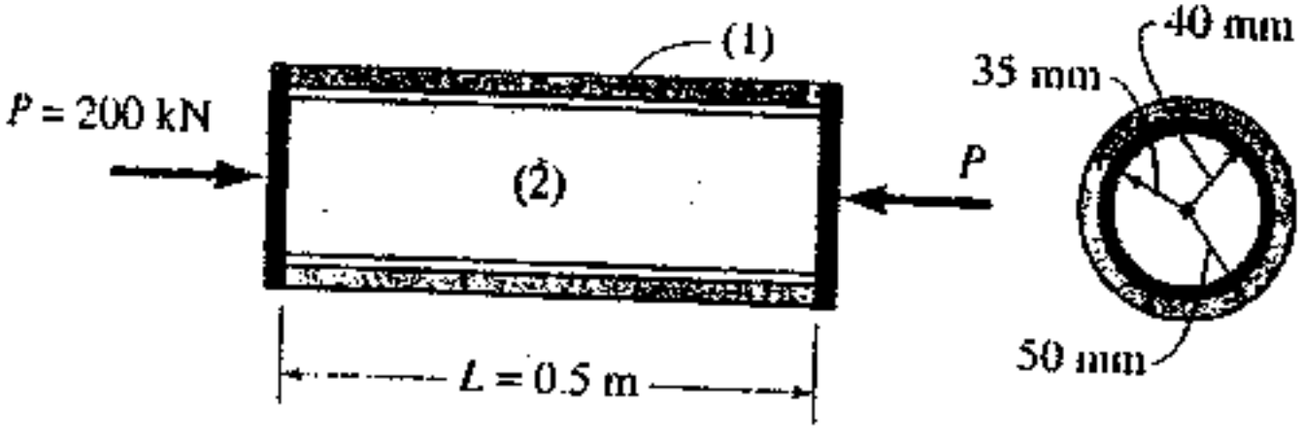
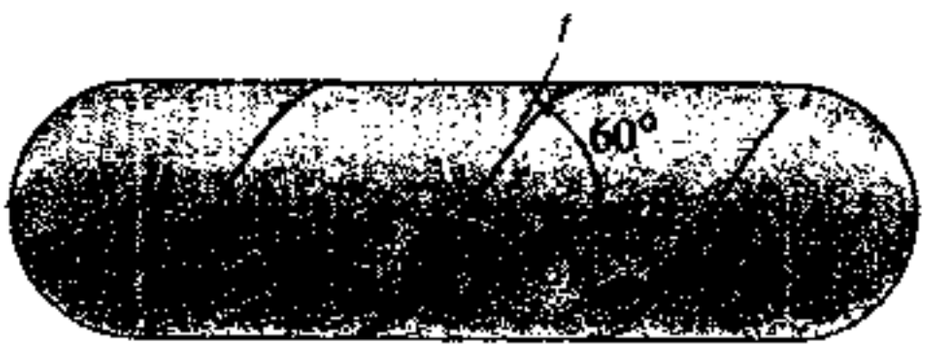
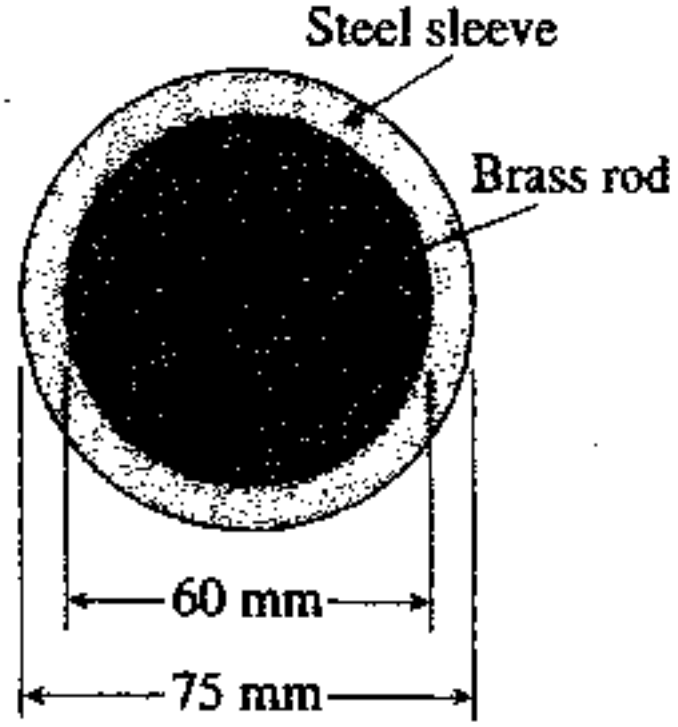
1. A hollow steel member (E_1 = 200 GPa) surrounds a solid aluminum core (E_2 = 70 GPa), and together they are subjected to a compressive force of 200 kN acting on rigid end caps. Determine the shortening of this compression member. (15%)



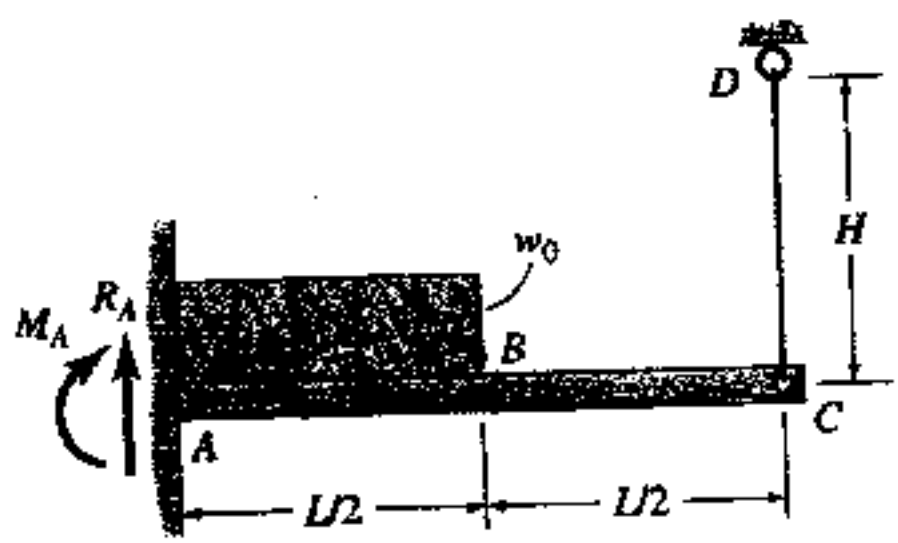
2. A cylindrical pressure vessel, 2m in diameter, is fabricated by shaping two 10mm-thick steel plates (E = 200 GPa) and butt-welding the plates along helical arcs. The maximum internal pressure in the pressure vessel is 1000 kPa. For this pressure level, calculate (1) the axial stress and the hoop stress; (2) the normal stress perpendicular to the weld line, and the shear stress tangent to the weld line. (20%)



3. A composite shaft is formed of two materials, an outer sleeve of steel (G_s= 80 GPa) and an inner rod of brass (G_b = 36 GPa), as shown. The outer diameters of the two parts are 75 mm and 60 mm. Assuming that the allowable shear stresses are τ_s = 65 MPa and τ_b= 25 MPa in the steel and brass, respectively, determine the maximum permissible torque T_{allow} that may be applied to the shaft. (15%)



4. The cantilever beam *AC* has additional support from cable *CD*. The beam supports a uniform load of intensity w_o over half of its length, as shown. Before the load is applied, the cable is taut, but force-free. Determine (a) the tension force in cable, and (b) the deflection and slope of the beam at point *C*. Assume the flexural rigidity of the beam is *EI*, the axial rigidity of the cable is *EA*. (20%)



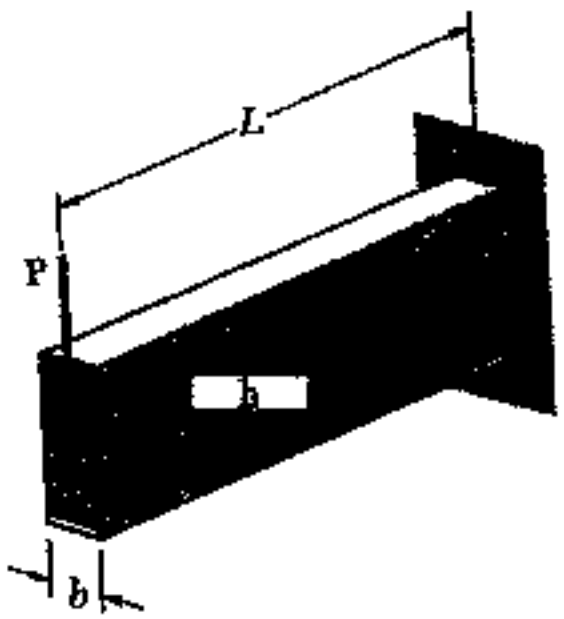
5. Answer the following questions. (30%, 6% each)

(a) Sketch the shape of breakage for a circular bar of brittle material under tensile and torsion tests.

(b) Explain "statically indeterminate problem".

(c) Define the Poisson's ratio and describe its upper and lower bounds for an isotropic engineering material.

(d) Describe the shearing stress distribution in a transverse section for the following rectangular beam of width b and depth h subjected to a load **P** at its free end.



(e) Explain how you can find the buckling load of the following columns from the buckling load of a pinned-pinned column $\pi^2 EI / L^2$.