Problems

6.1 Sketch the variations of the shape functions N_j and N_m, given by Eqs. (6.2.18), over the surface of the triangular element with nodes i, j, and m. Check that $N_i + N_j + N_m = 1$ anywhere on the element.

6.2 For a simple three-noded triangular element, show explicitly that differentiation of Eq. (6.2.47) indeed results in Eq. (6.2.48); that is, substitute the expression for [B] and the plane stress condition for [D] into Eq. (6.2.47), and then differentiate π_p with respect to each nodal degree of freedom in Eq. (6.2.47) to obtain Eq. (6.2.48).

6.3 Evaluate the stiffness matrix for the elements shown in Figure P6–3. The coordinates are in units of inches. Assume plane stress conditions. Let $E = 30 \times 10^6$ psi, $\nu = 0.25$, and thickness $t = 1$ in.

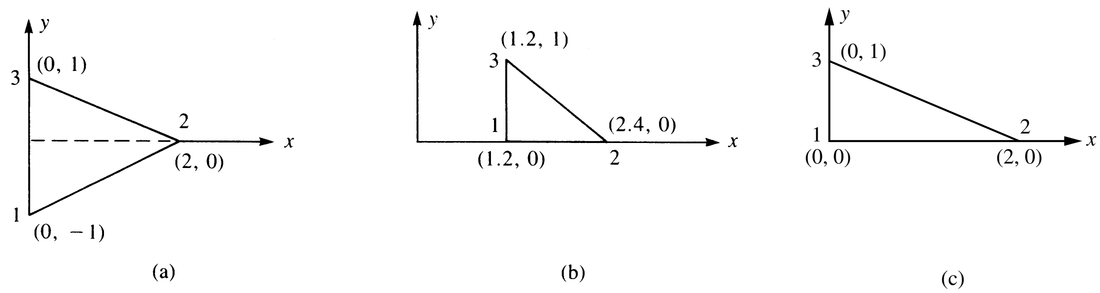

Figure P6–3

6.4 For the elements given in Problem 6.3, the nodal displacements are given as

$$u_1 = 0.0 \qquad v_1 = 0.0025 \text{ in.} \qquad u_2 = 0.0012 \text{ in.}$$
$$v_2 = 0.0 \qquad u_3 = 0.0 \qquad v_3 = 0.0025 \text{ in.}$$

Determine the element stresses $\sigma_x, \sigma_y, \tau_{xy}, \sigma_1$, and σ_2 and the principal angle θ_p. Use the values of E, ν, and t given in Problem 6.3.

6.5 Determine the von Mises stress for problem 6.4.

6.6 Evaluate the stiffness matrix for the elements shown in Figure P6–6. The coordinates are given in units of millimeters. Assume plane stress conditions. Let $E = 210$ GPa, $\nu = 0.25$, and $t = 10$ mm.

6.7 For the elements given in Problem 6.6, the nodal displacements are given as

$$u_1 = 2.0 \text{ mm} \qquad v_1 = 1.0 \text{ mm} \qquad u_2 = 0.5 \text{ mm}$$
$$v_2 = 0.0 \text{ mm} \qquad u_3 = 3.0 \text{ mm} \qquad v_3 = 1.0 \text{ mm}$$