1. A steel tube S is shrink-fitted over an aluminum tube A to form a composite shaft with diameters 3 in., 5 in., and 6 in. (see Figure 1). The allowable shear stresses in the steel and aluminum are τ_s = 9.0 ksi and τ_u = 4.0 ksi, respectively. Determine the allowable torque T_{allow} that may be applied to the shaft, assuming G_s = 11,600 ksi and G_a = 4000 ksi. (15%)

2. A box beam constructed of four wood boards of size 6 in. × 1 in. is shown in Figure 2. The boards are joined by screws for which the allowable load in shear is F = 210 lb per screw. Calculate the maximum permissible longitudinal spacing s_{max} of the screws if the shear force V is 1150 lb. (15%)

3. A steel plate with modulus of elasticity E = 30 × 10⁶ psi and Poisson's ratio ν = 0.3 is loaded in biaxial stress by normal stresses σ_x and σ_y (see Figure 3). A strain gage is bounded to the plate at an angle ϕ = 30°. If the stress σ_x is 18,000 psi and the strain measured by the gage is ε = 407 × 10⁻⁶, what is the maximum in-plane shear stress $(\tau_{max})_{xy}$ and shear strain $(\gamma_{max})_{xy}$? What is the maximum shear strain $(\gamma_{max})_{xz}$ in the xz plane? What is the maximum shear strain $(\gamma_{max})_{yz}$ in the yz plane? (20%)
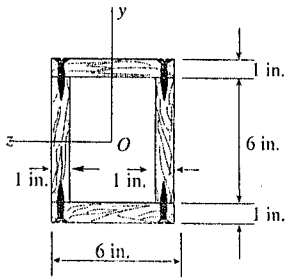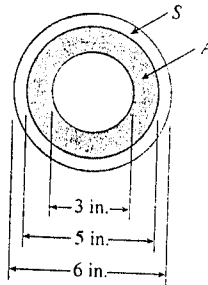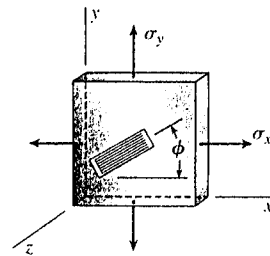
Figure 1

Figure 2

Figure 3

4. A 450-lb load hangs from the corner C of a rigid piece of pipe $ABCD$ which has been bent as shown. The pipe is supported by the ball-and-socket joints A and D, which are fastened, respectively, to the floor and to a vertical wall, and by a cable attached at the midpoint E of the portion BC of the pipe and at a point G on the wall. Determine (a) where G should be located if the tension in the cable is to be minimum, (b) the corresponding minimum value of the tension.　(20％)
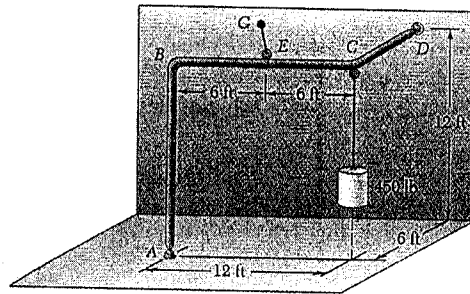
5. The 3×4-m side AB of a tank is hinged at its bottom A and is held in place by a thin rod BC. The maximum tensile force the rod can withstand without breaking is 200 kN, and the design specifications require the force in the rod not to exceed 20 percent of this value. If the tank is slowly filled with water, determine the maximum allowable depth of water d in the tank.　(15％)
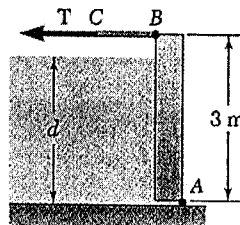
6. The cable AE supports three vertical loads from the points indicated. If point C is 5 ft below the left support, determine (a) the elevation of points B and D, (b) the maximum slope and the maximum tension in the cable.　(15％)