P2.13.

A thin rectangular plate $a = 30\,\text{mm} \times b = 15\,\text{mm}$ is acted upon by a stress distribution (Fig. 1) resulting in the uniforms strain $\varepsilon_x = 400\,\mu$, $\varepsilon_y = 200\,\mu$, and $\gamma_{xy} = -300\,\mu$. Determine the changes in length of diagonals $\overline{QB}$ and $\overline{AC}$.

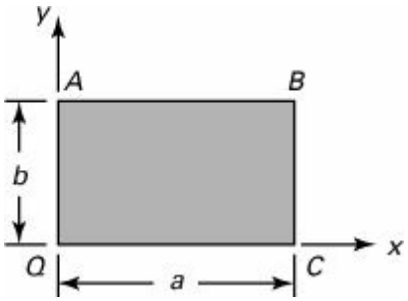

Figure 1: A thin rectangular plate

P2.16.

A $3\,\text{m} \times 2\,\text{m}$ thin rectangular plate is deformed by the movement of point B to B' as shown by the dashed lines in Fig. 2. Assuming a displacement field of the form $u = c_1xy$ and $v = c_2xy$ where c_1 and c_2 are constants, determine,

(a) expressions for displacements u and v.

(b) strain components ε_x, ε_y, and γ_{xy} at point B.

(c) the normal strain $\varepsilon_{x'}$ in the direction of $\overline{QB}$.

Verify that the strain field is possible.

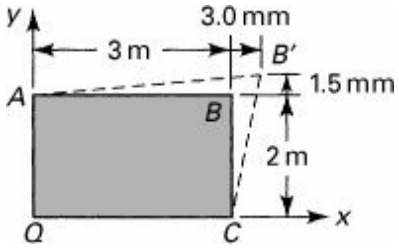

Figure 2: A thin rectangular plate

P2.22.

At a point in a stressed body, the strains, related to the coordinate set xyz, are given by Eqn. (1).

$$\boldsymbol{\varepsilon} = \begin{bmatrix} \varepsilon_x & \frac{1}{2}\gamma_{xy} & \frac{1}{2}\gamma_{xz} \\ \frac{1}{2}\gamma_{yx} & \varepsilon_y & \frac{1}{2}\gamma_{yz} \\ \frac{1}{2}\gamma_{zx} & \frac{1}{2}\gamma_{zy} & \varepsilon_z \end{bmatrix} = \begin{bmatrix} 400 & 100 & 0 \\ 100 & 0 & -200 \\ 0 & -200 & 600 \end{bmatrix} \mu \tag{1}$$

Determine,

(a) the strain invariants.

(b) the normal strain in the x' direction, which is directed at an angle 30° from the x-axis.

(c) the principal strains ε_1, ε_2, and ε_3.

(d) the maximum shear strain.

P2.27.

A 40 mm diameter bar ABC is composed of an aluminum part AB and a steel part BC as shown in Fig. 3. After axial force P is applied, a strain gage attached to the steel measures normal strain at the longitudinal direction as $\varepsilon_s = 600\,\mu$. Determine,

(a) the magnitude of the applied force P.

(b) the total elongation of the bar if each material behaves elastically. Take $E_{\text{aluminum}} = 70\,\text{GPa}$ and $E_{\text{steel}} = 210\,\text{GPa}$.

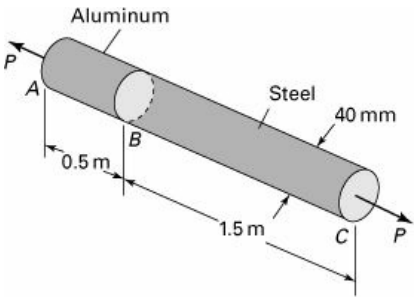

Figure 3: A composite steel rod

P2.31.

A solid sphere of diameter d experiences a uniform pressure of p. *Given:* $d = 250\,\text{mm}$, $p = 160\,\text{MPa}$, $E = 70\,\text{GPa}$, and $\nu = 0.3$. Determine,

(a) the decrease in circumference of the sphere.

(b) the decrease in volume of the sphere ΔV.

Note: Volume of a sphere is $V = \frac{4}{3}\pi r^3$, where $r = \frac{d}{2}$.

P2.36.

A 50 mm square plate is subjected to the stresses as shown in Fig. 4. What deformation is experienced by diagonal $\overline{BD}$? Determine the stress on planes perpendicular and parallel to $\overline{BD}$ and then employ ***generalized Hooke's law*** [Eqn. (2)]. Express the solution in terms of E for $v = 0.3$.

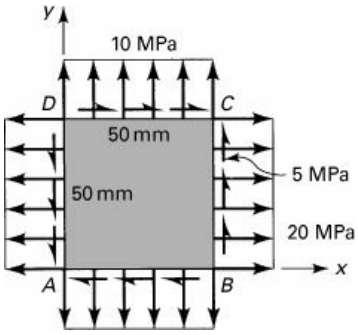

Figure 4: A square plate

$$\varepsilon_x = \frac{1}{E}\left[\sigma_x - \nu\left(\sigma_y + \sigma_z\right)\right] \tag{2a}$$

$$\varepsilon_y = \frac{1}{E}\left[\sigma_y - \nu\left(\sigma_x + \sigma_z\right)\right] \tag{2b}$$

$$\varepsilon_z = \frac{1}{E}\left[\sigma_z - \nu\left(\sigma_x + \sigma_y\right)\right] \tag{2c}$$