$$
\begin{bmatrix}
-m_1\frac{w_1}{2}\sin(\theta_1) & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
-m_1 w_1\sin(\theta_1) & -m_2\frac{w_2}{2}\sin(\theta_2) & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
-m_1 w_1\sin(\theta_1) & -m_2 w_2\sin(\theta_2) & -m_3\frac{w_3}{2}\sin(\theta_3) & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 \\
-m_1 w_1\sin(\theta_1) & -m_2 w_2\sin(\theta_2) & -m_3 w_3\sin(\theta_3) & -m_4\frac{w_4}{2}\sin(\theta_4) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 \\
-m_1 w_1\sin(\theta_1) & -m_2 w_2\sin(\theta_2) & -m_3 w_3\sin(\theta_3) & -m_4 w_4\sin(\theta_4) & -m_5\frac{w_5}{2}\sin(\theta_5) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 \\
\frac{w_1}{2}\cos(\theta_1) & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
w_1\cos(\theta_1) & \frac{w_2}{2}\cos(\theta_2) & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 & 0 & 0 \\
w_1\cos(\theta_1) & w_2\cos(\theta_2) & \frac{w_3}{2}\cos(\theta_3) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 & 0 \\
w_1\cos(\theta_1) & w_2\cos(\theta_2) & w_3\cos(\theta_3) & \frac{w_4}{2}\cos(\theta_4) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 0 \\
w_1\cos(\theta_1) & w_2\cos(\theta_2) & w_3\cos(\theta_3) & w_4\cos(\theta_4) & \frac{w_5}{2}\cos(\theta_5) & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 \\
\frac{1}{3}m_1 w_1^2 & 0 & 0 & 0 & 0 & 0 & 0 & -w_1\sin(\theta_1) & w_1\cos(\theta_1) & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \frac{1}{3}m_2 w_2^2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -w_2\sin(\theta_2) & w_2\cos(\theta_2) & 0 & 0 & 0 & 0 \\
0 & 0 & \frac{1}{3}m_3 w_3^2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -w_3\sin(\theta_3) & w_3\cos(\theta_3) & 0 & 0 \\
0 & 0 & 0 & \frac{1}{3}m_4 w_4^2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -w_4\sin(\theta_4) & w_4\cos(\theta_4) \\
0 & 0 & 0 & 0 & \frac{1}{3}m_5 w_5^2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
\begin{bmatrix}
\ddot{\theta}_1 \\ \ddot{\theta}_2 \\ \ddot{\theta}_3 \\ \ddot{\theta}_4 \\ \ddot{\theta}_5 \\ F_{ax} \\ F_{ay} \\ F_{bx} \\ F_{by} \\ F_{cx} \\ F_{cy} \\ F_{dx} \\ F_{dy} \\ F_{ex} \\ F_{ey}
\end{bmatrix}
=
\begin{bmatrix}
\frac{w_1}{2}\dot{\theta}_1^2\cos(\theta_1) \\
w_1\dot{\theta}_1^2\cos(\theta_1) + \frac{w_2}{2}\dot{\theta}_2^2\cos(\theta_2) \\
w_1\dot{\theta}_1^2\cos(\theta_1) + w_2\dot{\theta}_2^2\cos(\theta_2) + \frac{w_3}{2}\dot{\theta}_3^2\cos(\theta_3) \\
w_1\dot{\theta}_1^2\cos(\theta_1) + w_2\dot{\theta}_2^2\cos(\theta_2) + w_3\dot{\theta}_3^2\cos(\theta_3) + \frac{w_4}{2}\dot{\theta}_4^2\cos(\theta_4) \\
w_1\dot{\theta}_1^2\cos(\theta_1) + w_2\dot{\theta}_2^2\cos(\theta_2) + w_3\dot{\theta}_3^2\cos(\theta_3) + w_5\dot{\theta}_4^2\cos(\theta_4) + \frac{w_5}{2}\dot{\theta}_5^2\cos(\theta_5) \\
\frac{w_1}{2}\dot{\theta}_1^2\sin(\theta_1) \\
w_1\dot{\theta}_1^2\sin(\theta_1) + \frac{w_2}{2}\dot{\theta}_2^2\sin(\theta_2) \\
w_1\dot{\theta}_1^2\sin(\theta_1) + w_2\dot{\theta}_2^2\sin(\theta_2) + \frac{w_3}{2}\dot{\theta}_3^2\sin(\theta_3) \\
w_1\dot{\theta}_1^2\sin(\theta_1) + w_2\dot{\theta}_2^2\sin(\theta_2) + w_3\dot{\theta}_3^2\sin(\theta_3) + \frac{w_4}{2}\dot{\theta}_4^2\sin(\theta_4) \\
w_1\dot{\theta}_1^2\sin(\theta_1) + w_2\dot{\theta}_2^2\sin(\theta_2) + w_3\dot{\theta}_3^2\sin(\theta_3) + w_5\dot{\theta}_4^2\sin(\theta_4) + \frac{w_5}{2}\dot{\theta}_5^2\sin(\theta_5) \\
4k_a(\frac{3\pi}{2} - \theta_1) + 4k_b(\pi - \theta_1 + \theta_2) \\
-4k_b(\pi - \theta_1 + \theta_2) - 4k_c(\pi + \theta_2 - \theta_3) \\
4k_c(\pi + \theta_2 - \theta_3) + 4k_d(\pi - \theta_3 + \theta_4) \\
-4k_d(\pi - \theta_3 + \theta_4) - 4k_e(\pi + \theta_4 - \theta_5) \\
4k_e(\pi + \theta_4 - \theta_5)
\end{bmatrix}
$$

$$\tau_{Coulomb} = -\mu\|\vec{F}_{root}\|tanh(100\dot{\theta}_{root})$$

$$\tau_{viscous} = -b\dot{\theta}_i$$