Time derivatives example

$$q = \begin{bmatrix} x(t) \\ y(t) \\ \theta(t) \end{bmatrix} \qquad \Phi(q(t)) = 3x(t) + 2L\sin(\theta(t))$$

$$\Phi_q = \begin{bmatrix} 3 & 0 & 2L\cos(\theta(t)) \end{bmatrix}$$

Then $\dot{\Phi} = \Phi_q \cdot \dot{q} = \begin{bmatrix} 3 & 0 & 2L\cos(\theta(t)) \end{bmatrix} \begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix}$

$$= 3\dot{x} + 2L\dot{\theta} \cdot \cos(\theta(t))$$

For $\Phi(q) = \begin{bmatrix} 3x(t) + 2L\sin\theta(t) \\ y(t) - 2L\cos\theta(t) \end{bmatrix}$, follow the same steps as above to get,

$$\dot{\Phi} = \Phi_q \cdot \dot{q} = \begin{bmatrix} 3 & 0 & 2L\,c\theta(t) \\ 0 & 1 & 2L\,s\theta(t) \end{bmatrix} \begin{bmatrix} \dot{x} \\ \dot{y} \\ \dot{\theta} \end{bmatrix}$$

$$= \begin{bmatrix} 3\dot{x} + 2L\dot{\theta}\,c\theta(t) \\ \dot{y} + 2L\dot{\theta}\,s\theta(t) \end{bmatrix}$$