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① $\begin{cases} J_1\dot{\omega}_1 + B_1\omega_1 + T_1 = T_m \\ J_2\dot{\omega}_2 + B_2\omega_2 + T_c = T_2 \end{cases}$ $\quad \frac{\omega_1}{\omega_2} = n$

Hipótese: $\eta = 1$; $P_1 = P_2$

$P_1 = P_2 \Rightarrow T_1\omega_1 = T_2\omega_2$

$T_2 = \frac{T_1\omega_1}{\omega_2} = T_1 n$

$J_2\dot{\omega}_2 + B_2\omega_2 + T_c = T_1 n$

$J_2\dot{\omega}_2 + B_2\omega_2 + T_c = (T_m - J_1\dot{\omega}_1 - B_1\omega_1)\cdot n$

$J_2\dot{\omega}_2 + B_2\omega_2 + T_c = (T_m - J_1\dot{\omega}_2 n - B_1\omega_2 n)\cdot n$

$J_2\dot{\omega}_2 + J_1\dot{\omega}_2 n^2 + B_2\omega_2 + B_1\omega_2 n^2 + T_c = T_m n$

$J_2 + J_1 n^2 = J_{eq} \qquad B_2 + B_1 n^2 = B_{eq}$

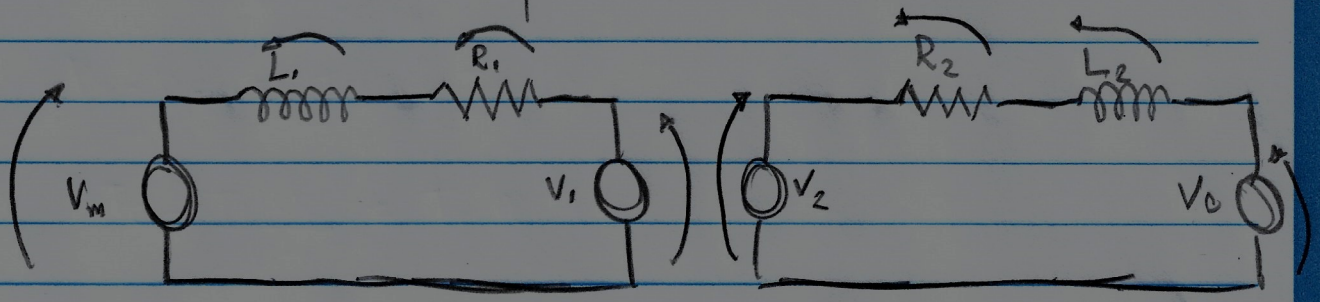
$J_{eq}\dot{\omega}_2 + B_{eq}\omega_2 + T_c = T_m n$

③ Analogia

$f \rightarrow M \rightarrow i$

$v \rightarrow w \rightarrow V$

Circuito elétrico equivalente



$$V_m - L_1 D i_1 - R_1 i_1 - V_1 = 0$$

$$V_2 - R_2 i_2 - L_2 D i_2 - V_c = 0$$

$$J_1 \dot{w}_1 + B_1 w_1 + T_1 = T_m$$
$$J_2 \dot{w}_2 + B_2 w_2 + T_c = T_2$$

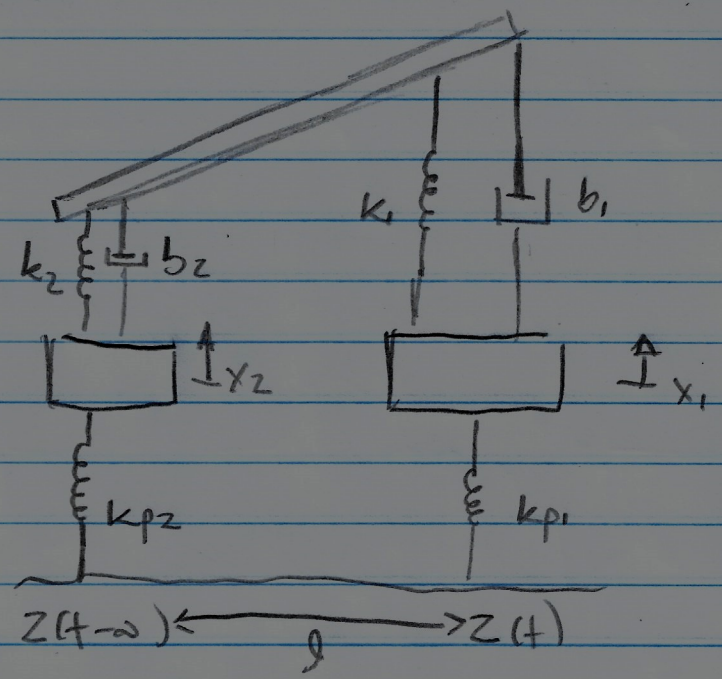
$$P_1 = P_2$$

$$V_1 i_1 = V_2 i_2 \Rightarrow i_1 = \frac{V_2 i_2}{V_1} \Rightarrow T_1 = \frac{w_2 T_2}{w_1} = \frac{T_2}{n}$$

Analogamente ao exercício anterior

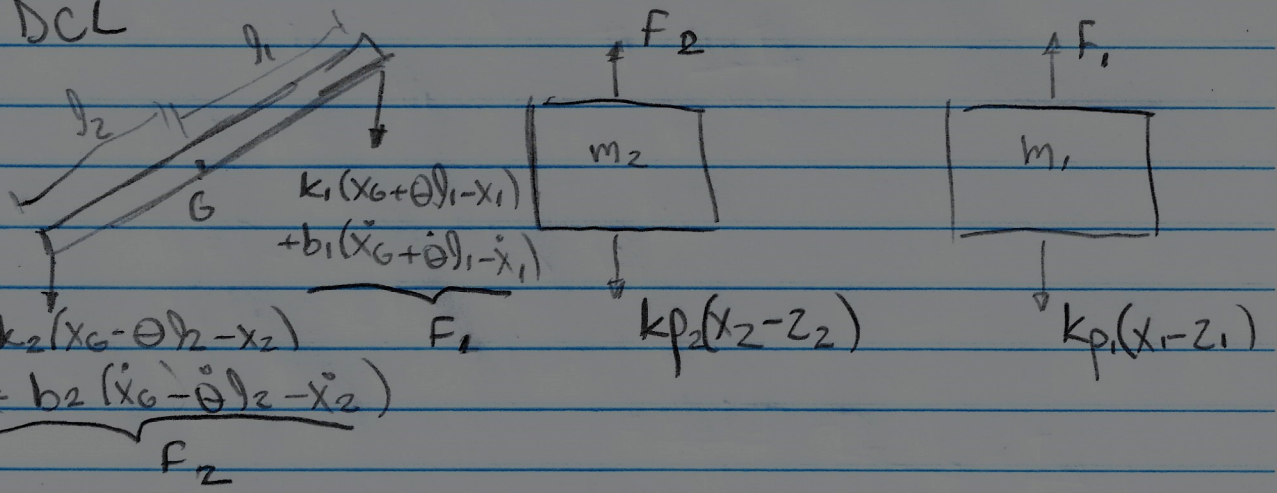
$$J_{eq} \dot{w}_2 + B_{eq} \dot{w}_2 + T_c = T_m n$$

③



Hipóteses: $\theta \approx 0$

DCL



$$\begin{cases} J\ddot{\theta} = l_2 F_2 - l_1 F_1 \\ m_2 \ddot{x}_2 = F_2 - k_{p2}(x_2 - z_2) \\ m_1 \ddot{x}_1 = F_1 - k_{p1}(x_1 - z_1) \\ m_G \ddot{x}_G = -F_1 - F_2 \end{cases}$$