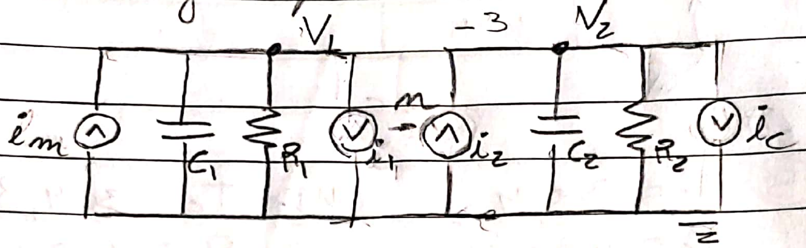
1) a) Analogia tipo 2:



$V_2 = V_1/n$

$i_2 = n i_1$

$\dot{i}_2 = n \dot{i}_1$

$$\left.\begin{aligned} V_1(C_1D + 1/R_1) &= i_m - i_1 \\ V_2(C_2D + 1/R_2) &= i_2 - i_c \end{aligned}\right\} \quad \begin{aligned} n^2V_1(C_1D + 1/R_1) &= (i_m - i_1)\,n^2 \\ V_1(C_2D + 1/R_2) &= n^2 i_1 - n\cdot i_c \end{aligned} \quad (+)$$

$$n^2V_1(C_1D + 1/R_1) + V_1(C_2D + 1/R_2) = n^2\cdot i_m - n\,i_c$$

$$V_1(C_1D + 1/R_1) + \frac{V_1}{n^2}(C_2D + 1/R_2) = i_m - \frac{i_c}{n}$$

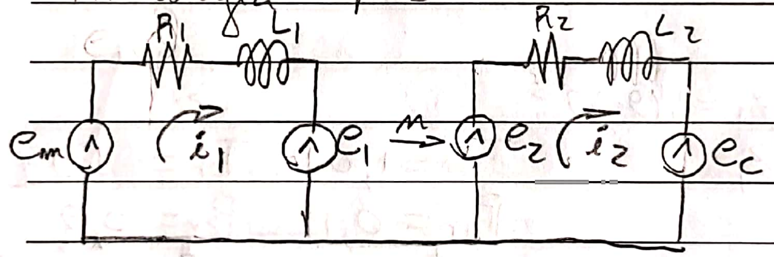
$V_1 \sim \dot{\theta}_1 \sim w_1$

analogia

$$J_1\dot{w}_1 + B_1 w_1 + \frac{J_2\dot{w}_1}{n^2} + \frac{B_2 w_1}{n^2} = T_m - \frac{T_c}{n}$$

$$\dot{w}_1\left(J_1 + \frac{J_2}{n^2}\right) + w_1\left(B_1 + \frac{B_2}{n^2}\right) = T_m - \frac{T_c}{n} \quad \text{e} \quad \begin{aligned} w_1 &= w_2 n \\ \dot{w}_1 &= \dot{w}_2 n \end{aligned}$$

b) Analogia tipo 1:



$e_2 = e_1 n$ $\quad$ $i_2 = \dot{i}_1/n$

$\dot{i}_2 = \dot{i}/n$

$$\left.\begin{aligned} R_1 i_1 + L_1\dot{i}_1 + e_1 &= e_m \\ R_2 i_2 + L_2\dot{i}_2 + e_c &= e_2 \end{aligned}\right\} \quad \begin{aligned} (R_1 i_1 + L_1\dot{i}_1 + e_1)\,n^2 &= e_m n^2 \\ R_2 i_1 + L_2\dot{i}_1 &= e_1 n^2 - e_c n \end{aligned} \quad (+)$$

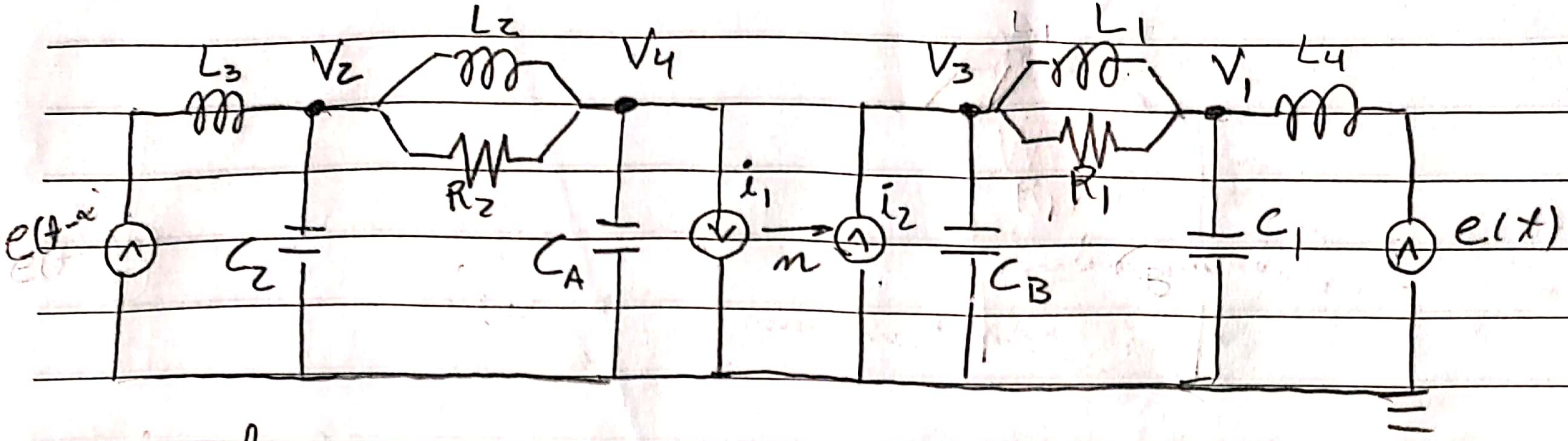
$$(R_1 i_1 + L_1\dot{i}_1)\,n^2 + R_2 i_1 + L_2\dot{i}_1 = e_m\cdot n^2 - e_c\cdot n$$

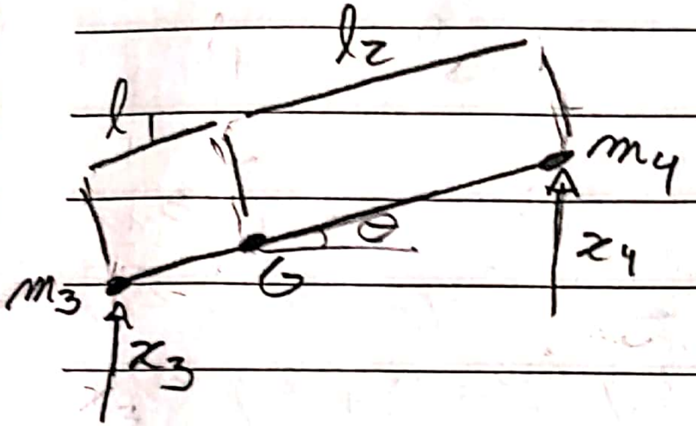
$i_1 \sim \dot{\theta}_1 \sim w_1$

$$(J_1\dot{w}_1 + B_1 w_1)\,n^2 + J_2\dot{w}_1 + B_2 w_1 = T_m\cdot n^2 - T_c\cdot n$$

$$\dot{w}_1\left(J_1 + \frac{J_2}{n^2}\right) + w_1\left(B_1 + \frac{B_2}{n^2}\right) = T_m - \frac{T_c}{n} \quad \text{e} \quad \begin{aligned} w_1 &= w_2 n \\ \dot{w}_1 &= \dot{w}_2 n \end{aligned}$$

1/4 de carro em 2 sistemas (analogia tipo 2)





$$\frac{J_G\dot{\theta}^2}{2} + \frac{M\dot{x}_G^2}{2} = E_c$$

$$x_G = \frac{x_3 l_2 + x_4 l_1}{l_1 + l_2}$$

$$\left(\frac{\dot{x}_4 - \dot{x}_3}{l_1 + l_2}\right)^2 \frac{J_G}{2} + \left(\frac{\dot{x}_3 l_2 + \dot{x}_4 l_1}{l_1 + l_2}\right)^2 \frac{M}{2}$$

$l_1 + l_2$ $\quad x_4 - x_3 \quad \theta$

$$\operatorname{sen}\theta \approx \theta = \frac{x_4 - x_3}{l_1 + l_2}$$