

1. (10%) A slender rod of length $L=100$ in is fixed at the left end but can expand freely under a temperature change (Fig.1). Find the change in length of the rod (a) if a uniform temperature change $\Delta T=100^\circ\text{F}$ occurs and (b) if a linearly varying temperature change $\Delta T=(100x/L)^\circ\text{F}$ occurs. In each case, use the coefficient of thermal expansion $\alpha=6 \times 10^{-6}$ in/in/ $^\circ\text{F}$.

2. (15%) The shaft shown in Fig.2 is subjected to the twisting moments T_1 (50 N·m) and T_2 (-250 N·m). Determine the shear stresses at the inside and the outside of the hollow shaft BC and at the outside of solid shaft AB.

3. (15%) If each bar shown in Fig.3 has a cross-sectional area of 25 cm^2 , what load P will stress all the bars equally? Assume all bars in the elastic range, $E_{st}=210 \times 10^3 \text{ MPa}$, and $E_{br}=105 \times 10^3 \text{ MPa}$.

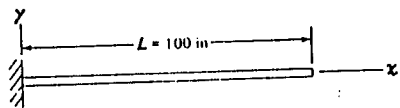


Fig.1

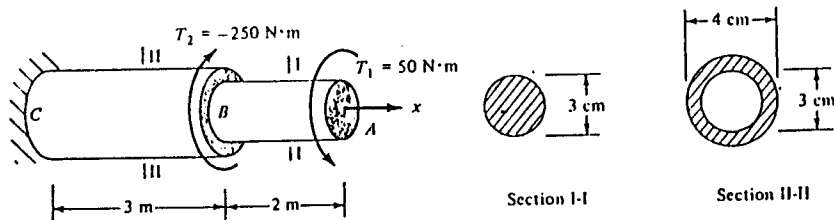


Fig.2

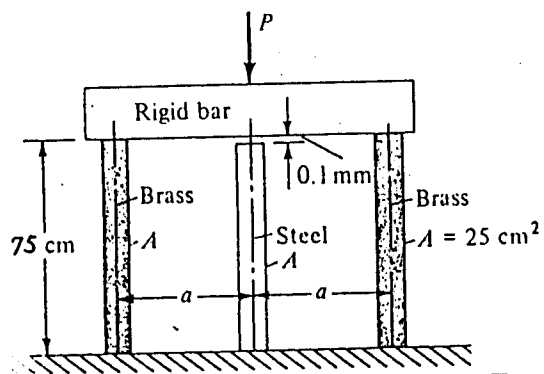


Fig.3

4. (20%) Consider the cantilever beam shown in Fig.4. Determine the shear and moment diagrams as well as the deflected shape of the beam.

5. (20%) A cylindrical pressure vessel, 20 ft long and 4 ft in diameter, with wall thickness $t = \frac{1}{8}$ in, is simply supported at each end as shown in Fig.5. The vessel and its contents weigh 900 lb per foot of length, and the contents exert a uniform internal pressure of 30 lb/in² on the vessel. Determine the biaxial stresses on elements A and B of the vessel wall, located as shown on Fig.5.

6. (20%) Consider the two-bar truss shown in Fig.6, determine the horizontal and vertical deflections (h and v) of point C by two methods: (1) Castigliano's first theorem, and (2) Castigliano's second theorem.

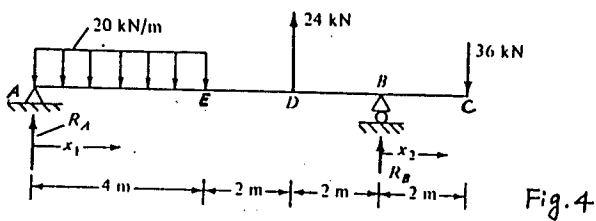
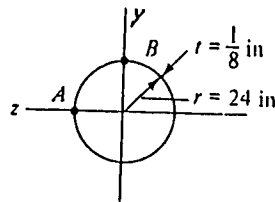
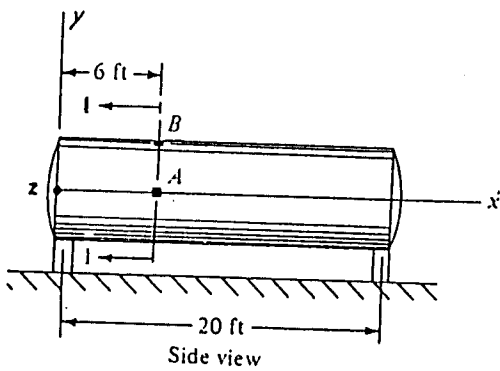


Fig.4



Section I-I

Fig.5

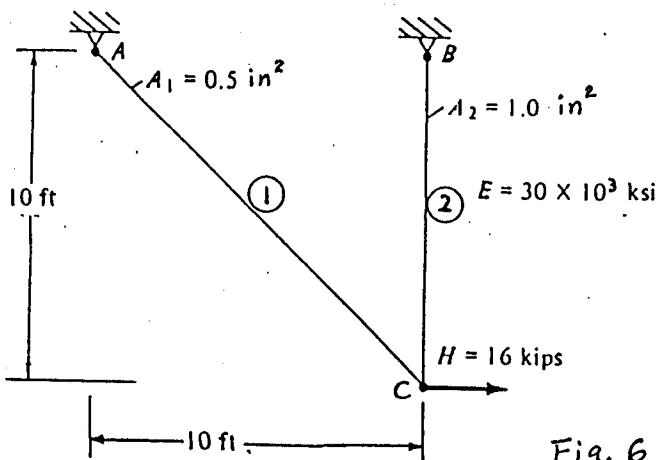


Fig.6