2) \( q_i = q_i^*(s_i, \ldots, s_n, t) \quad \text{for} \quad i \in \mathbb{L} \quad \frac{\partial q_i}{\partial q_j} - \frac{\partial q_j}{\partial q_i} = 0 \)

\[ \text{rewrite in terms of su variable} \]

\[ \frac{\partial}{\partial t} \left( \frac{\partial \phi}{\partial \phi_t} + \frac{\partial \phi}{\partial \phi_u} \right) - \frac{\partial \phi}{\partial \phi_t} \frac{\partial \phi_t}{\partial \phi_u} = 0 \]

\[ \frac{\partial\phi}{\partial\phi_t} \frac{\partial\phi_t}{\partial\phi_u} = \frac{\partial\phi}{\partial\phi_u} \]

\[ \frac{\partial}{\partial t} \left( \frac{\partial \phi}{\partial \phi_t} - \frac{\partial \phi}{\partial \phi_u} \right) \frac{\partial \phi}{\partial \phi_u} = 0 \]

\[ \frac{\partial\phi}{\partial\phi_t} - \frac{\partial \phi}{\partial \phi_u} = 0 \]

Note that

\[ \frac{\partial \phi}{\partial \phi_t} = \frac{\partial \phi}{\partial \phi_u} \]

\[ \frac{\partial \phi}{\partial \phi_t} = \frac{\partial x}{\partial \phi_t} \]

\[ \frac{\partial \phi}{\partial \phi_u} = \frac{\partial x}{\partial \phi_u} \]