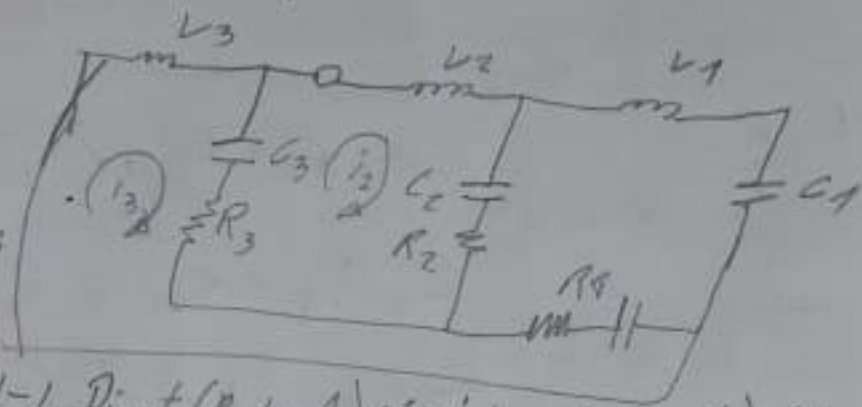
$$(J_2 D + B_2 + \frac{K_2}{D}) \dot{w}_3 + B_3 (w_3 - w_2) = 0$$

$$L_2 J_2 \ddot{\theta}_3 + (B_2 + B_3) \dot{\theta}_3 + K_2 \theta_3 = B_3 \dot{\theta}_2$$

Exercícios de lista adicionais

3

Conta pelo tipo



$$e_3(t) = L_3 D i_3 + \left( R_3 + \frac{1}{C_3 D} \right) (i_3 - i_2) + \left( R_4 + \frac{1}{C_4 D} \right) (i_2 - i_1)$$

$$e_2(t) = L_2 D i_2 + \left( R_2 + \frac{1}{C_2 D} \right) (i_2 - i_1) + \left( R_3 + \frac{1}{C_3 D} \right) (i_2 - i_3)$$

$$\textcircled{0} \left( L_1 D + R_1 + \frac{1}{C_1 D} \right) i_1 + \left( R_2 + \frac{1}{C_2 D} \right) (i_1 - i_2) + \left( R_4 + \frac{1}{C_4 D} \right) (i_1 - i_3) = 0$$

Para o sistema mecânico, por analogia:

$$m_3 D v_3 + \left( b_3 + \frac{K_3}{D} \right) (v_3 - v_2) + \left( b_4 + \frac{K_4}{D} \right) (v_3 - v_1) = f_3$$

$$\rightarrow m_3 \ddot{x}_3 + (b_3 + b_4) \dot{x}_3 + (K_3 + K_4) x_3 = f_3(t) + b_3 \dot{x}_2 + K_3 x_2 + b_4 \dot{x}_1 + K_4 x_1$$

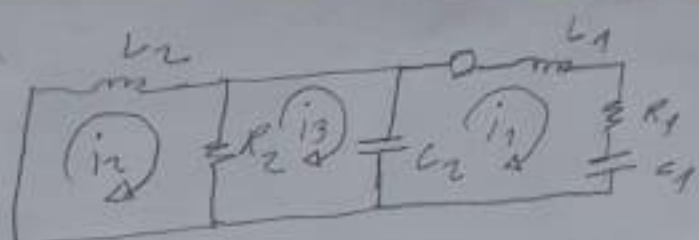
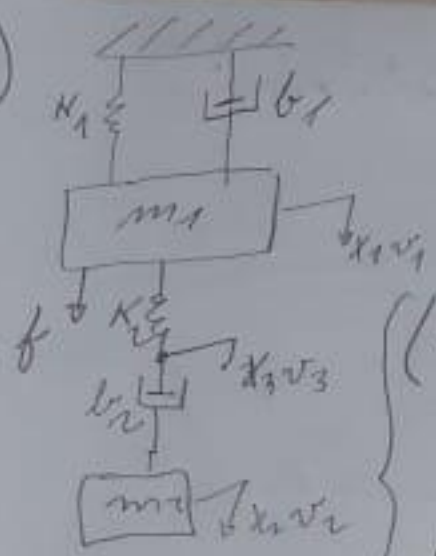
$$m_2 D v_2 + \left( b_2 + \frac{K_2}{D} \right) (v_2 - v_1) + \left( b_3 + \frac{K_3}{D} \right) (v_2 - v_3) = f_2$$

$$\rightarrow m_2 \ddot{x}_2 + (b_2 + b_3) \dot{x}_2 + (K_2 + K_3) x_2 = f_2 + b_2 \dot{x}_1 + b_3 \dot{x}_3 + K_2 x_1 + K_3 x_3$$

$$\left( m_1 D + b_1 + \frac{K_1}{D} \right) v_1 + \left( b_2 + \frac{K_2}{D} \right) (v_1 - v_2) + \left( b_4 + \frac{K_4}{D} \right) (v_1 - v_3) = 0$$

$$\rightarrow m_1 \ddot{x}_1 + (b_1 + b_2 + b_4) \dot{x}_1 + (K_1 + K_2 + K_4) x_1 = b_2 \dot{x}_2 + K_2 x_2 + b_4 \dot{x}_3 + K_4 x_3$$

7



$$\begin{cases} (L_1 D + R_1 + \frac{1}{C_1 D}) i_1 + \frac{1}{C_2 D} (i_1 - i_3) = e(t) \\ L_2 D i_2 + R_2 (i_2 - i_3) = 0 \\ R_3 (i_3 - i_2) + \frac{1}{C_3 D} (i_3 - i_1) = 0 \end{cases}$$

Sistema mecânico

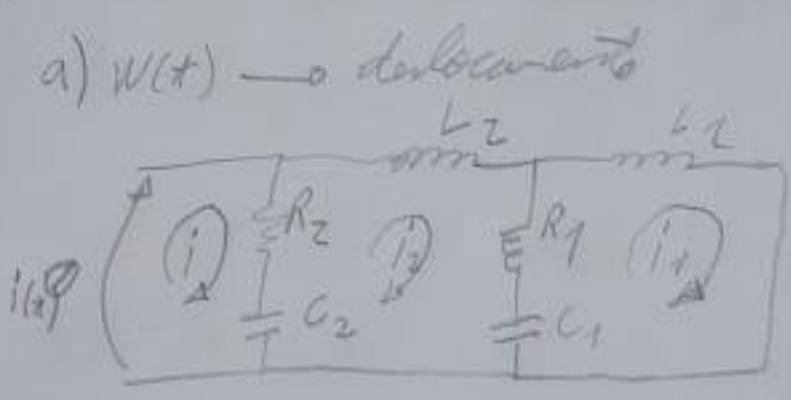
$$(m_1 D + b_1 + \frac{K_1}{D}) v_1 + \frac{K_2}{D} (v_1 - v_2) = f(t)$$

$$\rightarrow m_1 \ddot{x}_1 + b_1 \dot{x}_1 + (K_1 + K_2) x_1 = f(t) + K_2 x_2$$

$$m_2 D v_2 + b_3 (v_2 - v_3) = 0 \rightarrow m_2 \ddot{x}_2 + b_2 \dot{x}_2 = b_2 \dot{x}_3$$

$$b_2 (v_3 - v_2) + \frac{K_2}{D} (v_3 - v_1) = 0 \rightarrow b_2 \dot{x}_3 + K_2 x_3 = b_2 \dot{x}_2 + K_2 x_1$$

8



$$(L_1 D + R_1 + \frac{1}{C_1 D}) (i_1 - i_2) = 0$$

$$(L_2 D + R_2 + \frac{1}{C_2 D}) (i_2 - i_3) + (R_3 + \frac{1}{C_3 D}) (i_2 - i_1) = 0$$

equações do modelo mecânico

$$M D v_1 + (K_1 + K_2/D) (v_1 - v_2) = 0$$

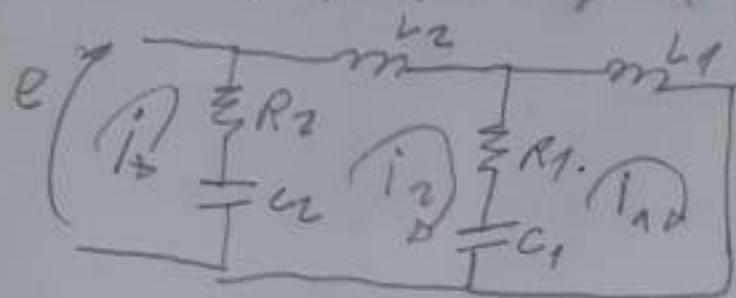
$$\rightarrow M \ddot{x}_1 + b_1 \dot{x}_1 + K_1 x_1 = b_1 \dot{x}_2 + K_1 x_2$$



$$m D^2 v_2 + (b_1 + \frac{K_1}{D})(v_2 - v_1) + (b_2 + \frac{K_2}{D})(v_2 - W(t)) = 0$$

b)  $W$  força imposta pela via

$$m \ddot{x}_2 + (b_1 + b_2) \dot{x}_2 + (K_1 + K_2) x_2 = b_1 \dot{x}_1 + K_1 x_1 + b_2 \dot{W}(t) + K_2 W(t)$$



$$\left( R_2 + \frac{1}{C_2 D} \right) (i_1 - i_2) = e(t)$$

$$L_2 D i_2 + \left( R_1 + \frac{1}{C_1 D} \right) (i_2 - i_1) +$$

$$+ \left( R_2 + \frac{1}{C_2 D} \right) (i_2 - i_1) = 0$$

- e(t)

$$L_1 D i_1 + \left( R_1 + \frac{1}{C_1 D} \right) (i_1 - i_2) = 0$$

Eq. do modelo mecânico

$$M D v_1 + (b_1 + \frac{K_1}{D})(v_1 - v_2) = 0$$

$$L_0 M \ddot{x}_1 + b_1 \dot{x}_1 + K_1 x_1 = b_1 \dot{x}_2 + K_1 x_2$$

$$m_2 D v_2 + (b_1 + \frac{K_1}{D})(v_2 - v_1) - W(t) = 0$$

$$L_0 m_2 \ddot{x}_2 + b_1 \dot{x}_2 + K_1 x_2 = W(t) + b_1 \dot{x}_1 + K_1 x_1$$

As equações obtidas foram as mesmas encontradas pela analogia 2.