E.6

$$\dot{\tilde{x}} = A\tilde{x} + B\tilde{u}$$
$$\tilde{y} = C\tilde{x} + D\tilde{u}$$

where $\tilde{x} = \begin{bmatrix} \tilde{z} \\ \dot{\tilde{\theta}} \\ \dot{\tilde{z}} \\ \dot{\tilde{\theta}} \end{bmatrix}$ $\tilde{u} = [\tilde{F}]$ $\tilde{y} = \begin{bmatrix} \tilde{z} \\ \tilde{\theta} \end{bmatrix}$

$$\begin{bmatrix} \dot{\tilde{z}} \\ \ddot{\tilde{\theta}} \\ \ddot{\tilde{z}} \\ \ddot{\tilde{\theta}} \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & -g & 0 & 0 \\ a_{41} & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} \tilde{z} \\ \tilde{\theta} \\ \dot{\tilde{z}} \\ \dot{\tilde{\theta}} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ b_4 \end{bmatrix} [\tilde{F}]$$

where $a_{41} = \dfrac{-gm_1}{\frac{1}{3}l^2 m_2 + m_1 z_e^2}$

$$b_4 = \frac{l}{\frac{1}{3}l^2 m_2 + m_1 z_e^2}$$

$$\begin{bmatrix} \tilde{z} \\ \tilde{\theta} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} \tilde{z} \\ \tilde{\theta} \\ \dot{\tilde{z}} \\ \dot{\tilde{\theta}} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} [\tilde{F}]$$

$$\dot{\tilde{x}} = \begin{bmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & -g & 0 & 0 \\ a_{41} & 0 & 0 & 0 \end{bmatrix} \tilde{x} + \begin{bmatrix} 0 \\ 0 \\ 0 \\ b_4 \end{bmatrix} \tilde{u}$$

$$\tilde{y} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} \tilde{x} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} \tilde{u}$$