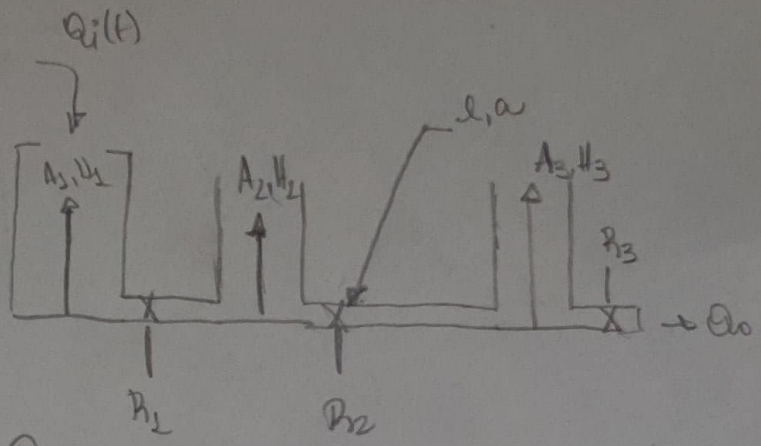
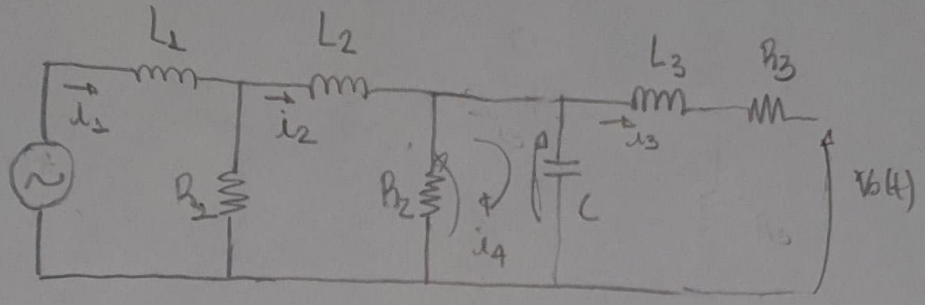
JOÃO PEDRO DIAS NUNES - 10705946



a) analogia ①



Malha ①: $V - L_1 D i_1 - R_3(i_1 - i_2) = 0$

Malha ②: $-L_2 D i_2 - R_2(i_2 - i_4) + R_3(i_3 - i_2) = 0$

Malha ③ $L_3 D i_3 + \frac{1}{R_3} i_3 = \frac{1}{CD}(i_4 - i_3) + \dot{V}_b(t)$

Malha ④: $\frac{1}{R_2}(i_2 - i_4) = \frac{1}{CD}(i_4 - i_3)$

Aplicando analogia: $V \to Q_i$; $Cg \to L$; $p \to i$; $Lp = C$; $R = \frac{1}{Rp}$

$$Q_1 = C_{p1}\dot{p}_1 + \frac{1}{R_{p1}} p_1 - \frac{1}{R_{p1}} p_2$$

$$0 = C_{p2}\dot{p}_2 + \frac{1}{R_{p2}} p_2 - \frac{p_1}{R_{p1}} - \frac{p_4}{R_{p2}} + \frac{p_3}{R_{p1}}$$

$$C_{p3}\dot{p}_3 + \frac{1}{R_{1p}} p_3 + \frac{1}{L_{2p}} \int (p_3 - p_4)\,dt = Q_0(t)$$

$$\frac{1}{R_{2p}}(p_2 - p_4) = \frac{1}{L_{1p}} \int (p_4 - p_3)\,dt$$

$p_i = \rho g h_i$

$\dot{p}_i = \rho g \dot{h}_i$

$\frac{1}{Lp} \int p\,dt = Q$

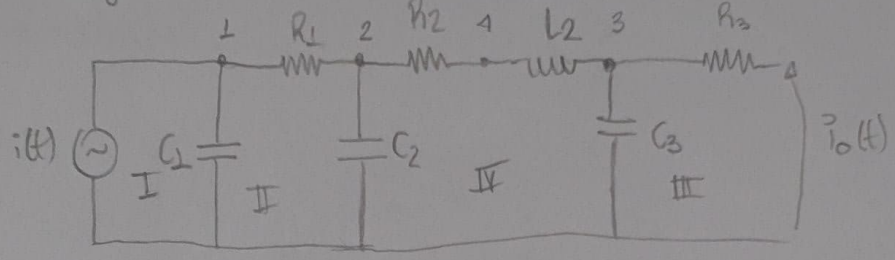
$C_i = \frac{A_i}{\rho g}$

$L_{pi} = \frac{\rho L_i}{A_i}$

$$\begin{cases} Q_i = A_1 \dot{h}_1 + \dfrac{h_1}{R_{f1}} - \dfrac{h_2}{R_{f2}} \\ 0 = A_2 \dot{h}_2 + \dfrac{h_2}{R_{f2}} - \dfrac{h_1}{R_{f1}} - \dfrac{h_4}{R_{f2}} + \dfrac{h_2}{R_{f1}} \\ A_3 \dot{h}_3 + \dfrac{1}{R_{f3}} h_3 + \int (p_3 - p_4)\,dt \cdot \dfrac{1}{L_f} = q_0(t) \\ \dfrac{1}{R_2}(h_2 - h_4) = \dfrac{1}{L_{2f}} \int (p_4 - p_3)\,dt \end{cases}$$

Obs: $L_{f2} = \dfrac{\rho L}{A} = \dfrac{\rho^2}{\alpha}$

Analogia ①



Elétrico

$$V_1\left(C_1 D + \frac{1}{R_1}\right) - V_2 \frac{1}{R_1} = i(t)$$

$$V_2\left(C_2 D + \frac{1}{R_1} + \frac{1}{R_2}\right) - \frac{V_1}{R_1} - \frac{V_4}{R_2} = 0$$

$$V_3\left(C_3 D + \frac{1}{R_3} + (L_2 D)^{-1}\right) - V_4 (L_2 D)^{-1} = i_0(t)$$

$$V_4\left(\frac{1}{R_2} + \frac{1}{L_2 D}\right) - \frac{V_2}{R_2} - \frac{V_3}{L_2 D} = 0$$

Hidráulico

$$\begin{cases} A_1 \dot{h}_1 + \dfrac{h_1}{R_{f1}} - \dfrac{h_2}{R_{f2}} = Q_i \\ A_2 \dot{h}_2 + \dfrac{h_2}{R_{f2}} - \dfrac{h_1}{R_{f1}} - \dfrac{h_4}{R_{f2}} + \dfrac{h_2}{R_{f1}} = 0 \\ A_3 \dot{h}_3 + \dfrac{h_3}{R_{f3}} + \dfrac{\int (p_3 - p_4)\,dt}{L_{2f}} = Q_0(t) \\ \dfrac{\int (p_3 - p_4)\,dt}{L_{2f}} = \dfrac{1}{R_{2f}} (h_2 - h_4) \end{cases}$$