$with(LinearAlgebra):$

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

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

$dJ\_inv := MatrixInverse(dJ)$

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

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

$$dw := \begin{bmatrix} w_1 \\ w_2 \\ w_3 \\ 0 \\ v_1 \\ v_2 \\ v_3 \\ 0 \end{bmatrix} \tag{3}$$

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

$$rf := \begin{bmatrix} r_1 \\ r_2 \\ r_3 \end{bmatrix} \tag{4}$$

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

$$Ft := \begin{bmatrix} F_1 \\ F_2 \\ F_3 \end{bmatrix} \tag{5}$$

$T := CrossProduct(rf, Ft)$

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

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

$$dF := \begin{bmatrix} F_1 \\ F_2 \\ F_3 \\ 0 \\ -F_2\, r_3 + F_3\, r_2 \\ F_1\, r_3 - F_3\, r_1 \\ -F_1\, r_2 + F_2\, r_1 \\ 0 \end{bmatrix} \tag{7}$$

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

$$dw2 := \begin{bmatrix} W_1 \\ W_2 \\ W_3 \\ 0 \\ V_1 \\ V_2 \\ V_3 \\ 0 \end{bmatrix} \tag{8}$$

$w\_comb := dw + dw2$

$$w\_comb := \begin{bmatrix} w_1 + W_1 \\ w_2 + W_2 \\ w_3 + W_3 \\ 0 \\ v_1 + V_1 \\ v_2 + V_2 \\ v_3 + V_3 \\ 0 \end{bmatrix} \tag{9}$$

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

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

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

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

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

$[-(v_2+V_2), (v_1+V_1), 0, (v_3+V_3), -(w_2+W_2), (w_1+W_1), 0, (w_3+W_3)],$
$[0, 0, 0, 0, 0, 0, 0, 0]]$

*dw3_omega* := **(12)**

$$[[0, -w_3 - W_3, w_2 + W_2, w_1 + W_1, 0, 0, 0, 0],$$
$$[w_3 + W_3, 0, -w_1 - W_1, w_2 + W_2, 0, 0, 0, 0],$$
$$[-w_2 - W_2, w_1 + W_1, 0, w_3 + W_3, 0, 0, 0, 0],$$
$$[0, 0, 0, 0, 0, 0, 0, 0],$$
$$[0, -v_3 - V_3, v_2 + V_2, v_1 + V_1, 0, -w_3 - W_3, w_2 + W_2, w_1 + W_1],$$
$$[v_3 + V_3, 0, -v_1 - V_1, v_2 + V_2, w_3 + W_3, 0, -w_1 - W_1, w_2 + W_2],$$
$$[-v_2 - V_2, v_1 + V_1, 0, v_3 + V_3, -w_2 - W_2, w_1 + W_1, 0, w_3 + W_3],$$
$$[0, 0, 0, 0, 0, 0, 0, 0]]$$

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

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

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

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

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

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

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

$$rr := \begin{bmatrix} -2.\ q_8\ q_1 - 2.\ q_7\ q_2 + 2.\ q_6\ q_3 + 2.\ q_5\ q_4 \\ 2.\ q_7\ q_1 - 2.\ q_8\ q_2 - 2.\ q_5\ q_3 + 2.\ q_6\ q_4 \\ \left(-2.\ q_1 + 2.\ q_5\right) q_2 - 2.\ q_8\ q_3 + 2.\ q_7\ q_4 \\ 2.\ q_5\ q_1 + 2.\ q_6\ q_2 + 2.\ q_7\ q_3 + 2.\ q_8\ q_4 \end{bmatrix} \tag{16}$$

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

$$R := \begin{bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ -2.\ q_8\ q_1 - 2.\ q_7\ q_2 + 2.\ q_6\ q_3 + 2.\ q_5\ q_4 \\ 2.\ q_7\ q_1 - 2.\ q_8\ q_2 - 2.\ q_5\ q_3 + 2.\ q_6\ q_4 \\ -2.\ q_2\ q_1 + 2.\ q_5\ q_2 - 2.\ q_8\ q_3 + 2.\ q_7\ q_4 \\ 2.\ q_5\ q_1 + 2.\ q_6\ q_2 + 2.\ q_7\ q_3 + 2.\ q_8\ q_4 \end{bmatrix} \tag{17}$$

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

$$dw\_dot := \Bigg[\bigg[\frac{1}{J_1}\Big(-F_2\ r_3 + F_3\ r_2 - \left(-v_3 - V_3\right) m \left(v_2 + V_2\right) - \left(v_2 + V_2\right) m \left(v_3 + V_3\right) - \big(-w_3 - W_3\big) J_2 \left(w_2 + W_2\right) - \left(w_2 + W_2\right) J_3 \left(w_3 + W_3\right) - J_1 \left(W_2\ w_3 - W_3\ w_2\right)\Big)\bigg], \bigg[\frac{1}{J_2}\Big(F_1\ r_3 - F_3\ r_1 - \left(v_3 + V_3\right) m \left(v_1 + V_1\right) - \left(-v_1 - V_1\right) m \left(v_3 + V_3\right) - \big(w_3 + W_3\big) J_1 \left(w_1 + W_1\right) - \left(-w_1 - W_1\right) J_3 \left(w_3 + W_3\right) - J_2 \left(-W_1\ w_3 + W_3\ w_1\right)\Big)\bigg], \tag{18}$$

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

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

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

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

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

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

$with(VectorCalculus):$

$$\frac{\partial}{\partial F_1} dw\_dot$$

$$(0) e_{x1}+\left(\frac{r_3}{J_2}\right) e_{x2}+\left(-\frac{r_2}{J_3}\right) e_{x3}+(0) e_{x4}+\left(\frac{1}{m}\right) e_{x5}+(0) e_{x6}+(0) e_{x7}+(0) e_{x8} \qquad \textbf{(19)}$$

$$\frac{\partial}{\partial F_2} dw\_dot$$

$$\left(-\frac{r_3}{J_1}\right)e_{x1} + (0)e_{x2} + \left(\frac{r_1}{J_3}\right)e_{x3} + (0)e_{x4} + (0)e_{x5} + \left(\frac{1}{m}\right)e_{x6} + (0)e_{x7} + (0)e_{x8} \quad \textbf{(20)}$$

$$\frac{\partial}{\partial F_3} dw\_dot$$

$$\left(\frac{r_2}{J_1}\right)e_{x1} + \left(-\frac{r_1}{J_2}\right)e_{x2} + (0)e_{x3} + (0)e_{x4} + (0)e_{x5} + (0)e_{x6} + \left(\frac{1}{m}\right)e_{x7} + (0)e_{x8} \quad \textbf{(21)}$$

$$phi\_f := dJ\_inv.\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -r_3 & r_2 & r_1 & 0 & 0 & 0 & 0 \\ r_3 & 0 & -r_1 & r_2 & 0 & 0 & 0 & 0 \\ -r_2 & r_1 & 0 & r_3 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$phi\_f := \begin{bmatrix} 0 & -\frac{r_3}{J_1} & \frac{r_2}{J_1} & \frac{r_1}{J_1} & 0 & 0 & 0 & 0 \\ \frac{r_3}{J_2} & 0 & -\frac{r_1}{J_2} & \frac{r_2}{J_2} & 0 & 0 & 0 & 0 \\ -\frac{r_2}{J_3} & \frac{r_1}{J_3} & 0 & \frac{r_3}{J_3} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \frac{1}{m} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & \frac{1}{m} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \frac{1}{m} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \quad \textbf{(22)}$$

$$f\_dot := \left\langle \frac{\partial}{\partial F_1} dw\_dot \middle| \frac{\partial}{\partial F_2} dw\_dot \middle| \frac{\partial}{\partial F_3} dw\_dot \right\rangle$$

$$f\_dot := \begin{bmatrix} 0 & -\frac{r_3}{J_1} & \frac{r_2}{J_1} \\ \frac{r_3}{J_2} & 0 & -\frac{r_1}{J_2} \\ -\frac{r_2}{J_3} & \frac{r_1}{J_3} & 0 \\ 0 & 0 & 0 \\ \frac{1}{m} & 0 & 0 \\ 0 & \frac{1}{m} & 0 \\ 0 & 0 & \frac{1}{m} \\ 0 & 0 & 0 \end{bmatrix} \tag{23}$$