$$c_x = x_1 - x_c \tag{1}$$

$$c_y = y_1 - y_c \tag{2}$$

$$c = \begin{bmatrix} c_x \\ c_y \end{bmatrix} \tag{3}$$

$$D(q) = jacobian(c) = \frac{\partial c}{\partial q} \tag{4}$$

$$\dot{c} = \frac{\partial c}{\partial q}\dot{q} = D(q)\dot{q} \tag{5}$$

$$\ddot{c} = \frac{d}{dt}(D(q)\dot{q}) = D(q)\ddot{q} + \frac{\partial}{\partial q}(D(q)\dot{q})\dot{q} = 0 \tag{6}$$

$$d = \frac{\partial}{\partial q}(D(q)\dot{q})\dot{q} \tag{7}$$

$$e = D(q) * (M(q) \backslash (D(q)^{\top} * (\alpha * c + \beta * \dot{c}))) \tag{8}$$

$$\begin{bmatrix} M(q)_{4x4} & -D(q)^{\top}_{4x2} \\ D(q)_{2x4} & 0_{2x2} \end{bmatrix} \begin{bmatrix} \ddot{q}_{4x1} \\ \lambda_{2x1} \end{bmatrix} = \begin{bmatrix} (-C(q,\dot{q}) - G(q))_{4x1} \\ -(d+e)_{2x1} \end{bmatrix} \tag{9}$$