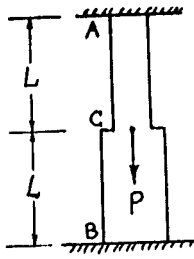
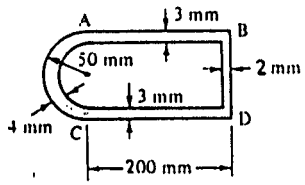
(15%) 1. The bar shown in the figure has cross-sectional area A_0 from A to C and $2A_0$ from C to B. The bar is subjected to its own weight and a load P at point C. The weight per unit volume is γ, and the modulus of elasticity is E. The total weight of the bar is $3\gamma A_1 L = P$. Determine (i) the reactions at supports A and B; (ii) the deflection at point C.



(10%) 2. Calculate the maximum shear stress τ_{max} and the angle of twist ϕ for a steel tube ($G = 76$ GPa) having the cross section shown in the figure. The tube has length $L = 1.5$m and is subjected to a torque $T = 15$ kN·m.

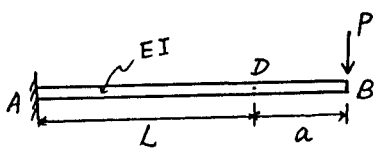


Given:

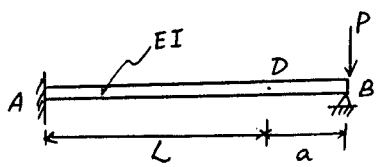
For a thin-walled tube: shear flow $f = \tau t = \frac{T}{2A_m}$, $\phi = \frac{TL}{GJ}$, $J = 4A_m^2 \left[\int_0^{L_m} \frac{ds}{t}\right]^{-1}$ where f is shear flow, L_m is the length of the median line, and A_m is the area enclosed by the median line of the cross section.

(25%) 3. Determine the deflection at point D for the following problems.

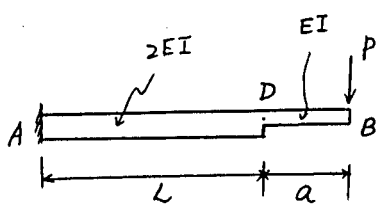
(a)



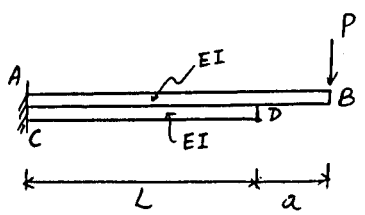
(b)



(c)



(d)



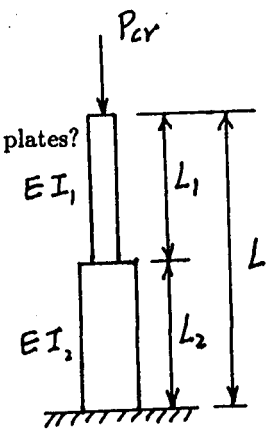
(**Hint:** The beams are in contact only at points C and D.)

4.

(5%) (a) What is "buckling"?

(5%) (b) Is there any difference in consideration between the buckling design of beams and plates? Why?

(15%) (c) Find the buckling load P_{cr} of the following step column by energy method.



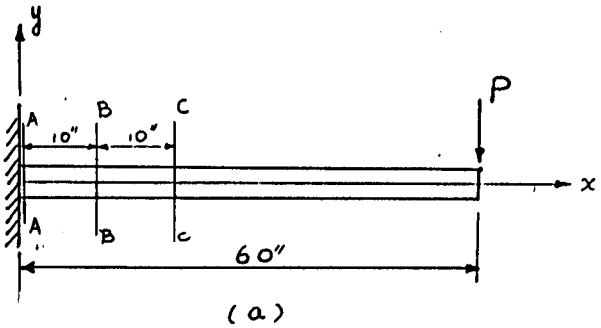
5.

(25%) A cantilever beam (Fig. a), having a length of 60 inches and a cross section of channel shape (Fig. b), is subjected to a concentrated vertical load P at its free end. The beam is made of a material whose stress-strain curve is shown in Figure c.

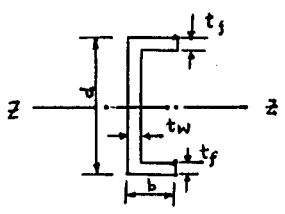
a. At which location the load P applied will result in pure bending about z-axis without twisting.

b. Determine the ultimate load P_u this beam can take.

c. Determine the stress (both normal and shear) distributions schematically at the sections A-A, B-B, and C-C as indicated in Fig. a under P_u.



(a)



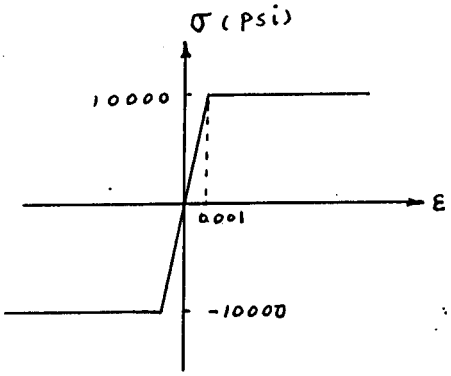
$t_f = 0.65$ in

$t_w = 0.4$ in

$d = 15$ in

$b = 3.4$ in

(b)



(c)