$with(LinearAlgebra):$

$$dJ := \begin{bmatrix} 0 & 0 & 0 & 0 & m & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & m & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & m & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ J_1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & J_2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & J_3 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$dJ := \begin{bmatrix} 0 & 0 & 0 & 0 & m & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & m & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & m & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ J_1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & J_2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & J_3 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \textbf{(1)}$$

$dJ\_inv := MatrixInverse(dJ)$

$$dJ\_inv := \begin{bmatrix} 0 & 0 & 0 & 0 & \frac{1}{J_1} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{1}{J_2} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & \frac{1}{J_3} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ \frac{1}{m} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{m} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{m} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \textbf{(2)}$$

$$dw := \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ 0 \\ v_1 \\ v_2 \\ v_3 \\ 0 \end{bmatrix}$$

$$dw := (w_1)e_{x1} + (w_2)e_{x2} + (w_3)e_{x3} + (0)e_{x4} + (v_1)e_{x5} + (v_2)e_{x6} + (v_3)e_{x7} + (0)e_{x8} \quad \textbf{(3)}$$

$$rf := \begin{bmatrix} r_1 \\ r_2 \\ r_3 \end{bmatrix}$$

$$rf := (r_1)e_x + (r_2)e_y + (r_3)e_z \quad \textbf{(4)}$$

$$Ft := \begin{bmatrix} F_1 \\ F_2 \\ F_3 \end{bmatrix}$$

$$Ft := (F_1)e_x + (F_2)e_y + (F_3)e_z \quad \textbf{(5)}$$

$$T := CrossProduct(rf, Ft)$$

$$T := \begin{bmatrix} -F_2\, r_3 + F_3\, r_2 \\ F_1\, r_3 - F_3\, r_1 \\ -F_1\, r_2 + F_2\, r_1 \end{bmatrix} \quad \textbf{(6)}$$

$$dF := \begin{bmatrix} F_1 \\ F_2 \\ F_3 \\ 0 \\ T_1 \\ T_2 \\ T_3 \\ 0 \end{bmatrix}$$

$$dF := (F_1)e_{x1} + (F_2)e_{x2} + (F_3)e_{x3} + (0)e_{x4} + (-F_2 r_3 + F_3 r_2)e_{x5} + (F_1 r_3 - F_3 r_1)e_{x6} + (-F_1 r_2 + F_2 r_1)e_{x7} + (0)e_{x8} \quad (7)$$

$$dw2 := \begin{bmatrix} W_1 \\ W_2 \\ W_3 \\ 0 \\ V_1 \\ V_2 \\ V_3 \\ 0 \end{bmatrix}$$

$$dw2 := (W_1)e_{x1} + (W_2)e_{x2} + (W_3)e_{x3} + (0)e_{x4} + (V_1)e_{x5} + (V_2)e_{x6} + (V_3)e_{x7} + (0)e_{x8} \quad (8)$$

$$w\_comb := dw + dw2$$

$$w\_comb := (w_1 + W_1)e_{x1} + (w_2 + W_2)e_{x2} + (w_3 + W_3)e_{x3} + (0)e_{x4} + (v_1 + V_1)e_{x5} + (v_2 + V_2)e_{x6} + (v_3 + V_3)e_{x7} + (0)e_{x8} \quad (9)$$

$$dw\_omega := \begin{bmatrix} 0 & -w_3 & w_2 & w_1 & 0 & 0 & 0 & 0 \\ w_3 & 0 & -w_1 & w_2 & 0 & 0 & 0 & 0 \\ -w_2 & w_1 & 0 & w_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -v_3 & v_2 & v_1 & 0 & -w_3 & w_2 & w_1 \\ v_3 & 0 & -v_1 & v_2 & w_3 & 0 & -w_1 & w_2 \\ -v_2 & v_1 & 0 & v_3 & -w_2 & w_1 & 0 & w_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$dw\_omega := \begin{bmatrix} 0 & -w_3 & w_2 & w_1 & 0 & 0 & 0 & 0 \\ w_3 & 0 & -w_1 & w_2 & 0 & 0 & 0 & 0 \\ -w_2 & w_1 & 0 & w_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -v_3 & v_2 & v_1 & 0 & -w_3 & w_2 & w_1 \\ v_3 & 0 & -v_1 & v_2 & w_3 & 0 & -w_1 & w_2 \\ -v_2 & v_1 & 0 & v_3 & -w_2 & w_1 & 0 & w_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \textbf{(10)}$$

$$dw2\_omega := \begin{bmatrix} 0 & -W_3 & W_2 & W_1 & 0 & 0 & 0 & 0 \\ W_3 & 0 & -W_1 & W_2 & 0 & 0 & 0 & 0 \\ -W_2 & W_1 & 0 & W_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -V_3 & V_2 & V_1 & 0 & -W_3 & W_2 & W_1 \\ V_3 & 0 & -V_1 & V_2 & W_3 & 0 & -W_1 & W_2 \\ -V_2 & V_1 & 0 & V_3 & -W_2 & W_1 & 0 & W_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$dw2\_omega := \begin{bmatrix} 0 & -W_3 & W_2 & W_1 & 0 & 0 & 0 & 0 \\ W_3 & 0 & -W_1 & W_2 & 0 & 0 & 0 & 0 \\ -W_2 & W_1 & 0 & W_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -V_3 & V_2 & V_1 & 0 & -W_3 & W_2 & W_1 \\ V_3 & 0 & -V_1 & V_2 & W_3 & 0 & -W_1 & W_2 \\ -V_2 & V_1 & 0 & V_3 & -W_2 & W_1 & 0 & W_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \textbf{(11)}$$

$$\begin{aligned} dw3\_omega := & [[0, -(w_3 + W_3), (w_2 + W_2), (w_1 + W_1), 0, 0, 0, 0], \\ & [(w_3 + W_3), 0, -(w_1 + W_1), (w_2 + W_2), 0, 0, 0, 0], \\ & [-(w_2 + W_2), (w_1 + W_1), 0, (w_3 + W_3), 0, 0, 0, 0], \\ & [0, 0, 0, 0, 0, 0, 0, 0], \\ & [0, -(v_3 + V_3), (v_2 + V_2), (v_1 + V_1), 0, -(w_3 + W_3), (w_2 + W_2), (w_1 + W_1)], \\ & [(v_3 + V_3), 0, -(v_1 + V_1), (v_2 + V_2), (w_3 + W_3), 0, -(w_1 + W_1), (w_2 + W_2)], \\ & [-(v_2 + V_2), (v_1 + V_1), 0, (v_3 + V_3), -(w_2 + W_2), (w_1 + W_1), 0, (w_3 + W_3)], \\ & [0, 0, 0, 0, 0, 0, 0, 0]] \end{aligned}$$

$$\begin{aligned} dw3\_omega := & \quad \textbf{(12)} \\ & [[0, -w_3 - W_3, w_2 + W_2, w_1 + W_1, 0, 0, 0, 0], \\ & [w_3 + W_3, 0, -w_1 - W_1, w_2 + W_2, 0, 0, 0, 0], \\ & [-w_2 - W_2, w_1 + W_1, 0, w_3 + W_3, 0, 0, 0, 0], \\ & [0, 0, 0, 0, 0, 0, 0, 0], \\ & [0, -v_3 - V_3, v_2 + V_2, v_1 + V_1, 0, -w_3 - W_3, w_2 + W_2, w_1 + W_1], \\ & [v_3 + V_3, 0, -v_1 - V_1, v_2 + V_2, w_3 + W_3, 0, -w_1 - W_1, w_2 + W_2], \\ & [-v_2 - V_2, v_1 + V_1, 0, v_3 + V_3, -w_2 - W_2, w_1 + W_1, 0, w_3 + W_3], \\ & [0, 0, 0, 0, 0, 0, 0, 0]] \end{aligned}$$

$$djw\_om := \begin{bmatrix} 0 & -m \cdot v_3 & m \cdot v_2 & m \cdot v_1 & 0 & 0 & 0 & 0 \\ m \cdot v_3 & 0 & -m \cdot v_1 & m \cdot v_2 & 0 & 0 & 0 & 0 \\ -m \cdot v_2 & m \cdot v_1 & 0 & m \cdot v_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -J_3.w_3 & J_2.w_2 & J_1.w_1 & 0 & -m \cdot v_3 & m \cdot v_2 & m \cdot v_1 \\ J_3.w_3 & 0 & -J_1.w_1 & J_2.w_2 & m \cdot v_3 & 0 & -m \cdot v_1 & m \cdot v_2 \\ -J_2.w_2 & J_1.w_1 & 0 & J_3.w_3 & -m \cdot v_2 & m \cdot v_1 & 0 & m \cdot v_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$djw\_om := \begin{bmatrix} 0 & -m\, v_3 & m\, v_2 & m\, v_1 & 0 & 0 & 0 & 0 \\ m\, v_3 & 0 & -m\, v_1 & m\, v_2 & 0 & 0 & 0 & 0 \\ -m\, v_2 & m\, v_1 & 0 & m\, v_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -J_3\, w_3 & J_2\, w_2 & J_1\, w_1 & 0 & -m\, v_3 & m\, v_2 & m\, v_1 \\ J_3\, w_3 & 0 & -J_1\, w_1 & J_2\, w_2 & m\, v_3 & 0 & -m\, v_1 & m\, v_2 \\ -J_2\, w_2 & J_1\, w_1 & 0 & J_3\, w_3 & -m\, v_2 & m\, v_1 & 0 & m\, v_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \textbf{(13)}$$

$$djw2\_om := \begin{bmatrix} 0 & -m \cdot V_3 & m \cdot V_2 & m \cdot V_1 & 0 & 0 & 0 & 0 \\ m \cdot V_3 & 0 & -m \cdot V_1 & m \cdot V_2 & 0 & 0 & 0 & 0 \\ -m.V_2 & m \cdot V_1 & 0 & m \cdot V_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -J_3.W_3 & J_2.W_2 & J_1.W_1 & 0 & -m \cdot V_3 & m \cdot V_2 & m \cdot V_1 \\ J_3.W_3 & 0 & -J_1.W_1 & J_2.W_2 & m \cdot V_3 & 0 & -m \cdot V_1 & m \cdot V_2 \\ -J_2.W_2 & J_1.W_1 & 0 & J_3.W_3 & -m \cdot V_2 & m \cdot V_1 & 0 & m \cdot V_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$djw2\_om := \begin{bmatrix} 0 & -m\,V_3 & m\,V_2 & m\,V_1 & 0 & 0 & 0 & 0 \\ m\,V_3 & 0 & -m\,V_1 & m\,V_2 & 0 & 0 & 0 & 0 \\ -m\,V_2 & m\,V_1 & 0 & m\,V_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -J_3\,W_3 & J_2\,W_2 & J_1\,W_1 & 0 & -m\,V_3 & m\,V_2 & m\,V_1 \\ J_3\,W_3 & 0 & -J_1\,W_1 & J_2\,W_2 & m\,V_3 & 0 & -m\,V_1 & m\,V_2 \\ -J_2\,W_2 & J_1\,W_1 & 0 & J_3\,W_3 & -m\,V_2 & m\,V_1 & 0 & m\,V_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \tag{14}$$

$$qd\_om := \begin{bmatrix} q_8 & q_7 & -q_6 & q_5 \\ -q_7 & q_8 & q_5 & q_6 \\ q_2 & -q_5 & q_8 & q_7 \\ -q_5 & -q_6 & -q_7 & q_8 \end{bmatrix}$$

$$qd\_om := \begin{bmatrix} q_8 & q_7 & -q_6 & q_5 \\ -q_7 & q_8 & q_5 & q_6 \\ q_2 & -q_5 & q_8 & q_7 \\ -q_5 & -q_6 & -q_7 & q_8 \end{bmatrix} \tag{15}$$

$$rr := simplify\left(2.\left(qd\_om.\begin{bmatrix} -q_1 \\ -q_2 \\ -q_3 \\ q_4 \end{bmatrix}\right)\right)$$

$$rr := \left(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\right)e_{x1} + \left(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\right)e_{x2} + \left(\left(-2.\,q_1 + 2.\,q_5\right)q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\right)e_{x3} + \left(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\right)e_{x4} \tag{16}$$

$$R := \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ -2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4 \\ 2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4 \\ -2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4 \\ 2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4 \end{bmatrix}$$

$$R := (0)e_{x1} + (0)e_{x2} + (0)e_{x3} + (0)e_{x4} + \left(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\right)e_{x5} + \left(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\right)e_{x6} + \left(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\right)e_{x7} + \left(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\right)e_{x8} \quad \textbf{(17)}$$

$dw\_dot := Multiply(dJ\_inv, (dF - Multiply(dw3\_omega\ , (Multiply(dJ, w\_comb)\ ))) - Multiply(dJ, (Multiply(dw2\_omega\ , dw)\ ))) - Multiply(dJ, Multiply(dw2\_omega, (\ Multiply(dw2\_omega\ , R)\ )\ )\ )\ )\ )$

$$dw\_dot := \left[\left[\frac{1}{J_1}\left(-F_2\,r_3 + F_3\,r_2 - \left(-v_3 - V_3\right)m\left(v_2 + V_2\right) - \left(v_2 + V_2\right)m\left(v_3 + V_3\right) - \left(-w_3 - W_3\right)J_2\left(w_2 + W_2\right) - \left(w_2 + W_2\right)J_3\left(w_3 + W_3\right) - J_1\left(W_2\,w_3 - W_3\,w_2\right)\right)\right],\right.$$

$$\left[\frac{1}{J_2}\left(F_1\,r_3 - F_3\,r_1 - \left(v_3 + V_3\right)m\left(v_1 + V_1\right) - \left(-v_1 - V_1\right)m\left(v_3 + V_3\right) - \left(w_3 + W_3\right)J_1\left(w_1 + W_1\right) - \left(-w_1 - W_1\right)J_3\left(w_3 + W_3\right) - J_2\left(-W_1\,w_3 + W_3\,w_1\right)\right)\right],$$

$$\left[\frac{1}{J_3}\left(-F_1\,r_2 + F_2\,r_1 - \left(-v_2 - V_2\right)m\left(v_1 + V_1\right) - \left(v_1 + V_1\right)m\left(v_2 + V_2\right) - \left(-w_2 - W_2\right)J_1\left(w_1 + W_1\right) - \left(w_1 + W_1\right)J_2\left(w_2 + W_2\right) - J_3\left(W_1\,w_2 - W_2\,w_1\right)\right)\right],$$

$$\left[0.\right],$$

$$\left[\frac{1}{m}\left(F_1 - \left(-w_3 - W_3\right)m\left(v_2 + V_2\right) - \left(w_2 + W_2\right)m\left(v_3 + V_3\right) - m\left(V_2\,w_3 - V_3\,w_2 + W_2\,v_3 - W_3\,v_2\right) - m\left(-W_3\left(W_3\left(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\right) - W_1\left(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\right) + W_2\left(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\right)\right) + W_2\left(-W_2\left(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\right) + W_1\left(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\right) + W_3\left(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\right)\right)\right)\right)\right],$$

(18)

$$\left[\frac{1}{m}\left(F_2-\left(w_3+W_3\right)m\left(v_1+V_1\right)-\left(-w_1-W_1\right)m\left(v_3+V_3\right)-m\left(-V_1\,w_3+V_3\,w_1-W_1\,v_3+W_3\,v_1\right)-m\left(W_3\left(-W_3\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_2\left(-2.\,q_2\,q_1+2.\,q_5\,q_2-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_1\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)-W_1\left(-W_2\left(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\right)+W_1\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_3\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)\right)\right],$$

$$\left[\frac{1}{m}\left(F_3-\left(-w_2-W_2\right)m\left(v_1+V_1\right)-\left(w_1+W_1\right)m\left(v_2+V_2\right)-m\left(V_1\,w_2-V_2\,w_1+W_1\,v_2-W_2\,v_1\right)-m\left(-W_2\left(-W_3\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_2\left(-2.\,q_2\,q_1+2.\,q_5\,q_2-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_1\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)+W_1\left(W_3\left(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\right)-W_1\left(-2.\,q_2\,q_1+2.\,q_5\,q_2-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_2\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)\right)\right],$$

$$\left[0.\right]\Big]$$

$$dw\_dot1 := \left[\left[\frac{1}{J_1}\left(-F_2\,r_3+F_3\,r_2-\left(-v_3-V_3\right)m\left(v_2+V_2\right)-\left(v_2+V_2\right)m\left(v_3+V_3\right)-\left(-w_3-W_3\right)J_2\left(w_2+W_2\right)-\left(w_2+W_2\right)J_3\left(w_3+W_3\right)-J_1\left(W_2\,w_3-W_3\,w_2\right)\right)\right],$$

$$\left[\frac{1}{J_2}\left(F_1\,r_3-F_3\,r_1-\left(v_3+V_3\right)m\left(v_1+V_1\right)-\left(-v_1-V_1\right)m\left(v_3+V_3\right)-\left(w_3+W_3\right)J_1\left(w_1+W_1\right)-\left(-w_1-W_1\right)J_3\left(w_3+W_3\right)-J_2\left(-W_1\,w_3+W_3\,w_1\right)\right)\right],$$

$$\left[\frac{1}{J_3}\left(-F_1\,r_2+F_2\,r_1-\left(-v_2-V_2\right)m\left(v_1+V_1\right)-\left(v_1+V_1\right)m\left(v_2+V_2\right)-\left(-w_2-W_2\right)J_1\left(w_1+W_1\right)-\left(w_1+W_1\right)J_2\left(w_2+W_2\right)-J_3\left(W_1\,w_2-W_2\,w_1\right)\right)\right],$$

$$\left[0.\right],$$

$$\left[\frac{1}{m}\left(F_1-\left(-w_3-W_3\right)m\left(v_2+V_2\right)-\left(w_2+W_2\right)m\left(v_3+V_3\right)-m\left(V_2\,w_3-V_3\,w_2+W_2\,v_3-W_3\,v_2\right)-m\left(-W_3\left(W_3\left(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\right)-W_1\left(-2.\,q_2\,q_1+2.\,q_5\,q_2-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_2\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)+W_2\left(-W_2\left(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\right)+W_1\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_3\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)\right)\right],$$

$$\left[\frac{1}{m}\left(F_2-\left(w_3+W_3\right)m\left(v_1+V_1\right)-\left(-w_1-W_1\right)m\left(v_3+V_3\right)-m\left(-V_1\,w_3+V_3\,w_1-W_1\,v_3+W_3\,v_1\right)-m\left(W_3\left(-W_3\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_2\left(-2.\,q_2\,q_1\right.\right.\right.\right.$$

$$+ 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\big) + W_1\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\big) - W_1\,\big(-W_2\,\big(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\big) + W_1\,\big(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\big) + W_3\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\big)\big)\big],$$

$$\Big[\frac{1}{m}\big(F_3 - \big(-w_2 - W_2\big)\,m\,\big(v_1 + V_1\big) - \big(w_1 + W_1\big)\,m\,\big(v_2 + V_2\big) - m\,\big(V_1\,w_2 - V_2\,w_1 + W_1\,v_2 - W_2\,v_1\big) - m\,\big(-W_2\,\big(-W_3\,\big(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\big) + W_2\,\big(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\big) + W_1\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\big) + W_1\,\big(W_3\,\big(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\big) - W_1\,\big(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\big) + W_2\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\big)\big)\big)\Big],$$

$$\Big[0.\Big]\Big]$$

$$dw\_dot1 := \Big(\frac{1}{J_1}\big(-F_2\,r_3 + F_3\,r_2 - \big(-v_3 - V_3\big)\,m\,\big(v_2 + V_2\big) - \big(v_2 + V_2\big)\,m\,\big(v_3 + V_3\big) - \big(-w_3 - W_3\big)\,J_2\,\big(w_2 + W_2\big) - \big(w_2 + W_2\big)\,J_3\,\big(w_3 + W_3\big) - J_1\,\big(W_2\,w_3 - W_3\,w_2\big)\big)\Big)e_{x1} \tag{19}$$

$$+ \Big(\frac{1}{J_2}\big(F_1\,r_3 - F_3\,r_1 - \big(v_3 + V_3\big)\,m\,\big(v_1 + V_1\big) - \big(-v_1 - V_1\big)\,m\,\big(v_3 + V_3\big) - \big(w_3 + W_3\big)\,J_1\,\big(w_1 + W_1\big) - \big(-w_1 - W_1\big)\,J_3\,\big(w_3 + W_3\big) - J_2\,\big(-W_1\,w_3 + W_3\,w_1\big)\big)\Big)e_{x2}$$

$$+ \Big(\frac{1}{J_3}\big(-F_1\,r_2 + F_2\,r_1 - \big(-v_2 - V_2\big)\,m\,\big(v_1 + V_1\big) - \big(v_1 + V_1\big)\,m\,\big(v_2 + V_2\big) - \big(-w_2 - W_2\big)\,J_1\,\big(w_1 + W_1\big) - \big(w_1 + W_1\big)\,J_2\,\big(w_2 + W_2\big) - J_3\,\big(W_1\,w_2 - W_2\,w_1\big)\big)\Big)e_{x3}$$

$$+ (0.)e_{x4} + \Big(\frac{1}{m}\big(F_1 - \big(-w_3 - W_3\big)\,m\,\big(v_2 + V_2\big) - \big(w_2 + W_2\big)\,m\,\big(v_3 + V_3\big) - m\,\big(V_2\,w_3 - V_3\,w_2 + W_2\,v_3 - W_3\,v_2\big) - m\,\big(-W_3\,\big(W_3\,\big(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\big) - W_1\,\big(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\big) + W_2\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\big) + W_2\,\big(-W_2\,\big(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\big) + W_1\,\big(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\big) + W_3\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\big)\big)\big)\Big)e_{x5} + \Big(\frac{1}{m}\big(F_2 - \big(w_3 + W_3\big)\,m\,\big(v_1 + V_1\big) - \big(-w_1 - W_1\big)\,m\,\big(v_3 + V_3\big) - m\,\big(-V_1\,w_3 + V_3\,w_1 - W_1\,v_3 + W_3\,v_1\big) - m\,\big(W_3\,\big(-W_3\,\big(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\big) + W_2\,\big(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\big) + W_1\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\big) - W_1\,\big(-W_2\,\big(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\big) + W_1\,\big(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\big) + W_3\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2$$

$$+ 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\big)\big)\big)e_{x6} + \left(\frac{1}{m}\left(F_3 - \left(-w_2 - W_2\right)m\left(v_1 + V_1\right) - \left(w_1 + W_1\right)m\left(v_2 + V_2\right) - m\left(V_1\,w_2 - V_2\,w_1 + W_1\,v_2 - W_2\,v_1\right) - m\left(-W_2\left(-W_3\left(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\right) + W_2\left(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\right) + W_1\left(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\right)\right) + W_1\left(W_3\left(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\right) - W_1\left(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\right) + W_2\left(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\right)\right)\right)\right)e_{x7} + (0.)e_{x8}$$

$dw\_dot - dw\_dot1$

$$(0)e_{x1} + (0)e_{x2} + (0)e_{x3} + (0.)e_{x4} + (0)e_{x5} + (0)e_{x6} + (0)e_{x7} + (0.)e_{x8} \qquad \textbf{(20)}$$

$with(VectorCalculus):$

$$m\_dot := \frac{\partial}{\partial m}dw\_dot$$

$$m\_dot := \left(\frac{-\left(-v_3 - V_3\right)\left(v_2 + V_2\right) - \left(v_2 + V_2\right)\left(v_3 + V_3\right)}{J_1}\right)e_{x1} \qquad \textbf{(21)}$$

$$+ \left(\frac{-\left(v_3 + V_3\right)\left(v_1 + V_1\right) - \left(-v_1 - V_1\right)\left(v_3 + V_3\right)}{J_2}\right)e_{x2}$$

$$+ \left(\frac{-\left(-v_2 - V_2\right)\left(v_1 + V_1\right) - \left(v_1 + V_1\right)\left(v_2 + V_2\right)}{J_3}\right)e_{x3} + (0)e_{x4} + \left(-\frac{1}{m^2}\left(F_1 - \left(-w_3 - W_3\right)m\left(v_2 + V_2\right) - \left(w_2 + W_2\right)m\left(v_3 + V_3\right) - m\left(V_2\,w_3 - V_3\,w_2 + W_2\,v_3 - W_3\,v_2\right) - m\left(-W_3\left(W_3\left(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\right) - W_1\left(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\right) + W_2\left(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\right)\right) + W_2\left(-W_2\left(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\right) + W_1\left(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\right) + W_3\left(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\right)\right)\right)\right) + \frac{1}{m}\left(-\left(-w_3 - W_3\right)\left(v_2 + V_2\right) - \left(w_2 + W_2\right)\left(v_3 + V_3\right) - V_2\,w_3 + V_3\,w_2 - W_2\,v_3 + W_3\,v_2 + W_3\left(W_3\left(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\right) - W_1\left(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\right) + W_2\left(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\right)\right) - W_2\left(-W_2\left(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\right) + W_1\left(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\right) + W_3\left(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\right)\right)\right)e_{x5} + \left(-\frac{1}{m^2}\left(F_2\right.\right.$$

$$-\left(w_3+W_3\right)m\left(v_1+V_1\right)-\left(-w_1-W_1\right)m\left(v_3+V_3\right)-m\left(-V_1\,w_3+V_3\,w_1-W_1\,v_3\right.$$

$$\left.+W_3\,v_1\right)-m\left(W_3\left(-W_3\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_2\left(-2.\,q_2\,q_1\right.\right.\right.$$

$$\left.\left.\left.+2.\,q_5\,q_2-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_1\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)\right.$$

$$\left.-W_1\left(-W_2\left(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\right)+W_1\left(2.\,q_7\,q_1-2.\,q_8\,q_2\right.\right.\right.$$

$$\left.\left.\left.-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_3\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)\right)+\frac{1}{m}\left(\right.$$

$$-\left(w_3+W_3\right)\left(v_1+V_1\right)-\left(-w_1-W_1\right)\left(v_3+V_3\right)+V_1\,w_3-V_3\,w_1+W_1\,v_3-W_3\,v_1$$

$$-W_3\left(-W_3\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_2\left(-2.\,q_2\,q_1+2.\,q_5\,q_2\right.\right.$$

$$\left.\left.-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_1\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)+W_1\left(-W_2\left(\right.\right.$$

$$-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\left.\right)+W_1\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3\right.$$

$$\left.\left.\left.+2.\,q_6\,q_4\right)+W_3\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)\right)e_{x6}+\left(-\frac{1}{m^2}\left(F_3\right.\right.$$

$$-\left(-w_2-W_2\right)m\left(v_1+V_1\right)-\left(w_1+W_1\right)m\left(v_2+V_2\right)-m\left(V_1\,w_2-V_2\,w_1+W_1\,v_2\right.$$

$$\left.-W_2\,v_1\right)-m\left(-W_2\left(-W_3\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_2\left(-2.\,q_2\,q_1\right.\right.\right.$$

$$\left.\left.\left.+2.\,q_5\,q_2-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_1\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)\right.$$

$$\left.+W_1\left(W_3\left(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\right)-W_1\left(-2.\,q_2\,q_1+2.\,q_5\,q_2\right.\right.\right.$$

$$\left.\left.\left.-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_2\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)\right)+\frac{1}{m}\left(\right.$$

$$-\left(-w_2-W_2\right)\left(v_1+V_1\right)-\left(w_1+W_1\right)\left(v_2+V_2\right)-V_1\,w_2+V_2\,w_1-W_1\,v_2+W_2\,v_1$$

$$+W_2\left(-W_3\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_2\left(-2.\,q_2\,q_1+2.\,q_5\,q_2\right.\right.$$

$$\left.\left.-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_1\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)-W_1\left(W_3\left(\right.\right.$$

$$-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\left.\right)-W_1\left(-2.\,q_2\,q_1+2.\,q_5\,q_2-2.\,q_8\,q_3\right.$$

$$\left.\left.\left.+2.\,q_7\,q_4\right)+W_2\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\right)\right)e_{x7}+(0)e_{x8}$$

$B := map(diff, dJ, m);$

$$B := \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \textbf{(22)}$$

$C := map(diff, dJ\_inv, m);$

$$C := \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -\frac{1}{m^2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -\frac{1}{m^2} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\frac{1}{m^2} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \textbf{(23)}$$

$dd2 := B \cdot dw2$

$$dd2 := (V_1)e_{x1} + (V_2)e_{x2} + (V_3)e_{x3} + (0)e_{x4} + (0)e_{x5} + (0)e_{x6} + (0)e_{x7} + (0)e_{x8} \quad \textbf{(24)}$$

$$dd\_om2 := \begin{bmatrix} 0 & -V_3 & V_2 & V_1 & 0 & 0 & 0 & 0 \\ V_3 & 0 & -V_1 & V_2 & 0 & 0 & 0 & 0 \\ -V_2 & V_1 & 0 & V_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -V_3 & V_2 & V_1 \\ 0 & 0 & 0 & 0 & V_3 & 0 & -V_1 & V_2 \\ 0 & 0 & 0 & 0 & -V_2 & V_1 & 0 & V_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$dd\_om2 := \begin{bmatrix} 0 & -V_3 & V_2 & V_1 & 0 & 0 & 0 & 0 \\ V_3 & 0 & -V_1 & V_2 & 0 & 0 & 0 & 0 \\ -V_2 & V_1 & 0 & V_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -V_3 & V_2 & V_1 \\ 0 & 0 & 0 & 0 & V_3 & 0 & -V_1 & V_2 \\ 0 & 0 & 0 & 0 & -V_2 & V_1 & 0 & V_3 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \textbf{(25)}$$

$phi\_m1 := Multiply(C, (dF - Multiply(dw3\_omega\ , (Multiply(dJ, w\_comb)\ )) - Multiply(dJ, (Multiply(dw2\_omega\ , dw)\ )) - Multiply(dJ, Multiply(dw2\_omega, (\ Multiply(dw2\_omega\ , R)\ )\ )\ )\ )\ )$

$$phi\_m1 := \begin{bmatrix} \begin{bmatrix} 0. \end{bmatrix}, \\ \begin{bmatrix} 0. \end{bmatrix}, \\ \begin{bmatrix} 0. \end{bmatrix}, \\ \begin{bmatrix} 0. \end{bmatrix}, \\ \begin{bmatrix} -\frac{1}{m^2}\left(F_1 - \left(-w_3 - W_3\right) m \left(v_2 + V_2\right) - \left(w_2 + W_2\right) m \left(v_3 + V_3\right) - m \left(V_2 w_3 \right. \right. \\ \left. - V_3 w_2 + W_2 v_3 - W_3 v_2\right) - m \left(-W_3 \left(W_3 \left(-2. q_8 q_1 - 2. q_7 q_2 + 2. q_6 q_3 + 2. q_5 q_4\right) \right. \right. \\ - W_1 \left(-2. q_2 q_1 + 2. q_5 q_2 - 2. q_8 q_3 + 2. q_7 q_4\right) + W_2 \left(2. q_5 q_1 + 2. q_6 q_2 + 2. q_7 q_3 \right. \\ \left. \left. + 2. q_8 q_4\right)\right) + W_2 \left(-W_2 \left(-2. q_8 q_1 - 2. q_7 q_2 + 2. q_6 q_3 + 2. q_5 q_4\right) + W_1 \left(2. q_7 q_1 \right. \right. \\ \left. \left. \left. - 2. q_8 q_2 - 2. q_5 q_3 + 2. q_6 q_4\right) + W_3 \left(2. q_5 q_1 + 2. q_6 q_2 + 2. q_7 q_3 + 2. q_8 q_4\right)\right)\right)\right], \\ \begin{bmatrix} -\frac{1}{m^2}\left(F_2 - \left(w_3 + W_3\right) m \left(v_1 + V_1\right) - \left(-w_1 - W_1\right) m \left(v_3 + V_3\right) - m \left(-V_1 w_3 \right. \right. \\ \left. + V_3 w_1 - W_1 v_3 + W_3 v_1\right) - m \left(W_3 \left(-W_3 \left(2. q_7 q_1 - 2. q_8 q_2 - 2. q_5 q_3 + 2. q_6 q_4\right) \right. \right. \\ + W_2 \left(-2. q_2 q_1 + 2. q_5 q_2 - 2. q_8 q_3 + 2. q_7 q_4\right) + W_1 \left(2. q_5 q_1 + 2. q_6 q_2 + 2. q_7 q_3 \right. \\ \left. \left. + 2. q_8 q_4\right)\right) - W_1 \left(-W_2 \left(-2. q_8 q_1 - 2. q_7 q_2 + 2. q_6 q_3 + 2. q_5 q_4\right) + W_1 \left(2. q_7 q_1 \right. \right. \\ \left. \left. \left. - 2. q_8 q_2 - 2. q_5 q_3 + 2. q_6 q_4\right) + W_3 \left(2. q_5 q_1 + 2. q_6 q_2 + 2. q_7 q_3 + 2. q_8 q_4\right)\right)\right)\right], \\ \begin{bmatrix} -\frac{1}{m^2}\left(F_3 - \left(-w_2 - W_2\right) m \left(v_1 + V_1\right) - \left(w_1 + W_1\right) m \left(v_2 + V_2\right) - m \left(V_1 w_2 \right. \right. \end{bmatrix} \end{bmatrix} \quad \textbf{(26)}$$

$$- V_2\, w_1 + W_1\, v_2 - W_2\, v_1\Big) - m\,\Big(-W_2\,\Big(-W_3\,\big(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\big) + W_2\,\big(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\big) + W_1\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\Big) + W_1\,\Big(W_3\,\big(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\big) - W_1\,\big(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\big) + W_2\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\Big)\Big)\Big],$$

$$\begin{bmatrix} 0. \end{bmatrix}\Big]$$

phi_m2 := *Multiply*(*dJ_inv*, (- *Multiply*(*dw3_omega* , (*Multiply*(*B*, *w_comb*))) - *Multiply*(*B*, (*Multiply*(*dw2_omega* , *dw*))) - *Multiply*(*B*, *Multiply*(*dw2_omega*, (*Multiply*(*dw2_omega* , *R*)))))))

$$phi\_m2 := \Bigg[\Bigg[\frac{-\left(-v_3 - V_3\right)\left(v_2 + V_2\right) - \left(v_2 + V_2\right)\left(v_3 + V_3\right)}{J_1}\Bigg], \quad \textbf{(27)}$$

$$\begin{bmatrix} \frac{-\left(v_3 + V_3\right)\left(v_1 + V_1\right) - \left(-v_1 - V_1\right)\left(v_3 + V_3\right)}{J_2} \end{bmatrix},$$

$$\begin{bmatrix} \frac{-\left(-v_2 - V_2\right)\left(v_1 + V_1\right) - \left(v_1 + V_1\right)\left(v_2 + V_2\right)}{J_3} \end{bmatrix},$$

$$\begin{bmatrix} 0. \end{bmatrix},$$

$$\Big[\frac{1}{m}\Big(-\left(-w_3 - W_3\right)\left(v_2 + V_2\right) - \left(w_2 + W_2\right)\left(v_3 + V_3\right) - V_2\, w_3 + V_3\, w_2 - W_2\, v_3 + W_3\, v_2 + W_3\,\Big(W_3\,\big(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\big) - W_1\,\big(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\big) + W_2\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\Big) - W_2\,\Big(-W_2\,\big(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\big) + W_1\,\big(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\big) + W_3\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\Big)\Big)\Big],$$

$$\Big[\frac{1}{m}\Big(-\left(w_3 + W_3\right)\left(v_1 + V_1\right) - \left(-w_1 - W_1\right)\left(v_3 + V_3\right) + V_1\, w_3 - V_3\, w_1 + W_1\, v_3 - W_3\, v_1 - W_3\,\Big(-W_3\,\big(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\big) + W_2\,\big(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\big) + W_1\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\Big) + W_1\,\Big(-W_2\,\big(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\big) + W_1\,\big(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\big) + W_3\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\Big)\Big)\Big],$$

$$\Big[\frac{1}{m}\Big(-\left(-w_2 - W_2\right)\left(v_1 + V_1\right) - \left(w_1 + W_1\right)\left(v_2 + V_2\right) - V_1\, w_2 + V_2\, w_1 - W_1\, v_2 + W_2\, v_1 + W_2\,\Big(-W_3\,\big(2.\,q_7\,q_1 - 2.\,q_8\,q_2 - 2.\,q_5\,q_3 + 2.\,q_6\,q_4\big) + W_2\,\big(-2.\,q_2\,q_1 + 2.\,q_5\,q_2 - 2.\,q_8\,q_3 + 2.\,q_7\,q_4\big) + W_1\,\big(2.\,q_5\,q_1 + 2.\,q_6\,q_2 + 2.\,q_7\,q_3 + 2.\,q_8\,q_4\big)\Big) - W_1\,\Big(W_3\,\big(-2.\,q_8\,q_1 - 2.\,q_7\,q_2 + 2.\,q_6\,q_3 + 2.\,q_5\,q_4\big) - W_1\,\big(-2.\,q_2\,q_1 + 2.\,q_5\,q_2$$

$$-2.\,q_8\,q_3+2.\,q_7\,q_4\big)+W_2\,\big(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\big)\big)\big)\big],$$

$$\big[0.\big]\big]$$

$$phi\_m := phi\_m1 + phi\_m2$$

$$phi\_m := \left(\frac{-\left(-v_3-V_3\right)\left(v_2+V_2\right)-\left(v_2+V_2\right)\left(v_3+V_3\right)}{J_1}\right)e_{x1} \tag{28}$$

$$+\left(\frac{-\left(v_3+V_3\right)\left(v_1+V_1\right)-\left(-v_1-V_1\right)\left(v_3+V_3\right)}{J_2}\right)e_{x2}$$

$$+\left(\frac{-\left(-v_2-V_2\right)\left(v_1+V_1\right)-\left(v_1+V_1\right)\left(v_2+V_2\right)}{J_3}\right)e_{x3}+(0.)e_{x4}+\left(-\frac{1}{m^2}\big(F_1\right.$$

$$-\left(-w_3-W_3\right)m\left(v_2+V_2\right)-\left(w_2+W_2\right)m\left(v_3+V_3\right)-m\left(V_2\,w_3-V_3\,w_2+W_2\,v_3\right.$$

$$\left.-W_3\,v_2\right)-m\left(-W_3\left(W_3\left(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\right)-W_1\left(-2.\,q_2\,q_1\right.\right.$$

$$\left.+2.\,q_5\,q_2-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_2\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\big)$$

$$+W_2\left(-W_2\left(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\right)+W_1\left(2.\,q_7\,q_1-2.\,q_8\,q_2\right.\right.$$

$$\left.\left.-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_3\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\big)\big)\big)+\frac{1}{m}\big($$

$$-\left(-w_3-W_3\right)\left(v_2+V_2\right)-\left(w_2+W_2\right)\left(v_3+V_3\right)-V_2\,w_3+V_3\,w_2-W_2\,v_3+W_3\,v_2$$

$$+W_3\left(W_3\left(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\right)-W_1\left(-2.\,q_2\,q_1+2.\,q_5\,q_2\right.\right.$$

$$\left.-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_2\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\big)-W_2\left(-W_2\,\big(\right.$$

$$-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\big)+W_1\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3\right.$$

$$\left.+2.\,q_6\,q_4\right)+W_3\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\big)\big)\big)e_{x5}+\left(-\frac{1}{m^2}\big(F_2\right.$$

$$-\left(w_3+W_3\right)m\left(v_1+V_1\right)-\left(-w_1-W_1\right)m\left(v_3+V_3\right)-m\left(-V_1\,w_3+V_3\,w_1-W_1\,v_3\right.$$

$$\left.+W_3\,v_1\right)-m\left(W_3\left(-W_3\left(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4\right)+W_2\left(-2.\,q_2\,q_1\right.\right.\right.$$

$$\left.+2.\,q_5\,q_2-2.\,q_8\,q_3+2.\,q_7\,q_4\right)+W_1\left(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4\right)\big)$$

$$-W_1\left(-W_2\left(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4\right)+W_1\left(2.\,q_7\,q_1-2.\,q_8\,q_2\right.\right.$$

$$-2.\,q_5\,q_3+2.\,q_6\,q_4)+W_3\,(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4))))+\frac{1}{m}($$
$$-(w_3+W_3)\,(v_1+V_1)-(-w_1-W_1)\,(v_3+V_3)+V_1\,w_3-V_3\,w_1+W_1\,v_3-W_3\,v_1$$
$$-W_3\,(-W_3\,(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4)+W_2\,(-2.\,q_2\,q_1+2.\,q_5\,q_2$$
$$-2.\,q_8\,q_3+2.\,q_7\,q_4)+W_1\,(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4))+W_1\,(-W_2\,($$
$$-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4)+W_1\,(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3$$
$$+2.\,q_6\,q_4)+W_3\,(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4))))e_{x6}+\left(-\frac{1}{m^2}(F_3\right.$$
$$-(-w_2-W_2)\,m\,(v_1+V_1)-(w_1+W_1)\,m\,(v_2+V_2)-m\,(V_1\,w_2-V_2\,w_1+W_1\,v_2$$
$$-W_2\,v_1)-m\,(-W_2\,(-W_3\,(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4)+W_2\,(-2.\,q_2\,q_1$$
$$+2.\,q_5\,q_2-2.\,q_8\,q_3+2.\,q_7\,q_4)+W_1\,(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4))$$
$$+W_1\,(W_3\,(-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4)-W_1\,(-2.\,q_2\,q_1+2.\,q_5\,q_2$$
$$-2.\,q_8\,q_3+2.\,q_7\,q_4)+W_2\,(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4))))+\frac{1}{m}($$
$$-(-w_2-W_2)\,(v_1+V_1)-(w_1+W_1)\,(v_2+V_2)-V_1\,w_2+V_2\,w_1-W_1\,v_2+W_2\,v_1$$
$$+W_2\,(-W_3\,(2.\,q_7\,q_1-2.\,q_8\,q_2-2.\,q_5\,q_3+2.\,q_6\,q_4)+W_2\,(-2.\,q_2\,q_1+2.\,q_5\,q_2$$
$$-2.\,q_8\,q_3+2.\,q_7\,q_4)+W_1\,(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4))-W_1\,(W_3\,($$
$$-2.\,q_8\,q_1-2.\,q_7\,q_2+2.\,q_6\,q_3+2.\,q_5\,q_4)-W_1\,(-2.\,q_2\,q_1+2.\,q_5\,q_2-2.\,q_8\,q_3$$
$$+2.\,q_7\,q_4)+W_2\,(2.\,q_5\,q_1+2.\,q_6\,q_2+2.\,q_7\,q_3+2.\,q_8\,q_4))))e_{x7}+(0.)e_{x8}$$

$check1 := m\_dot - phi\_m$

$$check1 := (0)e_{x1}+(0)e_{x2}+(0)e_{x3}+(0.)e_{x4}+(0)e_{x5}+(0)e_{x6}+(0)e_{x7}+(0.)e_{x8} \qquad \textbf{(29)}$$