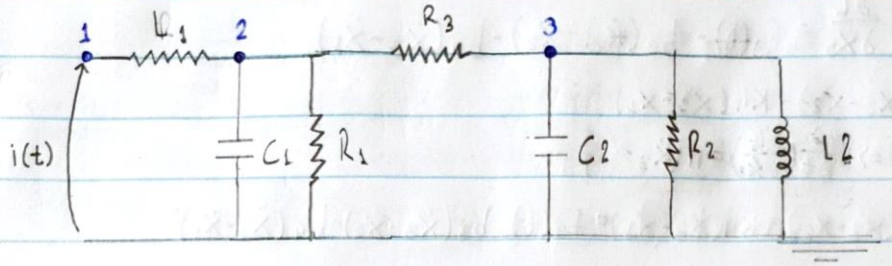
Gabriel Pinheiro
10336595

Ex 1:




Nó 1: $V_1\left(\frac{1}{LD_1}\right) - V_2\left(\frac{1}{LD_1}\right) = i(t)$

Nó 2: $V_2\left(CD_1 + \frac{1}{R_1} + \frac{1}{R_3} + \frac{1}{LD_1}\right) - V_1\left(\frac{1}{LD_1}\right) - V_3\left(\frac{1}{R_3}\right) = 0$

Nó 3: $V_3\left(CD_2 + \frac{1}{R_3} + \frac{1}{R_2} + \frac{1}{LD_2}\right) - V_2\left(\frac{1}{R_3}\right) = 0$

$$K_1\theta_1 - K_1\theta_2 = T$$
$$J_{G1}\ddot{\theta}_2 + B_1\dot{\theta}_2 + B_3\dot{\theta}_2 + K_1\theta_2 - K_1\theta_1 - B_3\dot{\theta}_3 = 0$$
$$J_{G2}\ddot{\theta}_3 + B_3\dot{\theta}_3 + B_2\dot{\theta}_3 + K_2\theta_3 - B_3\dot{\theta}_2 = 0$$

Ex 2:

a) $$T = \frac{m_1V_1^2}{2} + \frac{m_2V_2^2}{2} + \frac{m_3V_3^2}{2} = \frac{m_1\dot{x}_1^2}{2} + \frac{m_2\dot{x}_2^2}{2} + \frac{m_3\dot{x}_3^2}{2}$$
$$V = \frac{K_1}{2}x_1^2 + \frac{K_2}{2}(x_2-x_1)^2 + \frac{K_3}{2}(x_3-x_2)^2 + \frac{K_4}{2}(x_3-x_1)^2$$
$$\Big\} L = T - V$$

$L = T - V =$

1) $q_1 = x_1$: $\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_1}\right) - \frac{\partial L}{\partial x_1} = -b_1\dot{x}_1 + b_2(\dot{x}_2-\dot{x}_1) + b_4(\dot{x}_3-\dot{x}_1)$

$\frac{\partial L}{\partial x_1} = -K_1x_1 + K_2(x_2-x_1) + K_4(x_3-x_1)$

$\frac{\partial L}{\partial \dot{x}_1} = m_1\dot{x}_1 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_1}\right) = m_1\ddot{x}_1$

$$m_1\ddot{x}_1 + K_1x_1 - K_2(x_2-x_1) - K_4(x_3-x_1) = -b_1\dot{x}_1 + b_2(\dot{x}_2-\dot{x}_1) + b_4(\dot{x}_3-\dot{x}_1)$$

2) $q_2 = x_2$: $\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_2}\right) - \frac{\partial L}{\partial x_2} = -b_2(\dot{x}_2-\dot{x}_1) + b_3(\dot{x}_3-\dot{x}_2) + f_2(t)$

$\frac{\partial L}{\partial x_2} = -K_2(x_2-x_1) + K_3(x_3-x_2)$

$\frac{\partial L}{\partial \dot{x}_2} = m_2\dot{x}_2 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_2}\right) = m_2\ddot{x}_2$

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

/ /

3) $q_3 = x_3$: $\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_3}\right) - \frac{\partial L}{\partial x_3} = f_3(t) - b_3(\dot{x}_3 - \dot{x}_2) - b_4(\dot{x}_3 - \dot{x}_1)$

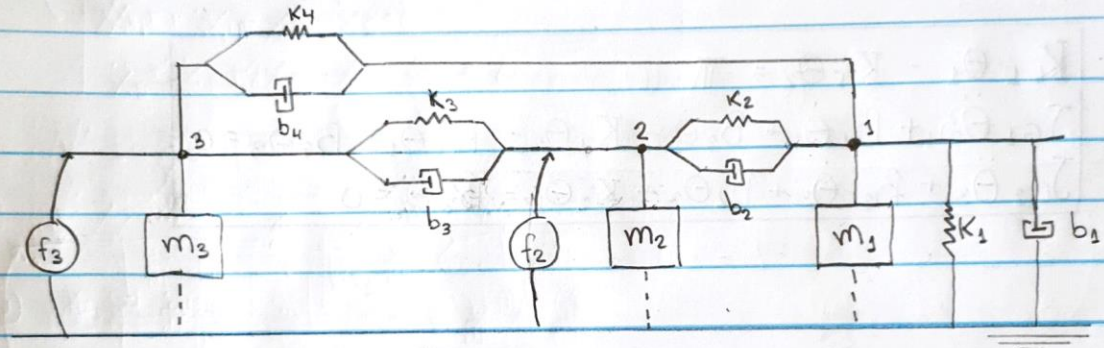
$\frac{\partial L}{\partial x_3} = -K_3(x_3 - x_2) - K_4(x_3 - x_1)$

$\frac{\partial L}{\partial \dot{x}_3} = m_3\dot{x}_3 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_3}\right) = m_3\ddot{x}_3$

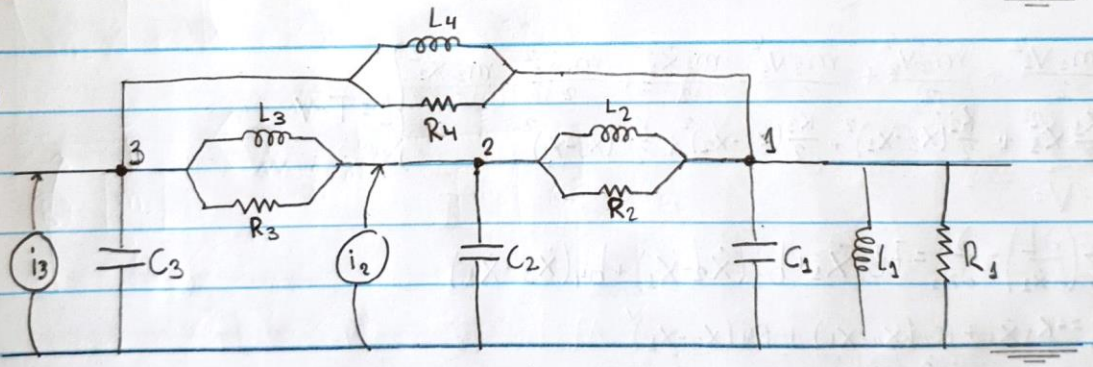
$m_3\ddot{x}_3 + K_3(x_3 - x_2) + K_4(x_3 - x_1) = f_3(t) - b_3(\dot{x}_3 - \dot{x}_2) - b_4(\dot{x}_3 - \dot{x}_1)$

$$m_1\ddot{x}_1 + b_1\dot{x}_1 + K_1x_1 = K_2(x_2 - x_1) + K_4(x_3 - x_1) + b_2(\dot{x}_2 - \dot{x}_1) + b_4(\dot{x}_3 - \dot{x}_1)$$
$$m_2\ddot{x}_2 + b_2(\dot{x}_2 - \dot{x}_1) + K_2(x_2 - x_1) = K_3(x_3 - x_2) + b_3(\dot{x}_3 - \dot{x}_2) + f_2(t)$$
$$m_3\ddot{x}_3 + b_3(\dot{x}_3 - \dot{x}_2) + K_3(x_3 - x_2) = f_3(t) - K_4(x_3 - x_1) - b_4(\dot{x}_3 - \dot{x}_1)$$

b)




c)




d)

Nó 1: $V_1\left(CD_1 + \frac{1}{LD_1} + \frac{1}{R_1} + \frac{1}{LD_2} + \frac{1}{R_2} + \frac{1}{R_4} + \frac{1}{LD_4}\right) - V_2\left(\frac{1}{LD_2} + \frac{1}{R_2}\right) - V_3\left(\frac{1}{LD_4} + \frac{1}{R_4}\right) = 0$

Nó 2: $V_2\left(CD_2 + \frac{1}{LD_2} + \frac{1}{R_2} + \frac{1}{LD_3} + \frac{1}{R_3}\right) - V_3\left(\frac{1}{LD_3} + \frac{1}{R_3}\right) - V_1\left(\frac{1}{LD_2} + \frac{1}{R_2}\right) = i_2$

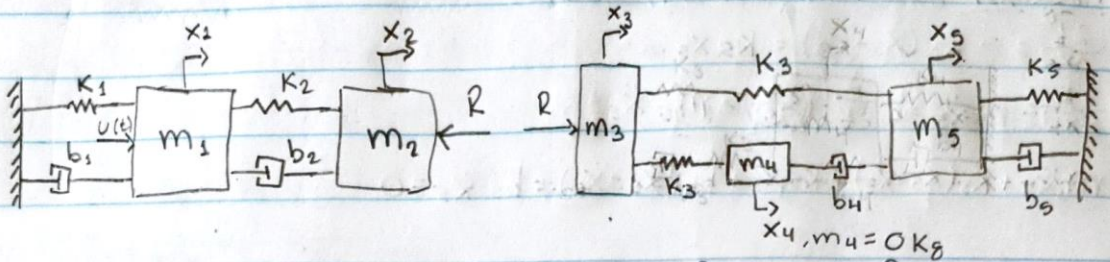
Nó 3: $V_3\left(CD_3 + \frac{1}{LD_3} + \frac{1}{R_3} + \frac{1}{LD_4} + \frac{1}{R_4}\right) - V_2\left(\frac{1}{LD_3} + \frac{1}{R_3}\right) - V_1\left(\frac{1}{LD_4} + \frac{1}{R_4}\right) = i_3$

e)

$$m_1\ddot{x}_1 + b_1\dot{x}_1 + K_1x_1 + K_2x_1 + b_2\dot{x}_1 + K_4x_1 + b_4\dot{x}_1 = K_2x_2 + b_2\dot{x}_2 + K_4x_3 + b_4\dot{x}_3$$
$$m_2\ddot{x}_2 + b_2\dot{x}_2 + K_2x_2 + K_3x_2 + b_3\dot{x}_2 = f_2 + K_3x_3 + b_3\dot{x}_3 + K_2x_1 + b_2\dot{x}_1$$
$$m_3\ddot{x}_3 + b_3\dot{x}_3 + K_3x_3 + K_4x_3 + b_4\dot{x}_3 = f_3 + K_3x_2 + b_3\dot{x}_2 + K_4x_1 + b_4\dot{x}_1$$

Ex 3:

a)




$$T = \frac{m_1}{2}\dot{x}_1^2 + \frac{m_2}{2}\dot{x}_2^2 + \frac{m_3}{2}\dot{x}_3^2 + \frac{m_4}{2}\dot{x}_4^2 + \frac{m_5}{2}\dot{x}_5^2$$

$$V = \frac{K_1}{2}(x_1)^2 + \frac{K_2}{2}(x_2 - x_1)^2 + \frac{K_3}{2}(x_5 - x_3)^2 + \frac{K_3}{2}(x_4 - x_3)^2 + \frac{K_5}{2}(x_5)^2$$

$L = T - V$

1) $q_1 = x_1$: $\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_1}\right) - \frac{\partial L}{\partial x_1} = U(t) - b_1\dot{x}_1 + b_2(\dot{x}_2 - \dot{x}_1)$

$\frac{\partial L}{\partial x_1} = -K_1 x_1 + K_2(x_2 - x_1)$

$\frac{\partial L}{\partial \dot{x}_1} = m_1\dot{x}_1 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_1}\right) = m_1\ddot{x}_1$

$m_1\ddot{x}_1 + K_1 x_1 + b_1\dot{x}_1 = U(t) + K_2(x_2 - x_1) + b_2(\dot{x}_2 - \dot{x}_1)$

2) $q_2 = x_2$: $\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_2}\right) - \frac{\partial L}{\partial x_2} = -b_2(\dot{x}_2 - \dot{x}_1) - R$

$\frac{\partial L}{\partial x_2} = -K_2(x_2 - x_1)$

$\frac{\partial L}{\partial \dot{x}_2} = m_2\dot{x}_2 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_2}\right) = m_2\ddot{x}_2$

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

3) $q_3 = x_3$: $\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_3}\right) - \frac{\partial L}{\partial x_3} = R + b_3(\dot{x}_4 - \dot{x}_3)$

$\frac{\partial L}{\partial x_3} = +K_3(x_5 - x_3) + K_3(x_4 - x_3)$

$\frac{\partial L}{\partial \dot{x}_3} = m_3\dot{x}_3 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_3}\right) = m_3\ddot{x}_3$

$m_3\ddot{x}_3 - K_3(x_5 - x_3) - K_3(x_4 - x_3) = R$

4) $q_4 = x_4$: $\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_4}\right) - \frac{\partial L}{\partial x_4} = +b_3(\dot{x}_5 - \dot{x}_4)$

$\frac{\partial L}{\partial x_4} = -K_3(x_4 - x_3)$

$\frac{\partial L}{\partial \dot{x}_4} = m_4\dot{x}_4 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_4}\right) = m_4\ddot{x}_4$

$m_4\ddot{x}_4 + K_3(x_4 - x_3) - b_3(\dot{x}_5 - \dot{x}_4) = 0$

/ /

5) $q_5 = x_5 : \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}_5}\right) - \frac{\partial L}{\partial x_5} = -b_4(\dot{x}_5 - \dot{x}_4) + b_5 \dot{x}_5$

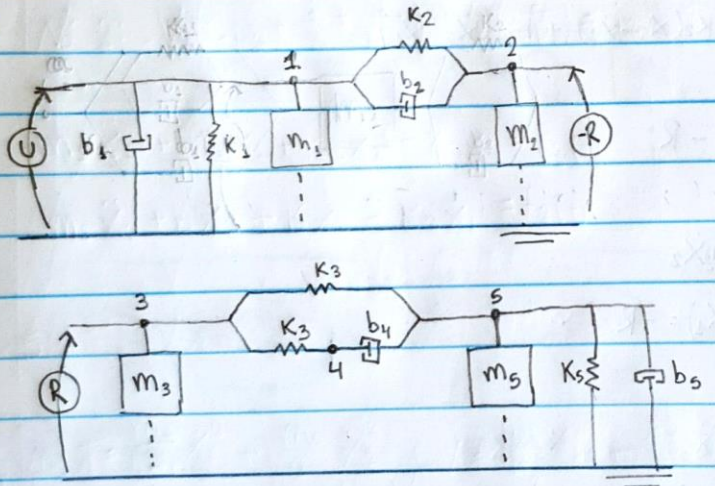
$\frac{\partial L}{\partial x_5} = -K_3(x_5 - x_3) - K_5 x_5$

$\frac{\partial L}{\partial \dot{x}_5} = m_5 \dot{x}_5 \Rightarrow \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}_5}\right) = m_5 \ddot{x}_5$

$m_5 \ddot{x}_5 + K_3(x_5 - x_3) + K_5 x_5 + b_4(\dot{x}_5 - \dot{x}_4) + b_5 \dot{x}_5 = 0$

$$\begin{cases} \ddot{x}_1 + 2\dot{x}_1 + 2x_1 = U(t) + x_2 \\ \ddot{x}_2 + (\dot{x}_2 - \dot{x}_1) + (x_2 - x_1) = -R \\ \ddot{x}_3 + 2x_3 - x_4 - x_5 = R \\ \ddot{x}_4 + x_4 - x_3 - \dot{x}_5 = 0 \\ \ddot{x}_5 + 2\dot{x}_5 + 2x_5 - x_3 - \dot{x}_4 = 0 \end{cases}, \text{ com } x_2 = x_3$$

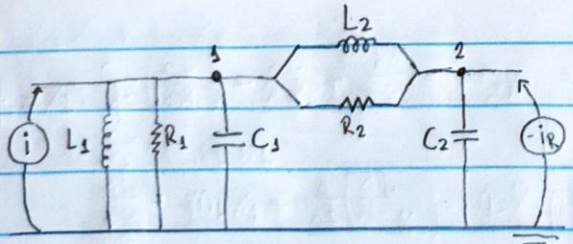
b)

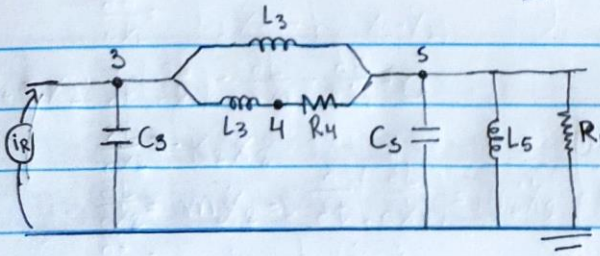






c)



d)

Nó 1: $V_1\left(CD_1+\frac{1}{R_1}+\frac{1}{LD_1}+\frac{1}{LD_2}+\frac{1}{R_2}\right)-V_2\left(\frac{1}{LD_2}+\frac{1}{R_2}\right)=i$

Nó 2: $V_2\left(CD_2+\frac{1}{R_2}+\frac{1}{LD_2}\right)-V_1\left(\frac{1}{R_2}+\frac{1}{LD_2}\right)=-i_R$

Nó 3: $V_3\left(CD_3+\frac{1}{LD_3}+\frac{1}{LD_3}\right)-V_4\left(\frac{1}{LD_3}\right)-V_5\left(\frac{1}{LD_3}\right)=i_R$ , com $V_2=V_3$

Nó 4: $V_4\left(\frac{1}{LD_3}+\frac{1}{R_4}\right)-V_3\left(\frac{1}{LD_3}\right)-V_5\left(\frac{1}{R_4}\right)=0$

Nó 5: $V_5\left(CD_5+\frac{1}{LD_5}+\frac{1}{R_5}+\frac{1}{R_4}+\frac{1}{LD_3}\right)-V_4\left(\frac{1}{R_4}\right)-V_3\left(\frac{1}{LD_3}\right)=0$

e)

$m_1\ddot{x}_1+b_1\dot{x}_1+b_2\dot{x}_1+K_1x_1+K_2x_1-K_2x_2-b_2\dot{x}_2=U$

$m_2\ddot{x}_2+b_2\dot{x}_2+K_2x_2-b_2\dot{x}_1-K_2x_1=-R$

$m_3\ddot{x}_3+2K_3x_3-K_3x_4-K_5x_5=R$ , com $\dot{x}_2=\dot{x}_3$

$b_4\ddot{x}_4+K_3x_4-K_3x_3-b_4\dot{x}_5=0$

$m_5\ddot{x}_5+b_5\dot{x}_5+K_5x_5+b_4x_5+K_3x_5)-b_4\dot{x}_4-K_3x_3=0$

## Ex 4:

a) $T=\frac{m_2}{2}\dot{x}_2^2+\frac{m_1}{2}\dot{x}_1^2$ ; $V=\frac{K_2}{2}(x_2-x_1)^2+\frac{K_1}{2}x_1^2$ } $L=T-V$

1) $q_1=x_1$: $\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_1}\right)-\frac{\partial L}{\partial x_1}=f_1(t)$

$\frac{\partial L}{\partial x_1}=K_2(x_2-x_1)-K_1x_1$

$\frac{\partial L}{\partial \dot{x}_1}=m_1\dot{x}_1 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_1}\right)=m_1\ddot{x}_1$

$m_1\ddot{x}_1+K_1x_1=f_1(t)+K_2(x_2-x_1)$

2) $q_2=x_2$: $\frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_2}\right)-\frac{\partial L}{\partial x_2}=f_2(t)-b\dot{x}_2$

$\frac{\partial L}{\partial x_2}=-K_2(x_2-x_1)$

$\frac{\partial L}{\partial \dot{x}_2}=m_2\dot{x}_2 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_2}\right)=m_2\ddot{x}_2$

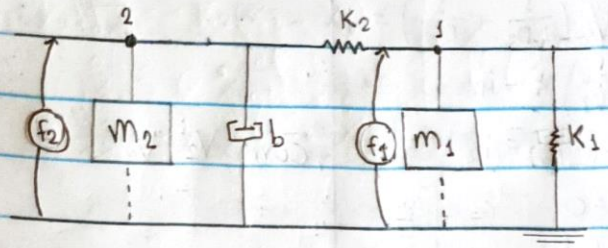
$m_2\ddot{x}_2+K_2(x_2-x_1)+b\dot{x}_2=f_2(t)$

b)

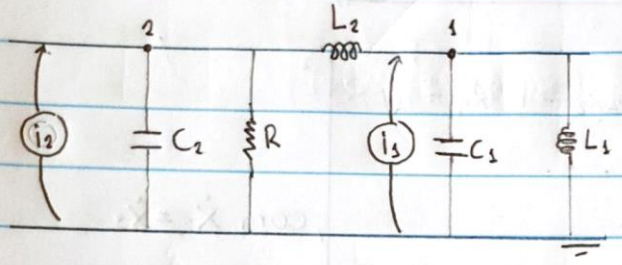
$m_1\ddot{x}_1+K_1x_1=f_1(t)+K_2(x_2-x_1)$

$m_2\ddot{x}_2+b\dot{x}_2+K_2(x_2-x_1)=f_2(t)$

b)




c)




d) Nó 1: $V_1\left(CD_1 + \frac{1}{LD_1} + \frac{1}{LD_2}\right) - V_2\left(\frac{1}{LD_2}\right) = i_1$

Nó 2: $V_2\left(CD_2 + \frac{1}{R} + \frac{1}{LD_2}\right) - V_1\left(\frac{1}{LD_2}\right) = i_2$

e) $m_1\ddot{x}_1 + K_1x_1 + K_2x_1 - K_2x_2 = f_1(t)$

$m_2\ddot{x}_2 + b\dot{x}_2 + Kx_2 - K_2x_1 = f_2(t)$

Ex 5:

a) $T = \frac{m_1}{2}\dot{x}_1^2 + \frac{m_2}{2}\dot{x}_2^2$, $V = \frac{K_1}{2}x_1^2 + \frac{K_2}{2}x_2^2$ $\Big\}$ $L = T - V$

$R = \frac{b_1}{2}\dot{x}_1^2 + \frac{b_2}{2}\dot{x}_2^2 + \frac{b_3}{2}(\dot{x}_2 - \dot{x}_1)^2$

1) $q_1 = x_1$: $\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}_1}\right) + \frac{\partial L}{\partial x_1} + \frac{\partial R}{\partial \dot{x}_1} = f(t)$

$\frac{\partial L}{\partial x_1} = -K_1x_1$

$\frac{\partial L}{\partial \dot{x}_1} = m_1\dot{x}_1 \Rightarrow \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}_1}\right) = m_1\ddot{x}_1$

$\frac{\partial R}{\partial \dot{x}_1} = b_1\dot{x}_1 - b_3(\dot{x}_2 - \dot{x}_1)$

$\Big\}$ $m_1\ddot{x}_1 + K_1x_1 + b_1\dot{x}_1 - b_3(\dot{x}_2 - \dot{x}_1) = f(t)$

2) $q_2 = x_2$: $\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}_2}\right) - \frac{\partial L}{\partial x_2} + \frac{\partial R}{\partial \dot{x}_2} = 0$

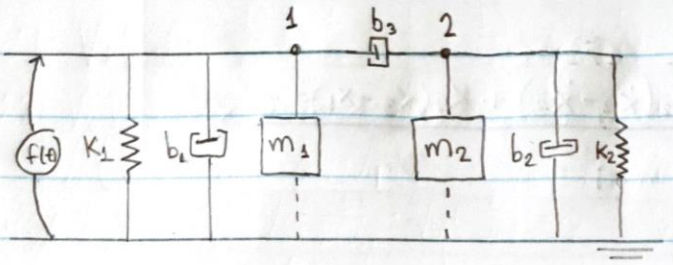
$\frac{\partial L}{\partial x_2} = -K_2x_2$

$\frac{\partial L}{\partial \dot{x}_2} = m_2\dot{x}_2 \Rightarrow \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}_2}\right) = m_2\ddot{x}_2$

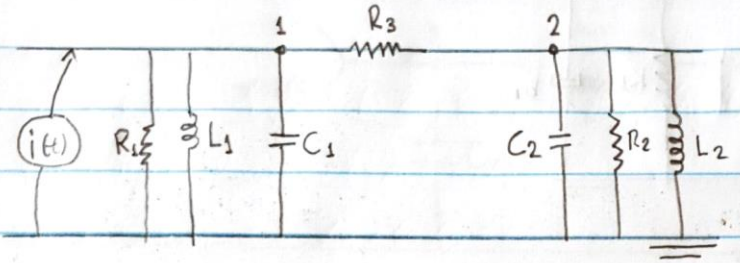
$\frac{\partial R}{\partial \dot{x}_2} = b_2\dot{x}_2 + b_3(\dot{x}_2 - \dot{x}_1)$

$\Big\}$ $m_2\ddot{x}_2 + K_2x_2 + b_2\dot{x}_2 + b_3(\dot{x}_2 - \dot{x}_1) = 0$

b)




c)



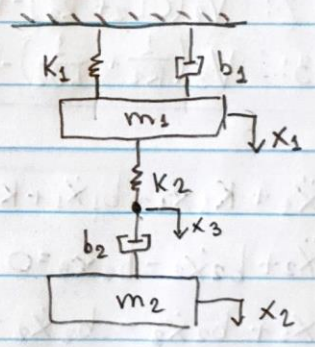

d) Nó 1: $V_1\left(CD_1 + \frac{1}{LD_1} + \frac{1}{R_1} + \frac{1}{R_3}\right) - V_2\left(\frac{1}{R_3}\right) = i(t)$

Nó 2: $V_2\left(CD_2 + \frac{1}{R_2} + \frac{1}{LD_2} + \frac{1}{R_3}\right) - V_1\left(\frac{1}{R_3}\right) = 0$

e) $m_1\ddot{x}_1 + K_1x_1 + b_1\dot{x}_1 + b_3\dot{x}_1 - b_3\dot{x}_2 = f(t)$

$m_2\ddot{x}_2 + b_2\dot{x}_2 + K_2x_2 + b_3\dot{x}_2 - b_3\dot{x}_1 = 0$

Ex6:




a) $T = \frac{m_1}{2}\dot{x}_1^2 + \frac{m_2}{2}\dot{x}_2^2$, $V = \frac{K_1}{2}x_1^2 + \frac{K_2}{2}(x_3 - x_1)^2$ $\Big\}$ $L = T - V$

$R = \frac{b_1}{2}\dot{x}_1^2 + \frac{b_2}{2}(\dot{x}_2 - \dot{x}_3)^2$

1) $q_1 = x_1$: $\frac{\partial L}{\partial x_1} = -K_1x_1 + K_2(x_3 - x_1)$

$\frac{\partial L}{\partial \dot{x}_1} = m_1\dot{x}_1 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_1}\right) = m_1\ddot{x}_1$

$\frac{\partial R}{\partial \dot{x}_1} = b_1\dot{x}_1$

$\Big\}$ $m_1\ddot{x}_1 + K_1x_1 - K_2(x_3 - x_1) + b_1\dot{x}_1 = f(t)$

2) $q_2 = x_2$: $\frac{\partial L}{\partial x_2} = 0$

$\frac{\partial L}{\partial \dot{x}_2} = m_2\dot{x}_2 \Rightarrow \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_2}\right) = m_2\ddot{x}_2$

$\frac{\partial R}{\partial \dot{x}_2} = b_2(\dot{x}_2 - \dot{x}_3)$

$\Big\}$ $m_2\ddot{x}_2 + b_2(\dot{x}_2 - \dot{x}_3) = 0$

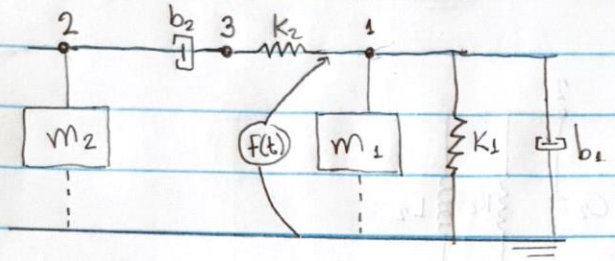
3) $q_3 = x_3$: $\frac{\partial L}{\partial x_3} = -K_2(x_3 - x_1)$

$\frac{\partial L}{\partial \dot{x}_3} = 0 = \frac{\partial}{\partial t}\left(\frac{\partial L}{\partial \dot{x}_3}\right) = 0$

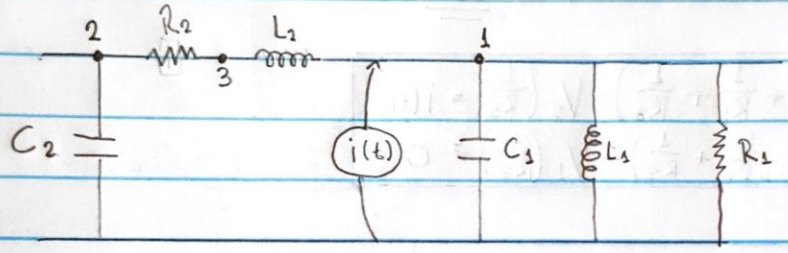
$\frac{\partial R}{\partial \dot{x}_3} = -b_2(\dot{x}_2 - \dot{x}_3)$

$$-b_2(\dot{x}_2 - \dot{x}_3) + K_2(x_3 - x_1) = 0$$

b)




c)




d)

Nó 1: $V_1\left(CD_1 + \frac{1}{LD_1} + \frac{1}{R_1} + \frac{1}{LD_2}\right) - V_3\left(\frac{1}{LD_2}\right) = i(t)$

Nó 2: $V_2\left(CD_2 + \frac{1}{R_2}\right) - V_3\left(\frac{1}{R_2}\right) = 0$

Nó 3: $V_3\left(\frac{1}{R_2} + \frac{1}{LD_2}\right) - V_2\left(\frac{1}{R_2}\right) - V_1\left(\frac{1}{LD_2}\right) = 0$

e)

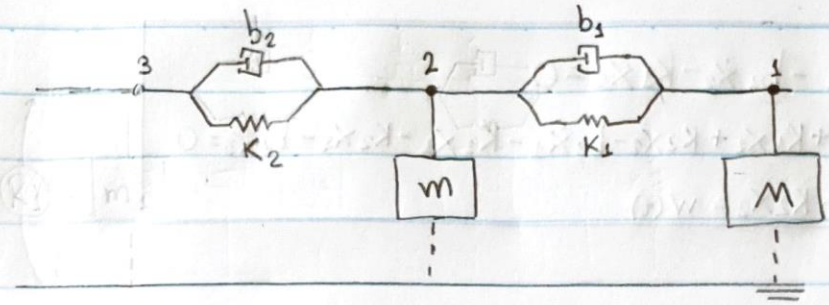
$$m_1\ddot{x}_1 + K_1x_1 + b_1\dot{x}_1 + K_2x_1 - K_2x_3 = f(t)$$

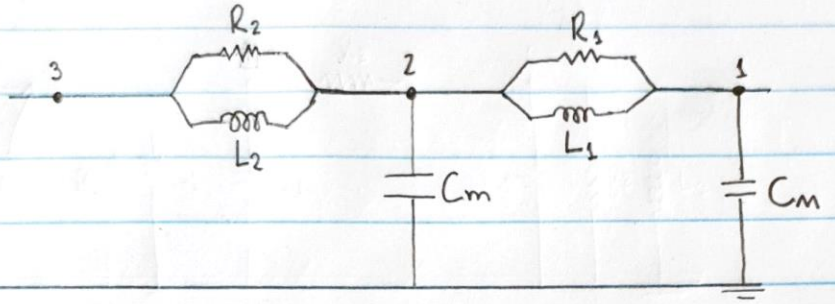
$$m_2\ddot{x}_2 + b_2\dot{x}_2 - b_2\dot{x}_3 = 0$$

$$K_2x_3 + b_2\dot{x}_3 - b_2\dot{x}_2 - K_2x_1 = 0$$

Ex 8:

a)




Nó 1: $V_1(CD_m + \frac{1}{LD_1} + \frac{1}{R_1}) - V_2(\frac{1}{LD_1} + \frac{1}{R_1}) = 0$

Nó 2: $V_2(CD_m + \frac{1}{LD_1} + \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{LD_2}) - V_1(\frac{1}{LD_1} + \frac{1}{R_1}) - V_3(\frac{1}{LD_2} + \frac{1}{R_2}) = 0$

Nó 3: $V_3(\frac{1}{LD_2} + \frac{1}{R_2}) - (\frac{1}{LD_2} + \frac{1}{R_2})V_2 = 0$

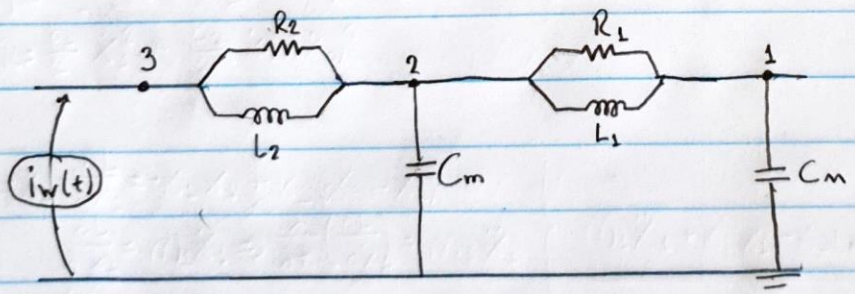
$V_3 \Rightarrow \dot{w}(t)$

$$M\ddot{x}_1 + b_1\dot{x}_1 + K_1x_1 - b_1\dot{x}_2 - K_1x_2 = 0$$

$$m\ddot{x}_2 + b_1\dot{x}_2 + b_2\dot{x}_2 + K_1x_2 + K_2x_2 - b_1\dot{x}_1 - K_1x_1 - K_2w(t) - b_2\dot{w}(t) = 0$$

$$b_2\dot{w}(t) + K_2w(t) - b_2\dot{x}_2 - K_2x_2 = 0$$

b)




Nó 1: $V_1(CD_m + \frac{1}{LD_1} + \frac{1}{R_1}) - V_2(\frac{1}{LD_1} + \frac{1}{R_1}) = 0$

Nó 2: $V_2(CD_m + \frac{1}{LD_1} + \frac{1}{R_1} + \frac{1}{LD_2} + \frac{1}{R_2}) - V_1(\frac{1}{LD_1} + \frac{1}{R_1}) - V_3(\frac{1}{LD_2} + \frac{1}{R_2}) = 0$

Nó 3: $V_3(\frac{1}{LD_2} + \frac{1}{R_2}) - V_2(\frac{1}{LD_2} + \frac{1}{R_2}) = iw(t)$

/ /

$$M\ddot{x}_1 + b_1\dot{x}_1 + K_1x_1 - b_1\dot{x}_2 - K_1x_2 = 0$$

$$m\ddot{x}_2 + b_1\dot{x}_2 + b_2\dot{x}_2 + K_1x_2 + K_2x_2 - b_1\dot{x}_1 - K_1x_1 - K_2x_3 - b_2\dot{x}_3 = 0$$

$$b_2\dot{x}_3 + K_2x_3 - b_2\dot{x}_2 - K_2x_2 = w(t)$$

Ex 7: