

$$\dot{\mathbf{x}} = \begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \end{bmatrix} = \begin{bmatrix} x_2 \\ f_1(x_1, x_2, x_3, x_4) \\ x_4 \\ f_2(x_1, x_2, x_3, x_4) \end{bmatrix}, \quad \mathbf{y} = \begin{bmatrix} x_1 \\ x_3 \end{bmatrix}$$

Let $\Delta = x_3 - x_1$

$$f_1(x) = \frac{m_2 \ell_2 x_4^2 \sin(\Delta) \cos(\Delta) + m_2 g \sin(x_3) \cos(\Delta) + m_2 \ell_1 x_2^2 \sin(\Delta) - (m_1 + m_2) g \sin(x_1)}{\ell_1 (m_1 + m_2 \sin^2(\Delta))}$$

$$f_2(x) = \frac{-m_2 \ell_2 x_4^2 \sin(\Delta) + (m_1 + m_2) [g \sin(x_1) \cos(\Delta) - \ell_1 x_2^2 \sin(\Delta) - g \sin(x_3)]}{\ell_2 (m_1 + m_2 \sin^2(\Delta))}$$