$$(M(E\psi))E\ddot{\psi} + C_\theta E\dot{\psi} + (C_{\theta^2}(E\psi))(E\dot{\psi})^2 + (G(E\psi))g = (E^T)^{-1}\begin{pmatrix}0\\1\\0\end{pmatrix}\tau_{in}$$

$$\Downarrow$$

$$(M(\theta))\ddot{\theta} + C_\theta\dot{\theta} + (C_{\theta^2}(\theta))(\dot{\theta})^2 + (G(\theta))g = (E^T)^{-1}\begin{pmatrix}0\\1\\0\end{pmatrix}\tau_{in}$$

I

$$\begin{pmatrix}\dot{\theta}_1\\ \vdots \\ \dot{\theta}_\nu\end{pmatrix} \equiv \begin{pmatrix}\omega_1\\ \vdots \\ \omega_\nu\end{pmatrix}$$

$$\begin{pmatrix}\dot{\omega}_1\\ \vdots \\ \dot{\omega}_\nu\end{pmatrix} \equiv \begin{pmatrix}\ddot{\theta}_1\\ \vdots \\ \ddot{\theta}_\nu\end{pmatrix}$$

$$\begin{pmatrix}\ddot{\theta}_1\\ \ddot{\theta}_2\end{pmatrix} = \left[\tau - C\left(\begin{pmatrix}\theta_1\\ \theta_2\end{pmatrix}, \begin{pmatrix}w_1\\ w_2\end{pmatrix}\right)\begin{pmatrix}w_1\\ w_2\end{pmatrix} - B\begin{pmatrix}w_1\\ w_2\end{pmatrix}\right] * inv\left(M\begin{pmatrix}\theta_1\\ \theta_2\end{pmatrix}\right)$$

System:

$$M(\theta)\ddot{\theta} + C(\theta, \dot{\theta})\dot{\theta} + B\dot{\theta} = \tau$$

$$c\left(\begin{pmatrix}\theta_1\\ \theta_2\end{pmatrix},\begin{pmatrix}w_1\\ w_2\end{pmatrix}\right)=\begin{pmatrix}-\beta w_2 \sin\theta_2 & -\beta(w_1+w_2)\sin\theta_2\\ \beta w_1 \sin\theta_2 & 0\end{pmatrix}$$

$$M\begin{pmatrix}t_1\\ t_2\end{pmatrix}=\begin{pmatrix}\alpha+2\beta\cos\theta_2 & \delta+\beta\cos\theta_2\\ \delta+\beta\sin t_2 & \delta\end{pmatrix}$$

$$\begin{pmatrix} \theta_1(t+1) \\ \theta_2(t+1) \end{pmatrix} = \begin{pmatrix} \theta_1(t) \\ \theta_2(t) \end{pmatrix} + dt \begin{pmatrix} w_1(t) \\ w_2(t) \end{pmatrix}$$

$$\begin{pmatrix} w_1(t+1) \\ w_2(t+1) \end{pmatrix} = \begin{pmatrix} v_1(t) \\ w_2(t) \end{pmatrix} + dt \begin{pmatrix} * \end{pmatrix}$$

$$(*) \rightarrow \left[\tau - C \left(\begin{pmatrix} \theta_1 \\ \theta_2 \end{pmatrix}, \begin{pmatrix} w_1 \\ w_2 \end{pmatrix} \right) \begin{pmatrix} w_1 \\ w_2 \end{pmatrix} - B \begin{pmatrix} w_1 \\ w_2 \end{pmatrix} \right] inv \left(M \begin{pmatrix} \theta_1 \\ \theta_2 \end{pmatrix} \right)$$

$$C(\theta,w)w = \begin{bmatrix} -\beta w_1 w_2 \sin\theta_2 - \beta w_2 (w_1 + w_2)\sin\theta_2 \\ \beta w_1^2 \sin\theta_2 \end{bmatrix}$$

$$B\dot{\theta} = \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \end{bmatrix} = \begin{bmatrix} b_{11}w_1 + b_{12}w_2 \\ b_{21}w_1 + b_{22}w_2 \end{bmatrix}$$