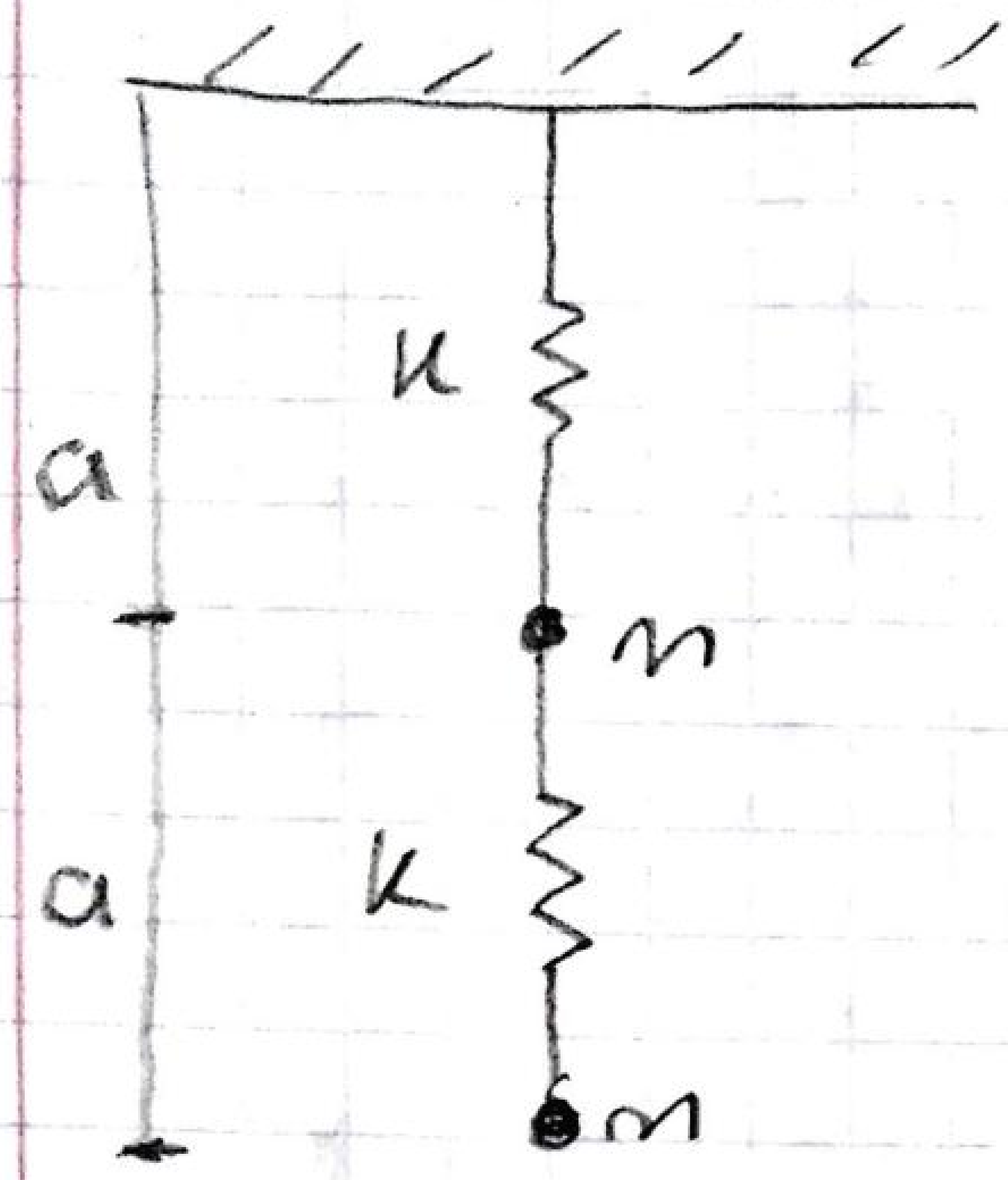
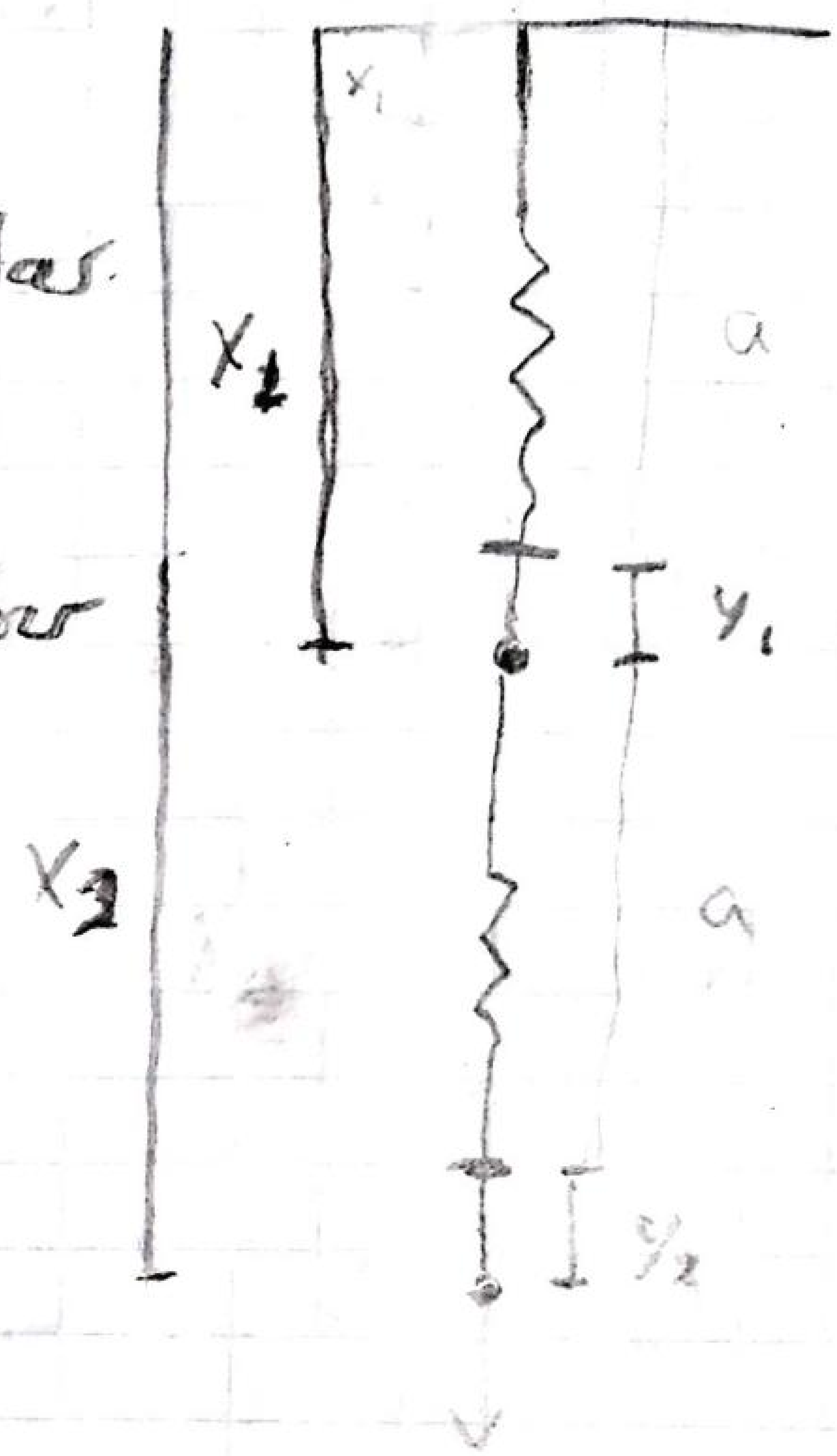


a) $L = ?$

b) Cambio de coordenadas.

$L =$

c) Resolver las ecuaciones



$$V = (L-a)^2 \frac{k}{2}$$

$$V_1 = (X_1 - a)^2 \frac{k}{2}$$

$$V_2 = (X_2 - X_1 - a)^2 \frac{k}{2}$$

$$X_1 = Y_1 + a$$

$$X_2 = Y_2 + 2a$$

$$V = (Y_1 + a - a)^2 \frac{k}{2} + (Y_3 + 2a - Y_1 \cancel{- a} \cancel{- a})^2 \frac{k}{2}$$

$$V = \frac{k}{2}\left[(Y_1)^2 + (Y_2 - Y_1)^2\right]$$

$$X_1 = Y_1 + a$$

$$X_2 = Y_2 + 2a$$

$$\dot{X}_1 = \dot{Y}_1$$

$$\dot{X}_2 = \dot{Y}_2$$

$$T = \frac{1}{2} m_1 \dot{X}_1^2 + \frac{1}{2} m_2 \dot{X}_2^2$$

$$T = \frac{1}{2} m (\dot{Y}_1^2 + \dot{Y}_2^2) = \frac{1}{2} m (\dot{Y}_1 + \dot{Y}_2)$$

$$L = \frac{1}{2} m (\dot{Y}_1^2 + \dot{Y}_2^2) - \frac{k}{2}\left[(Y_1)^2 + (Y_2 - Y_1)^2\right]$$

$$L = \frac{1}{2} m (\dot{y}_1^2 + \dot{y}_2^2) - \frac{k}{2} \underbrace{\left[(y_1)^2 + (y_2 - y_1)^2 \right]}$$

$$y_1^2 + y_2^2 - 2 y_2 y_1 + y_1^2 = 2 y_1^2 + y_2^2 - 2 y_2 y_1$$

$$(y_1 \ y_2) \begin{pmatrix} 2 & -1 \\ -1 & 1 \end{pmatrix} \begin{pmatrix} y_1 \\ y_2 \end{pmatrix}$$

$$A = \begin{pmatrix} 2 & -1 \\ -1 & 1 \end{pmatrix} \qquad A \begin{pmatrix} x \\ y \end{pmatrix} = \lambda \begin{pmatrix} x \\ y \end{pmatrix}$$

$$\begin{pmatrix} 2x & -y \\ -x & y \end{pmatrix} - \begin{pmatrix} \lambda x \\ \lambda y \end{pmatrix} = 0$$

$$\begin{pmatrix} 2x - y - \lambda x \\ -x + y - \lambda y \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix} \longrightarrow \begin{pmatrix} (2-\lambda) x - y \\ -x + (1-\lambda) y \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \end{pmatrix}$$

$$\begin{vmatrix} (2-\lambda) & -1 \\ -1 & (1-\lambda) \end{vmatrix} = \lambda^2 - 3\lambda - 1$$

$$\lambda_1 = \frac{3 + \sqrt{5}}{2}$$

$$\lambda_2 = \frac{3 - \sqrt{5}}{2}$$

$$\left(\frac{4 - 3 - \sqrt{5}}{2} \right) x - y = 0$$

$$-x + \left(\frac{2 - 3 - \sqrt{5}}{2} \right) y = 0$$

$$\left(\frac{1 - \sqrt{5}}{2} \right) x - y = 0 \rightarrow y = \frac{1 - \sqrt{5}}{2} x$$

$$-x + \left(\frac{-1 - \sqrt{5}}{2} \right) y = 0$$

$$-x + \left(\frac{-1 - \sqrt{5}}{2} \right) \left(\frac{1 - \sqrt{5}}{2} x \right) = 0$$

$$-x + \left(\frac{-1 - \sqrt{5} + \sqrt{5} + 5}{4} \right) x = 0$$

$$-x + x = 0$$

$$\boxed{x = 1} \qquad \boxed{y = \frac{1 - \sqrt{5}}{2}}$$

$$\sqrt{1^2 + \left(\frac{1-\sqrt{5}}{2}\right)^2} =$$

$$\vec{V}_1 = \frac{1}{\sqrt{\frac{5+\sqrt{5}}{2}}}\begin{pmatrix} 1 \\ \frac{1-\sqrt{5}}{2} \end{pmatrix}$$

$$\lambda_2 = \frac{3-\sqrt{5}}{2} \qquad \left[2 - \left(\frac{3-\sqrt{5}}{2}\right)\right]x - y = 0$$

$$-x + \left[1 - \left(\frac{3-\sqrt{5}}{2}\right)\right]y = 0$$

$$\frac{4-3+\sqrt{5}}{2}x - y = 0 \qquad -x + \left[\frac{-1+\sqrt{5}}{2}\right]\left[\frac{1+\sqrt{5}}{2}\right]x = 0$$

$$y = \frac{1+\sqrt{5}}{2}x \qquad -x + \left(\frac{\cancel{-1-\sqrt{5}+\sqrt{5}+5}}{4}\right)x = 0$$

$$\boxed{y = \frac{1+\sqrt{5}}{2}} \qquad -x + x = 0 \qquad \boxed{x = 1}$$

$$\sqrt{1^2 + \left(\frac{1+\sqrt{5}}{2}\right)^2} = \sqrt{\frac{5+\sqrt{5}}{2}}$$

$$V_2 = \frac{1}{\sqrt{\frac{5+\sqrt{5}}{2}}}\begin{pmatrix} 1 \\ \frac{1+\sqrt{5}}{2} \end{pmatrix}$$

$$M = \begin{pmatrix} 0.85 & 0.525 \\ -0.525 & 0.85 \end{pmatrix}$$

$$\begin{pmatrix} y_1 \\ y_2 \end{pmatrix} = \begin{pmatrix} 0.85 & 0.525 \\ -0.525 & 0.82 \end{pmatrix}\begin{pmatrix} z_1 \\ z_2 \end{pmatrix}$$

$$2.618\, z_1^2 + 0.381\, z_2^2$$

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$$L = \frac{1}{2} m \left[\dot{z}_1^2 + \dot{z}_2^2 \right] - \frac{k}{2} \left(2.618 z_1^2 + 0.381 z_2^2 \right)$$

$$q_1 = z_1 \qquad q_2 = z_2$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{z}_1}\right) - \frac{\partial L}{\partial z_1} = 0 \implies \frac{\partial L}{\partial \dot{z}_1} = \frac{1}{2} m 2 \dot{z}_1 = m \dot{z}_1$$

$$m\ddot{z}_1 + 2.618 k z_1 = 0$$
$$m\ddot{z}_2 + 0.381 k z_2 = 0$$
$$\implies \quad m\ddot{z}_1 = -2.618 k z_1 \quad -1$$
$$m\ddot{z}_2 = -0.381 k z_2 \quad -2$$

1) $m f''(t) = -2.618 k f(t)$ $\qquad k' = 2.618 k \qquad \omega_0 = \sqrt{\frac{k'}{m}}$

$$f''(t) + \frac{2.618 k}{m} f(t) = 0$$

$$\lambda^2 + \frac{2.618 k}{m} = 0 \longrightarrow \lambda = \pm\sqrt{\frac{2.618 k}{m}} = \pm \omega_0$$

$$f(t) = a e^{i\lambda_1 t} + b e^{i\lambda_2 t} = a e^{i\omega_0 t} + b e^{-i\omega_0 t}$$

$$f(t) = a(\cos \omega_0 t + i \operatorname{sen} \omega_0 t) + b(\cos \omega_0 t - i \operatorname{sen} \omega_0 t)$$

$$f(t) = \underbrace{(a+b)}_{C_1} \cos \omega_0 t + i \underbrace{(a-b)}_{C_2} \operatorname{sen} \omega_0 t \qquad C_1, C_2 \in \mathbb{R}$$

$$f(t) = D \cos(\omega_0 t + F)$$

$$z_1 = C \cos\left(\sqrt{2.618}\, \omega_0 t + D\right)$$
$$z_2 = F \cos\left(\sqrt{0.381}\, \omega_0 t + G\right)$$

Resolvamos

$$Y_1 = 0.85 Z_1 + 0.525 Z_2$$

$$Y_2 = -0.525 \cdot Z_1 + 0.85 Z_2$$

$$X_1 = 0.85\, C \cos\left(\sqrt{2.618}\, W_0 t + D\right) + 0.525\, F \cos\left(\sqrt{0.381}\, W_0 t + G\right) + a$$

$$X_2 = -0.525\, C \cos\left(\sqrt{2.618}\, W_0 t + D\right) + 0.82\, F \cos\left(\sqrt{0.381}\, W_0 t + G\right) + 2a$$

$$X_1 = Y_1 + a$$

$$X_2 = Y_2 + 2a$$

$$\begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} a \\ 2a \end{pmatrix} + C \begin{pmatrix} 0.85 \\ -0.525 \end{pmatrix} \cos\left(\sqrt{2.618}\, W_0 t + D\right) + F \begin{pmatrix} 0.525 \\ 0.82 \end{pmatrix} \cos\left(\sqrt{0.381}\, W_0 t + G\right)$$