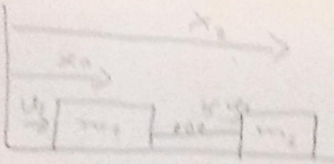

$$\bar{X} = \frac{X_1 M_1 + X_2 M_2}{M_1 + M_2} \Rightarrow \frac{X_1 M_1 + X_1 M_2}{M}$$

$$\delta = X_2 - X_1$$

$$u_2 + u_1 = M\ddot{\bar{X}} \Rightarrow \ddot{\bar{X}} = \frac{u_2 + u_1}{M}$$

$$\ddot{\delta} = \ddot{X}_2 - \ddot{X}_1$$

$$\Downarrow$$

$$\ddot{\delta} = \frac{u_1}{M_1} - \frac{u_2}{M_2} - \frac{KM}{M_1 \cdot M_2}\delta$$

$$z = \begin{Bmatrix} \bar{X} \\ \delta \\ \dot{\bar{X}} \\ \dot{\delta} \end{Bmatrix}$$

$$\dot{\bar{z}} = \bar{A}z + Bu \quad ; \quad Y = \bar{C}z$$

$$\begin{Bmatrix} \dot{\bar{X}} \\ \dot{\delta} \\ \ddot{\bar{X}} \\ \ddot{\delta} \end{Bmatrix} = \begin{Bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & -\frac{MK}{M_1 \cdot M_2} & 0 & 0 \end{Bmatrix} \bar{z} + \begin{Bmatrix} 0 & 0 \\ 0 & 0 \\ \frac{1}{M} & \frac{1}{M} \\ \frac{1}{M_1} & -\frac{1}{M_2} \end{Bmatrix} u$$

$$\begin{Bmatrix} \bar{X} \\ \delta \end{Bmatrix} = \begin{Bmatrix} \frac{M_1}{M} & \frac{M_2}{M} \\ 1 & -1 \end{Bmatrix} \begin{Bmatrix} X_1 \\ X_2 \end{Bmatrix} \Rightarrow \begin{Bmatrix} X_1 \\ X_2 \end{Bmatrix} = \begin{Bmatrix} 1 & \frac{M_2}{M} & 0 & 0 \\ 1 & -\frac{M_1}{M} & 0 & 0 \end{Bmatrix} \begin{Bmatrix} \bar{X} \\ \delta \\ \dot{\bar{X}} \\ \dot{\delta} \end{Bmatrix}$$

tal que:

$$Y = Cz \quad ; \quad \dot{z} = Az + Bu$$