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Advanced Continuum Mechanics
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When in an elastic material, the deformations are very large, one sometimes considers the possibility of higher order deformation gradients. Study, to that end, an elastic material with an elastic energy, which is a function of $x^i_{,K}$ as well as

$$x^i_{,KL} = \frac{\partial^2 x^i}{\partial X^K \partial X^L}.$$

This gives a Lagrangian density

$$\mathcal{L}(x^i, x^i_{,K}, x^i_{,KL}, x^i_{,t}, X^K, t).$$

Find the corresponding Euler-Lagrange equations. Suggest some possible boundary conditions. Compare the possibilities in the usual case.

We know that $x^i_{,K}$ are the components of the deformation gradient. Check out how $x^i_{,K}$ changes when new coordinates x'^i and X'^K in space and reference configuration are introduced. Are $x^i_{,KL}$ the components of a tensor? How do they transform under a change of coordinates?