Jacobian:

$$\frac{\partial u}{\partial x} = \frac{\partial u}{\partial \xi} \frac{\partial \xi}{\partial x} + \frac{\partial u}{\partial \eta} \frac{\partial \eta}{\partial x}$$
$$\frac{\partial u}{\partial y} = \frac{\partial u}{\partial \xi} \frac{\partial \xi}{\partial y} + \frac{\partial u}{\partial \eta} \frac{\partial \eta}{\partial y}$$

Hessian:

$$\begin{split} \frac{\partial^2 u}{\partial x^2} &= \frac{\partial}{\partial \xi} \left(\frac{\partial u}{\partial \xi} \frac{\partial \xi}{\partial x} + \frac{\partial u}{\partial \eta} \frac{\partial \eta}{\partial x} \right) \frac{\partial \xi}{\partial x} \\ &+ \frac{\partial}{\partial \eta} \left(\frac{\partial u}{\partial \xi} \frac{\partial \xi}{\partial x} + \frac{\partial u}{\partial \eta} \frac{\partial \eta}{\partial x} \right) \frac{\partial \eta}{\partial x} \\ &= \left(\frac{\partial^2 u}{\partial \xi^2} \frac{\partial \xi}{\partial x} + \frac{\partial u}{\partial \xi} \frac{\partial^2 \xi}{\partial x \partial \xi} + \frac{\partial^2 u}{\partial \xi \partial \eta} \frac{\partial \eta}{\partial x} + \frac{\partial u}{\partial \eta} \frac{\partial^2 \eta}{\partial x \partial \xi} \right) \frac{\partial \xi}{\partial x} \\ &+ \left(\frac{\partial^2 u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial x} + \frac{\partial u}{\partial \xi} \frac{\partial^2 \xi}{\partial \xi \partial \eta} + \frac{\partial^2 u}{\partial \eta^2} \frac{\partial \eta}{\partial x} + \frac{\partial u}{\partial \eta} \frac{\partial^2 \eta}{\partial x \partial \eta} \right) \frac{\partial \eta}{\partial x} \\ &= \left(\frac{\partial^2 u}{\partial \xi^2} \frac{\partial \xi}{\partial x} + \frac{\partial u}{\partial \xi} \frac{\partial \xi}{\partial x} + \frac{\partial^2 u}{\partial \xi \partial \eta} \frac{\partial \eta}{\partial x} \right) \frac{\partial \xi}{\partial x} \\ &+ \left(\frac{\partial^2 u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial x} + \frac{\partial^2 u}{\partial \eta^2} \frac{\partial \eta}{\partial x} + \frac{\partial u}{\partial \eta} \frac{\partial \eta}{\partial x} \right) \frac{\partial \eta}{\partial x} \\ &= \frac{\partial^2 u}{\partial \xi^2} \left(\frac{\partial \xi}{\partial x} \right)^2 + \frac{\partial^2 u}{\partial \eta^2} \left(\frac{\partial \eta}{\partial x} \right)^2 + 2 \frac{\partial^2 u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial x} \end{split}$$

$$\begin{split} \frac{\partial^{2} u}{\partial y^{2}} &= \frac{\partial}{\partial \xi} \left(\frac{\partial u}{\partial \xi} \frac{\partial \xi}{\partial y} + \frac{\partial u}{\partial \eta} \frac{\partial \eta}{\partial y} \right) \frac{\partial \xi}{\partial y} \\ &+ \frac{\partial}{\partial \eta} \left(\frac{\partial u}{\partial \xi} \frac{\partial \xi}{\partial y} + \frac{\partial u}{\partial \eta} \frac{\partial \eta}{\partial y} \right) \frac{\partial \eta}{\partial y} \\ &= \left(\frac{\partial^{2} u}{\partial \xi^{2}} \frac{\partial \xi}{\partial y} + \frac{\partial u}{\partial \xi} \frac{\partial^{2} \xi}{\partial \xi \partial y} + \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \eta}{\partial y} + \frac{\partial u}{\partial \eta} \frac{\partial^{2} \eta}{\partial \xi \partial y} \right) \frac{\partial \xi}{\partial y} \\ &+ \left(\frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial y} + \frac{\partial u}{\partial \xi} \frac{\partial^{2} \xi}{\partial \eta \partial y} + \frac{\partial^{2} u}{\partial \eta^{2}} \frac{\partial \eta}{\partial y} + \frac{\partial u}{\partial \eta} \frac{\partial^{2} \eta}{\partial \eta \partial y} \right) \frac{\partial \eta}{\partial y} \\ &= \frac{\partial^{2} u}{\partial \xi^{2}} \left(\frac{\partial \xi}{\partial y} \right)^{2} + \frac{\partial^{2} u}{\partial \eta^{2}} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \end{split}$$

$$\begin{split} \frac{\partial^{2} u}{\partial x \partial y} &= \frac{\partial}{\partial \xi} \left(\frac{\partial u}{\partial \xi} \frac{\partial \xi}{\partial x} + \frac{\partial u}{\partial \eta} \frac{\partial \eta}{\partial x} \right) \frac{\partial \xi}{\partial y} \\ &+ \frac{\partial}{\partial \eta} \left(\frac{\partial u}{\partial \xi} \frac{\partial \xi}{\partial x} + \frac{\partial u}{\partial \eta} \frac{\partial \eta}{\partial x} \right) \frac{\partial \eta}{\partial y} \\ &= \left(\frac{\partial^{2} u}{\partial \xi^{2}} \frac{\partial \xi}{\partial x} + \frac{\partial u}{\partial \xi} \frac{\partial^{2} \xi}{\partial \xi \partial x} + \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \eta}{\partial x} + \frac{\partial u}{\partial \eta} \frac{\partial^{2} \eta}{\partial \xi \partial x} \right) \frac{\partial \xi}{\partial y} \\ &+ \left(\frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial x} + \frac{\partial u}{\partial \xi} \frac{\partial^{2} \xi}{\partial \eta \partial x} + \frac{\partial^{2} u}{\partial \eta^{2}} \frac{\partial \eta}{\partial x} + \frac{\partial u}{\partial \eta} \frac{\partial^{2} \eta}{\partial \eta \partial x} \right) \frac{\partial \eta}{\partial y} \\ &= \frac{\partial^{2} u}{\partial \xi^{2}} \frac{\partial \xi}{\partial x} \frac{\partial \xi}{\partial y} + \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \eta}{\partial x} \frac{\partial \xi}{\partial y} + \frac{\partial^{2} u}{\partial \eta^{2}} \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial y} + \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \\ &= \frac{\partial^{2} u}{\partial \xi^{2}} \frac{\partial \xi}{\partial x} \frac{\partial \xi}{\partial y} + \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \eta}{\partial x} \frac{\partial \xi}{\partial y} + \frac{\partial^{2} u}{\partial \eta^{2}} \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial y} + \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \\ &= \frac{\partial^{2} u}{\partial \xi^{2}} \frac{\partial \xi}{\partial x} \frac{\partial \xi}{\partial y} + \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \eta}{\partial x} \frac{\partial \xi}{\partial y} + \frac{\partial^{2} u}{\partial \eta^{2}} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} + \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \\ &= \frac{\partial^{2} u}{\partial \xi^{2}} \frac{\partial \xi}{\partial x} \frac{\partial \xi}{\partial y} + \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \eta}{\partial x} \frac{\partial \xi}{\partial y} + \frac{\partial^{2} u}{\partial \eta^{2}} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} + \frac{\partial^{2} u}{\partial \xi^{2}} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \\ &= \frac{\partial^{2} u}{\partial \xi^{2}} \frac{\partial \xi}{\partial y} \frac{\partial \xi}{\partial y} + \frac{\partial^{2} u}{\partial \xi^{2}} \frac{\partial \eta}{\partial y} \frac{\partial \xi}{\partial y} + \frac{\partial^{2} u}{\partial \eta^{2}} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} + \frac{\partial^{2} u}{\partial \eta^{2}} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y}$$

Jerk matrix:

$$\frac{\partial^{3} u}{\partial x^{3}} = \frac{\partial}{\partial \xi} \left(\frac{\partial^{2} u}{\partial \xi^{2}} \left(\frac{\partial \xi}{\partial x} \right)^{2} + \frac{\partial^{2} u}{\partial \eta^{2}} \left(\frac{\partial \eta}{\partial x} \right)^{2} + 2 \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial x} \right) \frac{\partial \xi}{\partial x}
+ \frac{\partial}{\partial \eta} \left(\frac{\partial^{2} u}{\partial \xi^{2}} \left(\frac{\partial \xi}{\partial x} \right)^{2} + \frac{\partial^{2} u}{\partial \eta^{2}} \left(\frac{\partial \eta}{\partial x} \right)^{2} + 2 \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial x} \right) \frac{\partial \eta}{\partial x}
= \frac{\partial^{3} u}{\partial \xi^{3}} \left(\frac{\partial \xi}{\partial x} \right)^{3} + \frac{\partial^{3} u}{\partial \xi \partial \eta^{2}} \left(\frac{\partial \eta}{\partial x} \right)^{2} \frac{\partial \xi}{\partial x} + 2 \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial x} \right)^{2} \frac{\partial \eta}{\partial x}
+ \frac{\partial^{3} u}{\partial \eta^{3}} \left(\frac{\partial \eta}{\partial x} \right)^{3} + \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial x} \right)^{2} \frac{\partial \eta}{\partial x} + 2 \frac{\partial^{3} u}{\partial \xi \partial \eta^{2}} \frac{\partial \xi}{\partial x} \left(\frac{\partial \eta}{\partial x} \right)^{2}$$

$$\begin{split} \frac{\partial^{3} u}{\partial y^{3}} &= \frac{\partial}{\partial \xi} \left(\frac{\partial^{2} u}{\partial \xi^{2}} \left(\frac{\partial \xi}{\partial y} \right)^{2} + \frac{\partial^{2} u}{\partial \eta^{2}} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \right) \frac{\partial \xi}{\partial y} \\ &+ \frac{\partial}{\partial \eta} \left(\frac{\partial^{2} u}{\partial \xi^{2}} \left(\frac{\partial \xi}{\partial y} \right)^{2} + \frac{\partial^{2} u}{\partial \eta^{2}} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \right) \frac{\partial \eta}{\partial y} \\ &= \frac{\partial^{3} u}{\partial \xi^{3}} \left(\frac{\partial \xi}{\partial y} \right)^{3} + \frac{\partial u^{3}}{\partial \xi \partial \eta^{2}} \left(\frac{\partial \eta}{\partial y} \right)^{2} \frac{\partial \xi}{\partial y} + 2 \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial y} \right)^{2} \frac{\partial \eta}{\partial y} \\ &+ \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial y} \right)^{2} \frac{\partial \eta}{\partial y} + \frac{\partial^{3} u}{\partial \eta^{3}} \left(\frac{\partial \xi}{\partial y} \right)^{3} + 2 \frac{\partial^{3} u}{\partial \xi \partial \eta^{2}} \frac{\partial \xi}{\partial y} \left(\frac{\partial \eta}{\partial y} \right)^{2} \end{split}$$

$$\frac{\partial^{3} u}{\partial x^{2} \partial y} = \frac{\partial}{\partial \xi} \left(\frac{\partial^{2} u}{\partial \xi^{2}} \left(\frac{\partial \xi}{\partial x} \right)^{2} + \frac{\partial^{2} u}{\partial \eta^{2}} \left(\frac{\partial \eta}{\partial x} \right)^{2} + 2 \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial x} \right) \frac{\partial \xi}{\partial y}
+ \frac{\partial}{\partial \eta} \left(\frac{\partial^{2} u}{\partial \xi^{2}} \left(\frac{\partial \xi}{\partial x} \right)^{2} + \frac{\partial^{2} u}{\partial \eta^{2}} \left(\frac{\partial \eta}{\partial x} \right)^{2} + 2 \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial x} \right) \frac{\partial \eta}{\partial y}
= \frac{\partial^{3} u}{\partial \xi^{3}} \left(\frac{\partial \xi}{\partial x} \right)^{2} \frac{\partial \xi}{\partial y} + \frac{\partial^{3} u}{\partial \xi \partial \eta^{2}} \left(\frac{\partial \eta}{\partial x} \right)^{2} \frac{\partial \xi}{\partial y} + 2 \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \frac{\partial \xi}{\partial x} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial x}
+ \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial x} \right)^{2} \frac{\partial \eta}{\partial y} + \frac{\partial^{3} u}{\partial \eta^{3}} \left(\frac{\partial \eta}{\partial x} \right)^{2} \frac{\partial \eta}{\partial y} + 2 \frac{\partial^{3} u}{\partial \xi \partial \eta^{2}} \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial x} \frac{\partial \eta}{\partial y}$$

$$\begin{split} \frac{\partial^{3} u}{\partial x \partial y^{2}} &= \frac{\partial}{\partial \xi} \left(\frac{\partial^{2} u}{\partial \xi^{2}} \left(\frac{\partial \xi}{\partial y} \right)^{2} + \frac{\partial^{2} u}{\partial \eta^{2}} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \right) \frac{\partial \xi}{\partial x} \\ &+ \frac{\partial}{\partial \eta} \left(\frac{\partial^{2} u}{\partial \xi^{2}} \left(\frac{\partial \xi}{\partial y} \right)^{2} + \frac{\partial^{2} u}{\partial \eta^{2}} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{2} u}{\partial \xi \partial \eta} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \right) \frac{\partial \eta}{\partial x} \\ &= \frac{\partial^{3} u}{\partial \xi^{3}} \frac{\partial \xi}{\partial x} \left(\frac{\partial \xi}{\partial y} \right)^{2} + \frac{\partial^{3} u}{\partial \xi \partial \eta^{2}} \frac{\partial \xi}{\partial x} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \frac{\partial \xi}{\partial x} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \\ &+ \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial y} \right)^{2} \frac{\partial \eta}{\partial x} + \frac{\partial^{3} u}{\partial \eta^{3}} \frac{\partial \eta}{\partial x} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{3} u}{\partial \xi \partial \eta^{2}} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial x} \frac{\partial \eta}{\partial y} \\ &+ \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial y} \right)^{2} \frac{\partial \eta}{\partial x} + \frac{\partial^{3} u}{\partial \eta^{3}} \frac{\partial \eta}{\partial x} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{3} u}{\partial \xi \partial \eta^{2}} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial x} \frac{\partial \eta}{\partial y} \\ &+ \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial y} \right)^{2} \frac{\partial \eta}{\partial x} + \frac{\partial^{3} u}{\partial \eta^{3}} \frac{\partial \eta}{\partial x} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{3} u}{\partial \xi \partial \eta^{2}} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial x} \frac{\partial \eta}{\partial y} \\ &+ \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial y} \right)^{2} \frac{\partial \eta}{\partial x} + \frac{\partial^{3} u}{\partial \eta^{3}} \frac{\partial \eta}{\partial x} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial y} \frac{\partial \eta}{\partial y} \\ &+ \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial y} \right)^{2} \frac{\partial \eta}{\partial x} + \frac{\partial^{3} u}{\partial \eta^{3}} \frac{\partial \eta}{\partial x} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \frac{\partial \xi}{\partial x} \frac{\partial \eta}{\partial y} \frac{\partial \eta}{\partial y} \frac{\partial \eta}{\partial y} \\ &+ \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial y} \right)^{2} \frac{\partial \eta}{\partial x} + \frac{\partial^{3} u}{\partial \eta} \frac{\partial \eta}{\partial x} \left(\frac{\partial \eta}{\partial y} \right)^{2} + 2 \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \frac{\partial \xi}{\partial y} \frac{\partial \eta}{\partial y} \frac{\partial \eta}{\partial y} \frac{\partial \eta}{\partial y} \\ &+ \frac{\partial^{3} u}{\partial \xi^{2} \partial \eta} \left(\frac{\partial \xi}{\partial y} \right)^{2} \frac{\partial \eta}{\partial x} \frac{\partial \eta}{\partial y} \frac{\partial \eta}{\partial y$$