

$$\begin{aligned}
X_1 &= l_1 \sin q_1 & X_2 &= l_2 \cos q_2 \sin q_3 & X_3 &= 0 \\
Y_1 &= 0 & Y_2 &= l_2 \sin q_2 \sin q_3 & Y_3 &= 0 \\
Z_1 &= l_1 \cos q_1 & Z_2 &= l_2 \cos q_3 & Z_3 &= q_4
\end{aligned}$$

$$\mathbb{I} = \begin{bmatrix} \mu_1 l_1^2 \cos^2 q_1 + \mu_2 l_2^2 (\sin^2 q_2 \sin^2 q_3 + \cos^2 q_3) + \mu_3 q_4^2 & -\mu_2 l_2^2 \sin q_2 \cos q_2 \sin^2 q_3 & -\mu_1 l_1^2 \sin q_1 \cos q_1 - \mu_2 l_2^2 \cos q_2 \sin q_3 \cos q_3 \\ -\mu_2 l_2^2 \sin q_2 \cos q_2 \sin^2 q_3 & \mu_1 l_1^2 + \mu_2 l_2^2 (\cos^2 q_2 \sin^2 q_3 + \cos^2 q_3) + \mu_3 q_4^2 & -\mu_2 l_2^2 \sin q_2 \sin q_3 \cos q_3 \\ -\mu_1 l_1^2 \sin q_1 \cos q_1 - \mu_2 l_2^2 \cos q_2 \sin q_3 \cos q_3 & -\mu_2 l_2^2 \sin q_2 \sin q_3 \cos q_3 & \mu_1 l_1^2 \sin^2 q_1 + \mu_2 l_2^2 \sin^2 q_3 \end{bmatrix}$$

$$a = \begin{bmatrix} \mu_1 l_1^2 & 0 & 0 & 0 \\ 0 & \mu_2 l_2^2 \sin^2 q_3 & 0 & 0 \\ 0 & 0 & \mu_2 l_2^2 & 0 \\ 0 & 0 & 0 & \mu_3 \end{bmatrix}$$

$$\mathbb{A} = \begin{bmatrix} 0 & -\mu_2 l_2^2 \cos q_2 \sin q_3 \cos q_3 & -\mu_2 l_2^2 \sin q_2 & 0 \\ \mu_1 l_1^2 & -\mu_2 l_2^2 \sin q_2 \sin q_3 \cos q_3 & \mu_2 l_2^2 \cos q_2 & 0 \\ 0 & \mu_2 l_2^2 \sin^2 q_3 & 0 & 0 \end{bmatrix}$$