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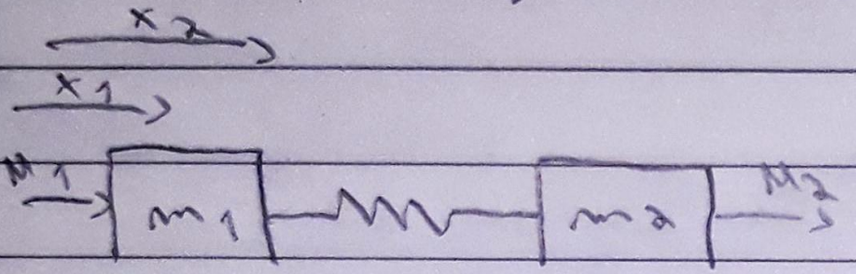

$$\bar{x} = \frac{m_1 x_1 + m_2 x_2}{m_1 + m_2} = \frac{m_1 x_1 + m_2 x_2}{M}$$

$$\delta = x_1 - x_2$$

$$\dot{\bar{x}} = \frac{M_1 + M_2}{M} \quad ; \quad \ddot{\delta} = -\frac{\kappa M \delta}{M_1 M_2} + \frac{M_2}{M_1} - \frac{M_2}{M_2}$$

$$\begin{bmatrix} \bar{x} \\ \delta \end{bmatrix} = \begin{bmatrix} \frac{m_2}{M} & \frac{m_2}{M} \\ 1 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} \Rightarrow \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \frac{1}{\frac{m_1 - m_2}{M}} \begin{bmatrix} -1 & -\frac{m_2}{M} \\ -1 & \frac{m_1}{M} \end{bmatrix} \begin{bmatrix} \bar{x} \\ \delta \end{bmatrix}$$

$$\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 1 & \frac{m_2}{M} \\ 1 & -\frac{m_1}{M} \end{bmatrix} \begin{bmatrix} \bar{x} \\ \delta \end{bmatrix} \Rightarrow \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 1 & \frac{m_2}{M} & 0 & 0 \\ 1 & -\frac{m_1}{M} & 0 & 0 \end{bmatrix} \begin{bmatrix} \bar{x} \\ \delta \\ \dot{\bar{x}} \\ \dot{\delta} \end{bmatrix}$$

$$y = \bar{C} z$$

$$\dot{z} = A z + B u$$