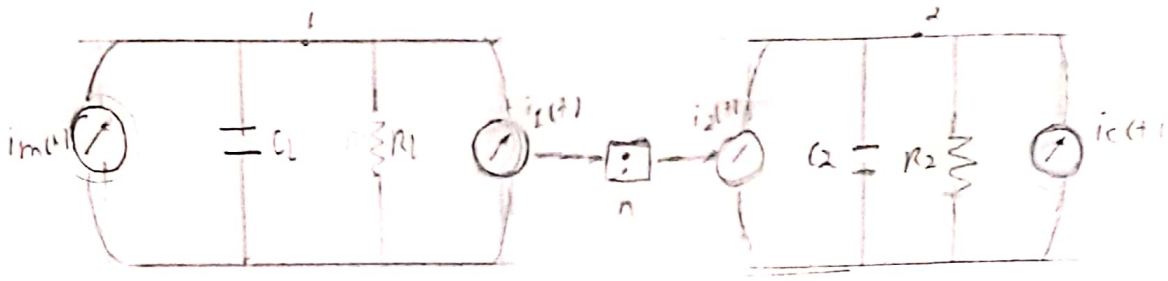
Samuel Alves 10769639

a)



Nó 1: $V_1\left(C_1 D + \frac{1}{R_1}\right) = i_m - i_1$

Nó 2: $V_2\left(C_2 D + \frac{1}{R_2}\right) = i_2 - i_c$

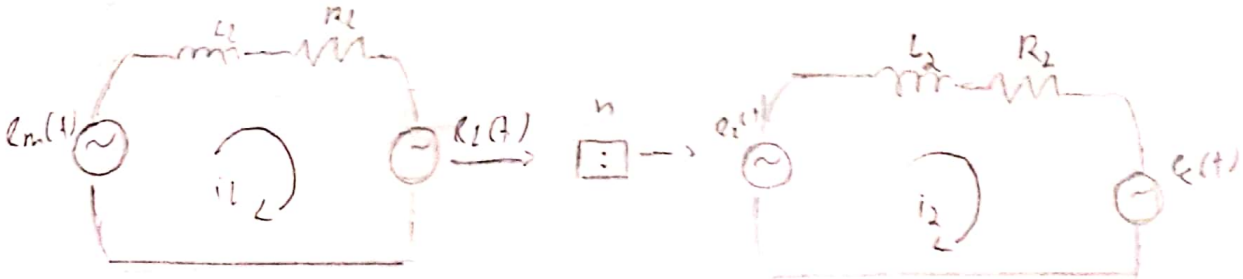
Para o sistema mecânico

$\omega_1\left(J_1 D + B_1\right) = T_m - T_1 \Rightarrow J_1\ddot{\theta}_1 + B_1\dot{\theta}_1 = T_m - T_1$

$\omega_2\left(J_2 D + B_2\right) = T_2 - T_0 \Rightarrow J_2\ddot{\theta}_2 + B_2\dot{\theta}_2 = T_2 - T_c$

$T_2 = nT_1 \qquad \dot{\theta}_1 = \frac{\dot{\theta}_2}{n}$

b)



$e_m(t) = i_1(L_1 D + R_1) + e_1(t)$

$e_2(t) = i_2(L_2 D + R_2) + e_c(t)$

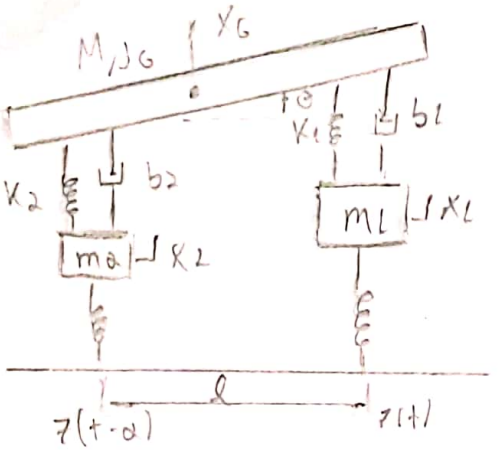
$e_2(t) = n\,e_1(t)$

$\omega_1(J_1 D + B_1) = T_m - T_1 \Rightarrow J_1\ddot{\theta}_1 + B_1\dot{\theta}_1 = T_m - T_1$

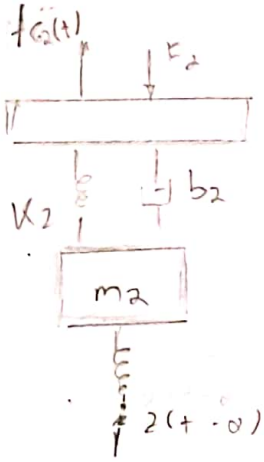
$\omega_2(J_2 D + B_2) = T_2 - T_c \Rightarrow J_2\ddot{\theta}_2 + B_2\dot{\theta}_2 = T_2 - T_c$

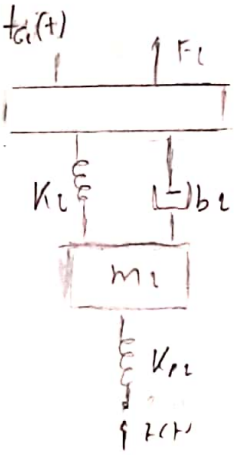
$T_2 = nT_1 \qquad \dot{\theta}_2 = \frac{\dot{\theta}_1}{n}$

2.



Separando em 2 sistemas de $\frac{1}{4}$ de carro ligados por um transformador

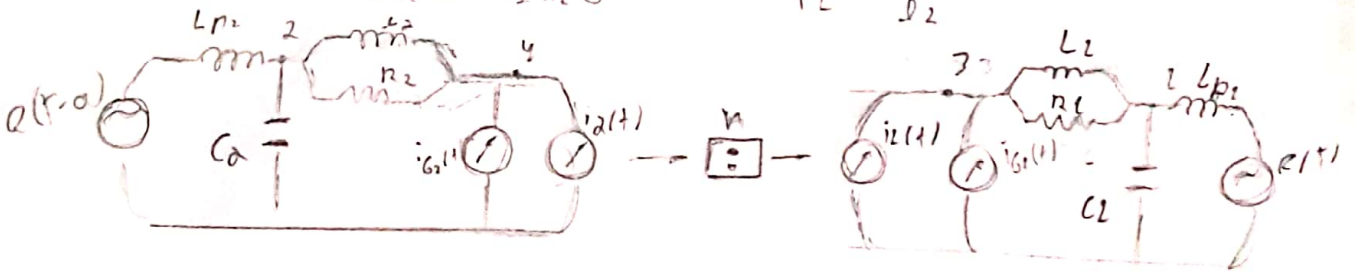




$F_1 V_1 = F_2 V_2$

$F_1 L_1 \dot{s} = F_2 l_2 \dot{\theta}$

$n = \frac{F_2}{F_1} = \frac{l_1}{l_2}$



Nó 1: $V_1\left(C_1 D + \frac{1}{R_1} + \frac{1}{L_1} + \frac{1}{L_{p1} D}\right) - r(t)\frac{1}{L_{p1} D} - V_3\left(\frac{1}{R_1} + \frac{1}{L_1 D}\right) = 0$

Nó 2: $V_2\left(C_2 D + \frac{1}{R_2} + \frac{1}{L_2 D} + \frac{1}{L_{p2} D}\right) - e(t-\alpha)\frac{1}{L_{p2} D} - V_4\left(\frac{1}{R_2} + \frac{1}{L_2 D}\right) = 0$

Nó 3: $V_3\left(\frac{1}{R_1} + \frac{1}{L_1 D}\right) = r(t) + i_{G1}(t)$

Nó 4: $V_4\left(\frac{1}{R_2} + \frac{1}{L_2 D}\right) = -i_2(t) - i_{G2}(t)$

$$V_1\left(C_1 D + \frac{1}{R_1} + \frac{1}{L_1 D} + \frac{1}{L_{p1} D}\right) = \frac{e(t)}{L_{p1} D} + i(t) + i_{G1}(t)$$

$$V_2\left(C_2 D + \frac{1}{R_2} + \frac{1}{L_2 D} + \frac{1}{L_{p2} D}\right) = \frac{a(t-\alpha)}{L_{p2} D} - i_2(t) + i_{G2}(t)$$

Para a mecânica:

$$m_1 \ddot{x}_1 + b_1 \dot{x}_1 + (K_1 + K_{p1}) x_1 = K_{p1} a(t) + f_1(t) + f_{G1}(t)$$

$$m_2 \ddot{x}_2 + b_2 \dot{x}_2 + (K_2 + K_{p2}) x_2 = K_{p2}(t-\alpha) - f_2(t) + f_{G2}(t)$$

3-

$$P_1 = P_2 \rightarrow T_1 \omega_1 = T_2 \omega_2 \rightarrow T_2 = \frac{T_1 \omega_1}{\omega_2} = n T_1$$

$$J_1 \dot{\omega}_1 + B_1 \omega_1 + T_1 = T_m \rightarrow T_1 = T_m - J_1 \dot{\omega}_1 - B_1 \omega_1$$

$$J_2 \dot{\omega}_2 + B_2 \omega_2 + T_C = T_2 \rightarrow n T_1 = J_2 \dot{\omega}_2 + B_2 \omega_2 + T_C$$

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

$$\omega_1 = n \omega_2 \qquad \dot{\omega}_1 = n \dot{\omega}_2$$

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

$$\dot{\omega}_2 (J_1 n^2 + J_2) + \omega_2 (B_1 n^2 + B_2) + T_C = n \cdot T_m$$

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