4-5, 10, 13, 14, 15, 17

4.5 Following the steps outlined in the text, invert the form of Hooke's law given by (4.2.7) and develop form (4.2.10). Explicitly show that $E = \mu(3\lambda + 2\mu)/(\lambda + \mu)$ and $\nu = \lambda/[2(\lambda + \mu)]$.

4.10 If the elastic constants E, k, and μ are required to be positive, show that Poisson's ratio must satisfy the inequality $-1 < \nu < \frac{1}{2}$. For most real materials it has been found that $0 < \nu < \frac{1}{2}$. Show that this more restrictive inequality in this problem implies that $\lambda > 0$.

4.13 Consider the three deformation cases of simple tension, pure shear, and hydrostatic compression as discussed in Section 4.3. Using the nominal values from Table 4.2, calculate the resulting strains in each of these cases for:

(a) Aluminum: with loadings ($\sigma = 150\ MPa$, $\tau = 75\ MPa$, $p = 500\ MPa$)

(b) Steel: with loadings ($\sigma = 300\ MPa$, $\tau = 150\ MPa$, $p = 500\ MPa$)

(c) Rubber: with loadings ($\sigma = 15\ MPa$, $\tau = 7\ MPa$, $p = 500\ MPa$)

Note that for aluminum and steel, these tensile and shear loadings are close to the yield values of the material.

4.14 Show that Hooke's law for an isotropic material may be expressed in terms of spherical and deviatoric tensors by the two relations

$$\tilde{\sigma}_{ij} = 3k\tilde{e}_{ij}, \quad \hat{\sigma}_{ij} = 2\mu\hat{e}_{ij}$$

4.15 A sample is subjected to a test under *plane stress* conditions (specified by $\sigma_z = \tau_{zx} = \tau_{zy} = 0$) using a special loading frame that maintains an in-plane loading constraint $\sigma_x = 2\sigma_y$. Determine the slope of the stress–strain response σ_x vs. e_x for this sample.

4.17 A rectangular steel plate (thickness 4 mm) is subjected to a uniform biaxial stress field as shown in the following figure. Assuming all fields are uniform, determine changes in the dimensions of the plate under this loading.