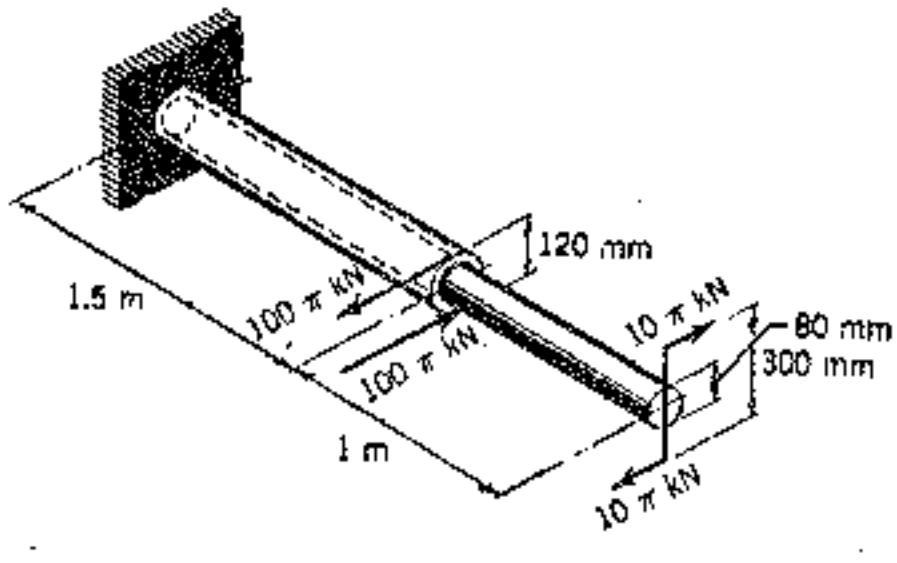
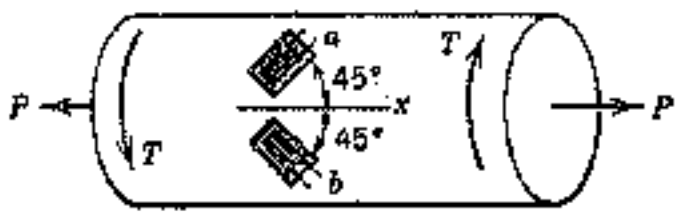
1. A stainless-steel (G = 86 GPa) shaft 2.5 m long extends through and is attached to a hollow brass (G = 39 GPa) shaft 1.5 m long, as shown in the figure. Both shafts are fixed at the wall. When the two couples shown are applied to the shaft, determine
   (a) the maximum shearing stress in the steel.
   (b) the maximum shearing stress in the brass.
   (c) the rotation of the right end of the shaft. (20%)

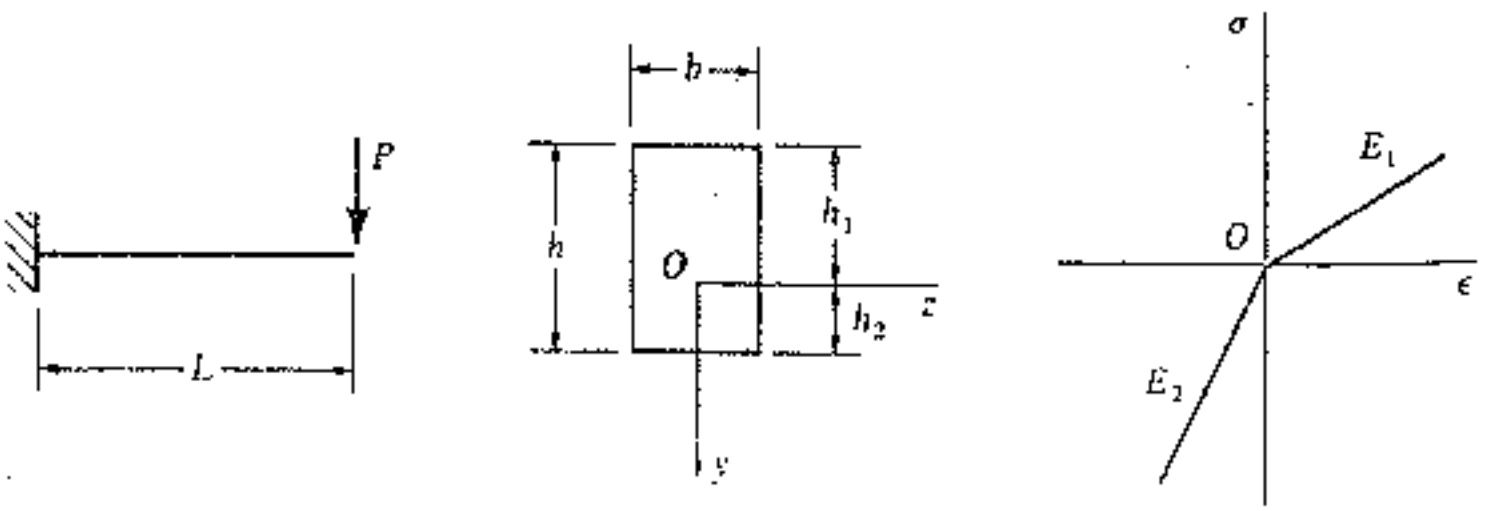


2. A 50-mm-diameter steel (E = 200 GPa and ν = 0.30) bar is subjected to a tensile load P and a torque T as shown in the figure. Determine the axial load P and the torque T if the strains indicated by gages ***a*** and ***b*** on the bar are $\varepsilon_a = 1414\ \mu$ and $\varepsilon_b = -212\ \mu$. (15%)

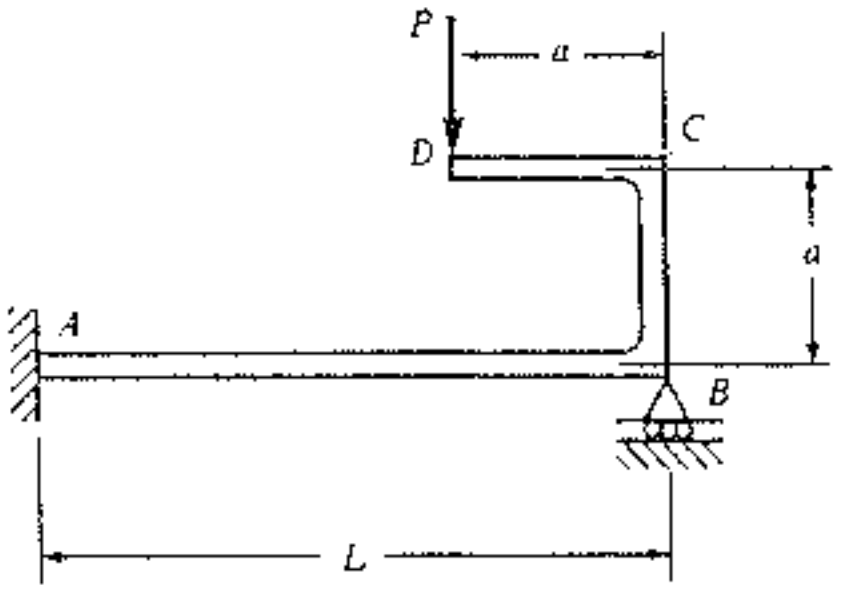


3. A thick-walled cylindrical pressure vessel will be used to store gas under a pressure of 100 MPa. During initial pressurization of the vessel, axial and hoop components of strain were measured on the inside and outside surface. On the inside surface the axial strain was 500 μ m/m and the hoop strain was 750 μ m/m. On the outside surface the axial strain was 500 μ m/m and the hoop strain was 100 μ m/m. Determine the axial and hoop components of stress associated with these strains if $E = 200$ GPa and $\nu = 0.30$, where E and ν are Young's modulus and Posson's ratio of the pressure vessel material, respectively.
(15%)

4. A cantilever beam of rectangular cross section and length L supports a concentrated load P at its free end as shown. The material of the beam has modulus of elasticity E_1 in tension and E_2 in compression. Numerical values are as follows: $L = 1.2$ m, $P = 5$kN, $b = 40$ mm, $h = 100$ mm, $E_1 = 100$ GPa, and $E_2 = 200$ GPa.
   (a) Determine the distances h_1 and h_2 from the neutral axis to the tension and compression surface, respectively.
   (b) Calculate the maximum tensile stress σ_t and maximum compressive stress σ_c due to bending. (15%)



5. The beam AB with an attached bracket BCD is supported and loaded as shown in the figure. The flexural rigidity EI is the same for all parts of the structure. Determine
   (a) the vertical and horizontal deflections at point D
   (b) the slope at point D
   (c) the maximum deflection on the beam AB. (20%)



6. An aluminum column of length L and rectangular cross section has a fixed end B and supports a centric load at A. Two smooth and rounded fixed plates restrain end A from moving in one of the vertical planes of symmetry of the column, but allow it to move in the other plane.
   (a) Determine the ratio a/b of the two sides of the cross section corresponding to the most efficient design against buckling.
   (b) Design the most efficient cross section for the column, knowing that L = 0.5 m, E = 70 GPa, P = 50 kN. (15%)