1. (20%)

(a) Describe briefly the methods for analyzing statically indeterminate beams.

(b) The propped cantilever beam shown in Figure 1 is subjected to a couple M_o and a concentrated load $P_o = M_o/L$. Determine the reactions for this beam.

(c) At what distance a_1 from the fixed support should the couple act in order that the deflection curve at end B will be horizontal?

(d) At what distance a_2 from the fixed support should the couple act in order that no moment reaction develops at support A?

(e) At what distance a_3 from the fixed support should the couple act in order that no reaction develops at support B?

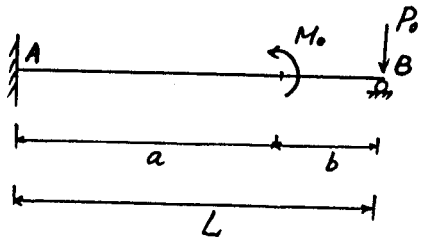
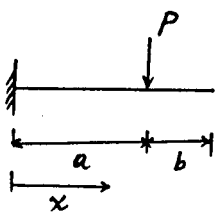


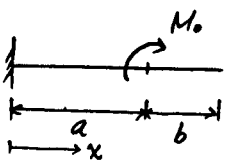
Figure 1

Hint :



$$v = \frac{Px^2}{6EI}(3a-x) \quad , \quad v' = \frac{Px}{2EI}(2a-x) \quad , \quad 0 \le x \le a$$

$$v = \frac{Pa^2}{6EI}(3x-a) \quad , \quad v' = \frac{Pa^2}{2EI} \quad , \quad a \le x \le L$$



$$v = \frac{M_o x^2}{2EI} \quad , \quad v' = \frac{M_o x}{EI} \quad , \quad 0 \le x \le a$$

$$v = \frac{M_o a}{2EI}(2x-a) \quad , \quad v' = \frac{M_o a}{EI} \quad , \quad a \le x \le L$$

2. (20%)

(a) For a prismatic beam of rectangular cross section, briefly derive a formula for the shear stress at a cross section with a shear force V. State all your assumptions.

(b) Determine the maximum bending stress and maximum shear stress for a simply-supported prismatic beam of rectangular cross section (width $b = 6in$, height $h = 10in$, length $\ell = 10ft$) carrying a concentrated load $P = 1000lb$ at mid-span. The beam itself weighs $50lb/ft$.

3. (20%)

(a) What is shear center?

(b) Determine the shear center of a slit circular tube of constant thickness as shown below (Figure 2).

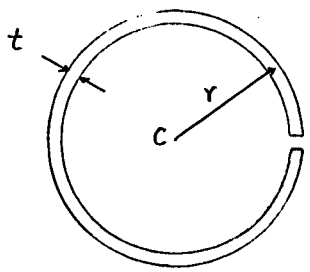


Figure 2

4. (20%)

(a) Briefly explain strain energy. Also derive a formula for the strain energy of a structure with stress-strain relation $\sigma = E\epsilon^{\alpha}$ where E is a constant, and $0 < \alpha \leq 1$.

(b) Consider a cantilever beam with uniform loading shown in Figure 3. Let A and I be the cross section area and moment inertia. Determine the reaction force at the left-end support when $\alpha = 1/2$ for the above stress-strain relation.

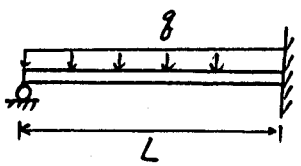


Figure 3

5. (20%)

(a) Figure 4 shows the relationship between axial compressive stress versus effective slenderness ratio for column of a material with Young's modulus $E = 10 \times 10^3 ksi$. The solid line in the figure is based on the Euler's formula $\frac{P_{cr}}{A} = \frac{\pi E^2}{(L_e/r)^2}$, while the discrete data are obtained from experiments. Explain the reasons which result in such discrepancy between the two curves.

(b) Find the buckling load for the column shown below (Figure 5).

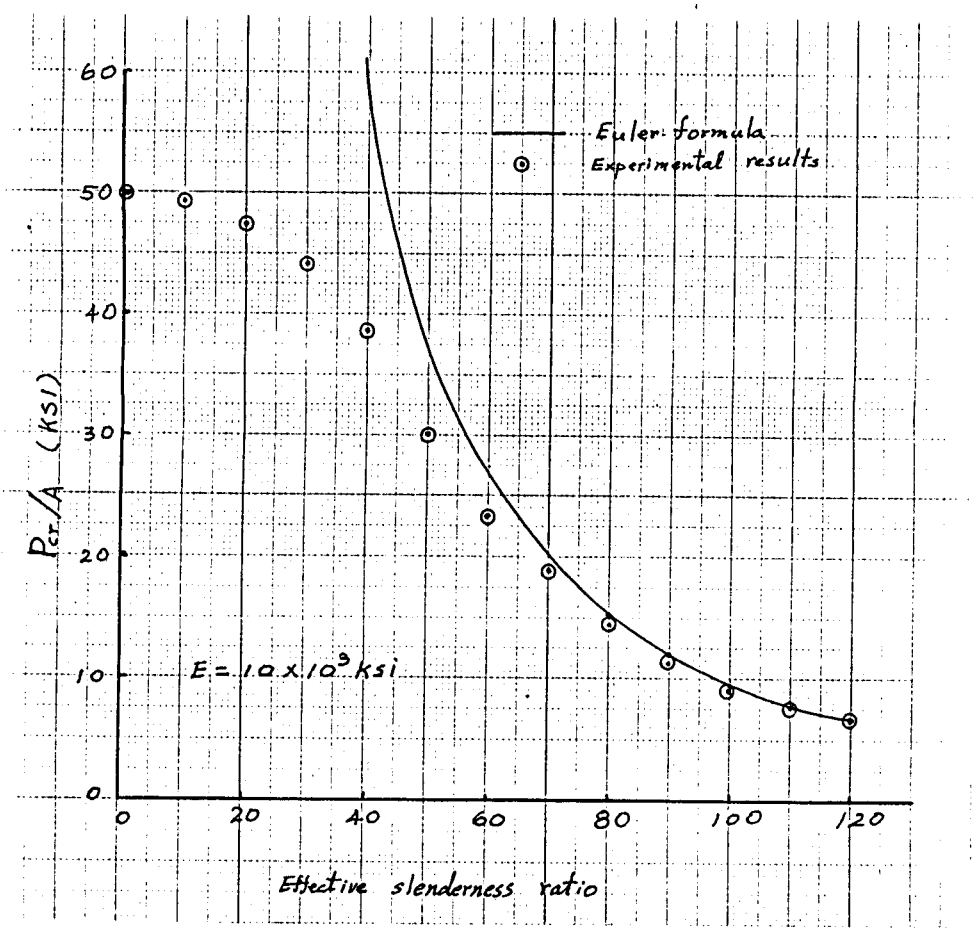


Figure 4

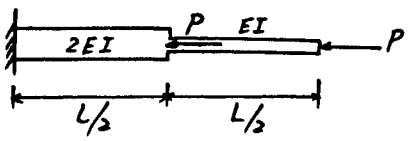


Figure 5