$$
\begin{bmatrix}
\dfrac{\partial R_k}{\partial \ddot{q}_k} & \dfrac{\partial S_k}{\partial \ddot{q}_k} & \dfrac{\partial T_k}{\partial \ddot{q}_k} & \dfrac{\partial R_{k+1}}{\partial \ddot{q}_k} & \dfrac{\partial S_{k+1}}{\partial \ddot{q}_k} & \dfrac{\partial T_{k+1}}{\partial \ddot{q}_k} & \dfrac{\partial R_{k+2}}{\partial \ddot{q}_k} & \dfrac{\partial S_{k+2}}{\partial \ddot{q}_k} & \dfrac{\partial T_{k+2}}{\partial \ddot{q}_k} \\[10pt]
 & \dfrac{\partial S_k}{\partial \dot{q}_k} & \dfrac{\partial T_k}{\partial \dot{q}_k} & \dfrac{\partial R_{k+1}}{\partial \dot{q}_k} & \dfrac{\partial S_{k+1}}{\partial \dot{q}_k} & \dfrac{\partial T_{k+2}}{\partial \dot{q}_k} & \dfrac{\partial R_{k+2}}{\partial \dot{q}_k} & \dfrac{\partial S_{k+2}}{\partial \dot{q}_k} & \dfrac{\partial T_{k+2}}{\partial \dot{q}_k} \\[10pt]
 & & \dfrac{\partial T_k}{\partial q_k} & \dfrac{\partial R_{k+1}}{\partial q_k} & \dfrac{\partial S_{k+1}}{\partial q_k} & \dfrac{\partial T_{k+2}}{\partial q_k} & \dfrac{\partial R_{k+2}}{\partial q_k} & \dfrac{\partial S_{k+2}}{\partial q_k} & \dfrac{\partial T_{k+2}}{\partial q_k} \\[10pt]
 & & & \dfrac{\partial R_{k+1}}{\partial \ddot{q}_{k+1}} & \dfrac{\partial S_{k+1}}{\partial \ddot{q}_{k+1}} & \dfrac{\partial T_{k+2}}{\partial \ddot{q}_{k+1}} & \dfrac{\partial R_{k+2}}{\partial \ddot{q}_{k+1}} & \dfrac{\partial S_{k+2}}{\partial \ddot{q}_{k+1}} & \dfrac{\partial T_{k+2}}{\partial \ddot{q}_{k+1}} \\[10pt]
 & & & & \dfrac{\partial S_{k+1}}{\partial \dot{q}_{k+1}} & \dfrac{\partial T_{k+2}}{\partial \dot{q}_{k+1}} & \dfrac{\partial R_{k+2}}{\partial \dot{q}_{k+1}} & \dfrac{\partial S_{k+2}}{\partial \dot{q}_{k+1}} & \dfrac{\partial T_{k+2}}{\partial \dot{q}_{k+1}} \\[10pt]
 & & & & & \dfrac{\partial T_{k+1}}{\partial q_{k+1}} & \dfrac{\partial R_{k+2}}{\partial q_{k+1}} & \dfrac{\partial S_{k+2}}{\partial q_{k+1}} & \dfrac{\partial T_{k+2}}{\partial q_{k+1}} \\[10pt]
 & & & & & & \dfrac{\partial T_{k+2}}{\partial \ddot{q}_{k+2}} & \dfrac{\partial S_{k+2}}{\partial \ddot{q}_{k+1}} & \dfrac{\partial T_{k+2}}{\partial \ddot{q}_{k+1}} \\[10pt]
 & & & & & & & \dfrac{\partial S_{k+2}}{\partial \dot{q}_{k+2}} & \dfrac{\partial T_{k+2}}{\partial \ddot{q}_{k+2}} \\[10pt]
 & & & & & & & & \dfrac{\partial T_{k+2}}{\partial q_{k+2}}
\end{bmatrix}
\begin{bmatrix}
\rho_k \\[10pt] \sigma_k \\[10pt] \tau_k \\[10pt] \rho_{k+1} \\[10pt] \sigma_{k+1} \\[10pt] \tau_{k+1} \\[10pt] \rho_{k+2} \\[10pt] \sigma_{k+2} \\[10pt] \tau_{k+2}
\end{bmatrix}
= -
\begin{bmatrix}
\dfrac{\partial f_k}{\partial \ddot{q}_k} \\[10pt]
\dfrac{\partial f_k}{\partial \dot{q}_k} \\[10pt]
\dfrac{\partial f_k}{\partial q_k} \\[10pt]
\dfrac{\partial f_{k+1}}{\partial \ddot{q}_{k+1}} \\[10pt]
\dfrac{\partial f_{k+1}}{\partial \dot{q}_{k+1}} \\[10pt]
\dfrac{\partial f_{k+1}}{\partial q_{k+1}} \\[10pt]
\dfrac{\partial f_{k+2}}{\partial \ddot{q}_{k+2}} \\[10pt]
\dfrac{\partial f_{k+2}}{\partial \dot{q}_{k+2}} \\[10pt]
\dfrac{\partial f_{k+2}}{\partial q_{k+2}}
\end{bmatrix}
$$