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1.

$\ddot{\bar{X}} = (U_1+U_2)/M$

$\ddot{\delta} = -\frac{KM}{M_1 M_2}\delta + \frac{U_1}{M_1} - \frac{U_2}{M_2}$

$$\left.\begin{array}{ll} X_1 = \bar{X} & \dot{X}_1 = X_3 \\ X_2 = \delta & \dot{X}_2 = X_4 \\ X_3 = \dot{\bar{X}} & \dot{X}_3 = (U_1+U_2)/M \\ X_4 = \dot{\delta} & \dot{X}_4 = -\frac{KM}{M_1+M_2}X_2 + \frac{U_1}{M_1} - \frac{U_2}{M_2} \end{array}\right\} \text{Utilizando expansão de Taylor para linearização}$$

$$\bar{A} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 \\ 0 & \frac{-KM}{M_1+M_2} & 0 & 0 \end{bmatrix} \quad \bar{B} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ \frac{1}{M} & \frac{1}{M} \\ \frac{1}{M_1} & \frac{-1}{M_2} \end{bmatrix}$$

$$\left.\begin{array}{l} \bar{X}_1 = \frac{M_1X_1 + M_2X_2}{M} \\ \bar{X}_2 = X_1 - X_2 \end{array}\right\} \text{Deslocamentos}$$

$$\bar{C}\bar{X} = \begin{bmatrix} 1 & C_2 & 0 & 0 \\ 1 & C_6 & 0 & 0 \end{bmatrix}\begin{bmatrix} X_1 \\ X_2 \\ X_3 \\ X_4 \end{bmatrix} = $$

$$1\,\frac{M_1X_1 + M_2X_2}{M} + C_2(X_1 - X_2) = X_1 \Rightarrow C_2 = \frac{M_2}{M}$$

$$1\,\frac{M_1X_1 + M_2X_2}{M} + C_6(X_1 - X_2) = X_2 \Rightarrow C_6 = -\frac{M_1}{M}$$

$$\boxed{\bar{C} = \begin{bmatrix} 1 & -\frac{M_2}{M} & 0 & 0 \\ 1 & -\frac{M_1}{M} & 0 & 0 \end{bmatrix}}$$