(25%) 1. A composite bar of length L is made of concentric, circular bars bonded together. The shear moduli of elasticity are G_c and G_t respectively for the core and the tube. Consider that the composite bar is acted upon by a total torque T.

(a) Find the polar moments of inertia J_c and J_t for the core and the tube.

(b) Find the angle of rotation ϕ of the bar.

(c) Find the maximum shear stresses in the core and the tube.

(d) Discuss the compatibility of stresses and strains at the common boundary of the two parts.
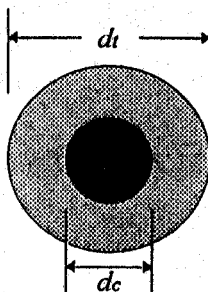
(25%) 2. Consider the beam structure as shown.

(a) Construct the shear-force and bending-moment diagrams for the beam.

(b) If the beam has a channel cross section as shown, find the maximum bending stress and shear stress in the beam. Assume that the loads go through shear center of the cross section

(c) Find the *shear center* of the channel section.
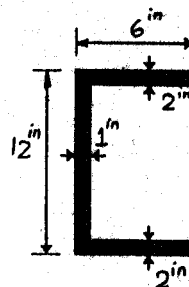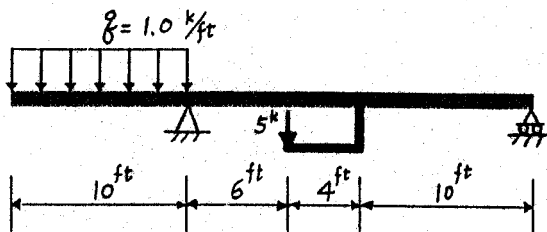
(25%) 3. Find deflection at load point of the following beams with uniform E and I.
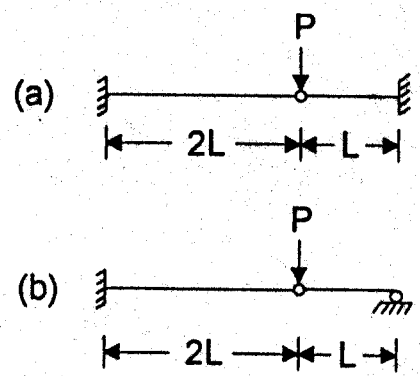
(25%) 4. (a) What is 'Reciprocal Theorems'?

(b) What restrictions embeded in the theorems?

(c) Prove the reciprocal-displacement theorem.