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Advanced Continuum Mechanics
Home assignment number 3, 1999

a) Show that when using curvilinear coordinates for an elastic material, the Euler-Lagrange equations in fact give the acceleration expressed in terms of covariant derivatives and the divergence of the stress tensor also expressed in terms of covariant derivatives. Hint: the elastic energy is a function of the right Cauchy-Green tensor, with covariant components

$$C_{KL} = g_{ij}(x^k)\, x^i_{,K}\, x^j_{,L}.$$

b) Show the formula

$$\frac{\partial C_{MN}}{\partial X^K_{\ ,i}} = -(C_{KM}\, x^i{}_{,N} + C_{KN}\, x^i{}_{,M}),$$

which is used for deriving the conservation of energy and momentum via inverse kinematics.