1. A solid circular bar of diameter d = 2.0 in. (see figure 1) is twisted in a testing machine until the applied torque reaches the value T = 11,000 lb-in. At this value of torque, a strain gage oriented at 45° to the axis of the bar gives a reading $\epsilon = 305 \times 10^{-6}$. Determine the shear modulus G of the material. (20%)

2. A box beam constructed of four wood boards of size 6 in. X 1 in. (actual dimensions) is shown in the 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. (20%)

3. A cantilever beam of rectangular cross section is subjected to a concentrated load P = 15 k acting at the free end (see figure 3). The beam has width b = 4 in. and height h = 10 in. Point A is located at distance c = 2 ft from the free end and distance d = 3 in. from the bottom of the beam. Calculate the principal stresses σ_1 and σ_2 and the maximum shear stress τ_{max} at point A. Show these stresses on sketches of properly oriented elements. (20%)

4. The figure 4 shows a propped cantilever beam ABC having span length L and an overhang of length a. A concentrated load P acts at the end of the overhang. Determine the reactions R_A, R_B, and M_A for this beam. Also, draw the shear-force and bending-moment diagrams, labeling all critical ordinates. (20%)

5. A horizontal beam AB is supported by a pinned-end column CD, as shown in the figure 5. The column is a solid steel bar (E = 200 GPa) of square cross section having length L = 1.8 m and side dimensions b = 50mm. Based upon load Q if the factor of safety with respect to bucking is n = 2.0. (20%)

Figure 1

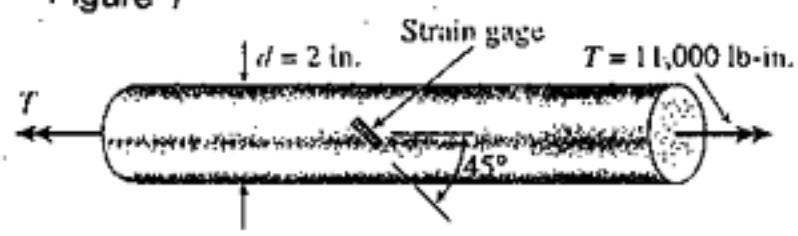


Figure 3

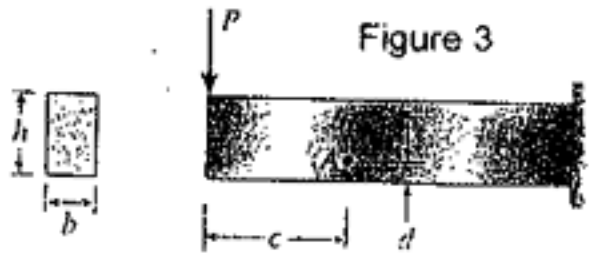


Figure 2

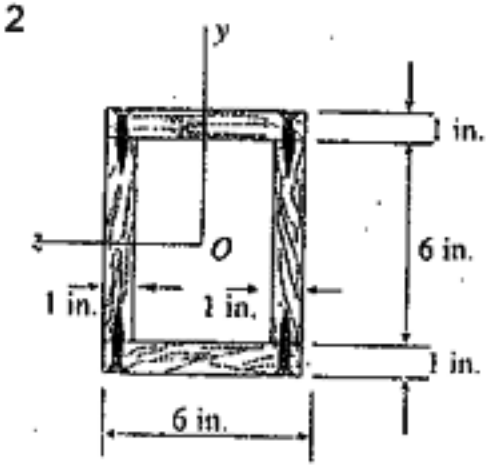


Figure 4

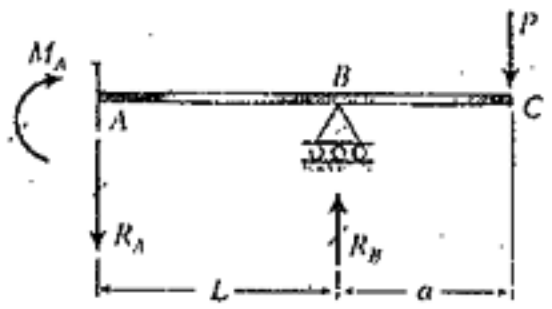
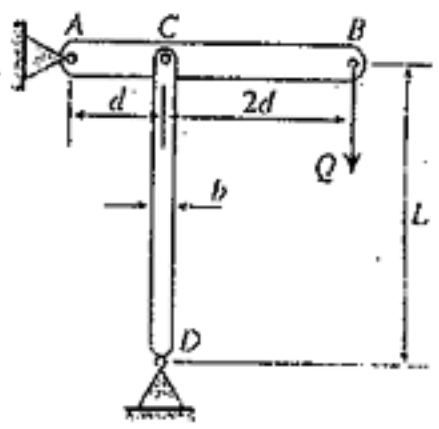


Figure 5



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