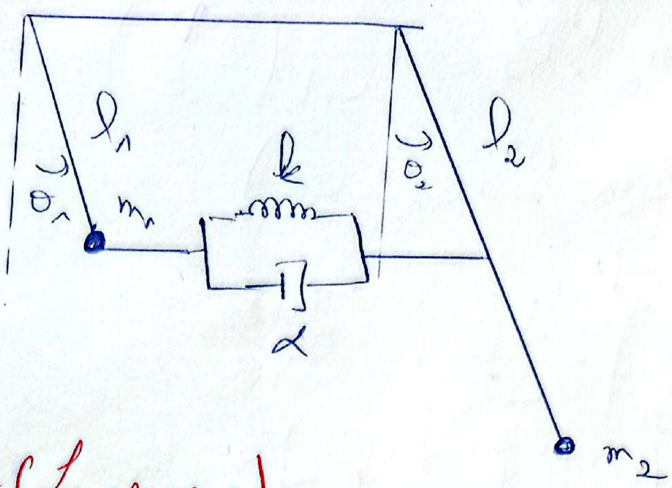


1/ Eq diff de mouvement (Lagrange)

$$L = E_c - E_p$$

$$E_c = \frac{1}{2} m_1 l_1^2 \dot{\theta}_1^2 + \frac{1}{2} m_2 l_2^2 \dot{\theta}_2^2$$

$$E_p = m_1 g l_1 (1 - \cos\theta_1) + m_2 g l_2 (1 - \cos\theta_2) + \frac{1}{2} k (l_1\theta_1 - l_1\theta_2)^2$$

$$D = \frac{1}{2} \alpha (l_1\dot{\theta}_1 - l_1\dot{\theta}_2)^2$$

1 $$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_1}\right) - \frac{\partial L}{\partial \theta_1} = -\frac{\partial D}{\partial \dot{\theta}_1}$$

$$\frac{\partial L}{\partial \theta_1} = -m_1 g l_1 \theta_1 - k l_1 (l_1\theta_1 - l_1\theta_2)$$

$$\frac{\partial L}{\partial \dot{\theta}_1} = m_1 l_1^2 \dot{\theta}_1 \longrightarrow \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\theta}_1}\right) = m_1 l_1^2 \ddot{\theta}_1$$

$$\frac{\partial D}{\partial \dot{\theta}_1} = \alpha l_1 (l_1\dot{\theta}_1 - l_1\dot{\theta}_2) = \alpha l_1^2 (\dot{\theta}_1 - \dot{\theta}_2)$$

On aura :

$$m_1 l_1^2 \ddot{\theta}_1 + m_1 g l_1 \theta_1 + k l_1^2 \theta_1 - k l_1^2 \theta_2 = -\alpha l_1^2 \dot{\theta}_1 + \alpha l_1^2 \dot{\theta}_2$$

$$\boxed{m_1 l_1^2 \ddot{\theta}_1 + \alpha l_1^2 \dot{\theta}_1 + (m_1 g l_1 + k l_1^2)\theta_1 = k l_1^2 \theta_2 + \alpha l_1^2 \dot{\theta}_2}$$

(2)

$$\begin{cases} \dfrac{\partial L}{\partial \theta_2} = -m_2 g l_2 \theta_2 + k l_1^2 (\theta_1 - \theta_2) \\ \dfrac{\partial L}{\partial \dot\theta_2} = m_2 l_2 \dot\theta_2 \rightarrow \dfrac{d}{dt}\left(\dfrac{\partial L}{\partial \dot\theta_2}\right) = m_2 l_2 \ddot\theta_2 \\ \dfrac{\partial D}{\partial \dot\theta_2} = -\alpha l_1^2 (\dot\theta_1 - \dot\theta_2) \end{cases}$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot\theta_2}\right) - \frac{\partial L}{\partial \theta_2} = -\frac{\partial D}{\partial \dot\theta_2}$$

$$\boxed{m_2 l_2^2 \ddot\theta_2 + (m_2 g l_2 + k l_1^2)\theta_2 + \alpha l_1^2 \dot\theta_2 = k l_1^2 \theta_1 + \alpha l_1^2 \dot\theta_1}$$

2- circuit RLC équivalent.

$m_1 \longrightarrow L_1$

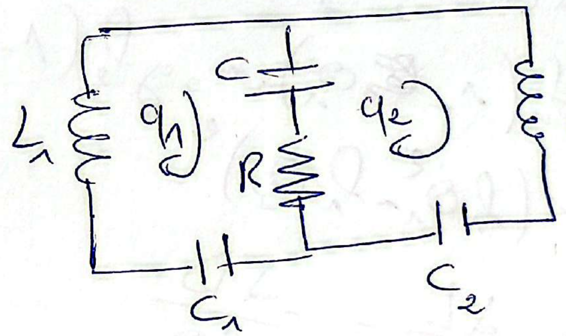
$m_2 \longrightarrow L_2$

$m_1 g l_1 \longrightarrow C_1$

$m_2 g l_2 \longrightarrow C_2$

$k \longrightarrow C$

$\alpha \longrightarrow R$



$$\begin{cases} \underbrace{m_1 l_1^2}_{L_1} \ddot\theta_1 + \underbrace{\alpha l_1^2}_{R} \dot\theta_1 + (\underbrace{k l_1^2}_{C} + \underbrace{m_1 g l_1}_{C_1})\theta_1 = \underbrace{k l_1^2}_{C} \theta_2 + \underbrace{\alpha l_1^2}_{R} \dot\theta_2 \\ \underbrace{m_2 l_2^2}_{L_2} \ddot\theta_2 + \underbrace{\alpha l_1^2}_{R} \dot\theta_2 + (\underbrace{m_2 g l_2}_{C_2} + \underbrace{k l_1^2}_{C})\theta_2 = \underbrace{k l_1^2}_{C} \theta_1 + \underbrace{\alpha l_1^2}_{R} \dot\theta_1 \end{cases}$$