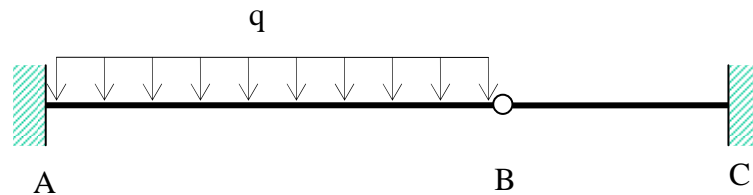


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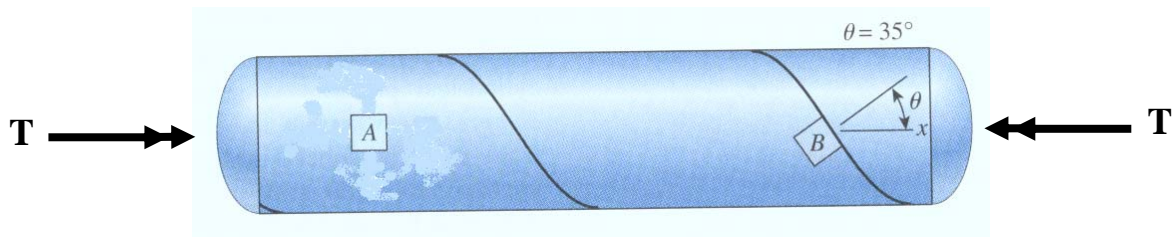
1. Two cantilever beams AB and CB are hinged together at B as shown. Before the uniform load is applied to AB the beams are perfectly aligned and straight.

- Determine the shear force  $R$  at the hinge if the intensity of the load is  $q = 400 \text{ lb/ft}$  and the lengths of beams AB and CB are  $L_{AB} = 16 \text{ ft}$  and  $L_{CB} = 8 \text{ ft}$ , respectively.
- What is the deflection of the beams at B if  $EI = 690 \times 10^6 \text{ lb-in.}^2$ ?
- Draw the shear-force and bending-moment diagrams for ABC and label all critical ordinates, including the maximum and minimum values.

Feel free to use the attached beam solutions. (40%)



2. A cylindrical pressure vessel is constructed from a long, narrow steel plate by wrapping the plate around a mandrel and then welding along the edges of the plate to make a helical joint as shown. The helical-weld orientation is indicated by the angle  $\theta = 35^\circ$ . The vessel has inner radius  $r = 400 \text{ mm}$  and wall thickness  $t = 12 \text{ mm}$ . It has an internal pressure  $p = 300 \text{ kPa}$ . In addition, the vessel is loaded by torques  $T = 100 \text{ kN.m}$



- Complete the stress element A by providing the stresses on the four sides of the element, including the magnitude and direction of each stress component. The direction/sign of your shear stress must be consistent with the applied torques.
- Complete the stress element B by providing the stresses on the four sides of the element, including the magnitude and direction of each stress component.
- Determine the principal directions  $\theta = \theta_{p_1}$  and  $\theta_{p_2}$  and principal stresses. (30%)

3. A bracket ABC lying in a horizontal xy-plane and supported at A is made of two identical solid steel bars AB and BC welded together at right angle. Each bar is 20 in. long and has a diameter  $d = 1.6$  in. A vertical steel rod CD is attached to the bracket as shown. The rod is 18 in. long and has a diameter  $d_{rod} = 0.3$  in. A vertical load  $P = 100$  lb is applied at D.
- (a) Calculate the strain energies  $U_{AB}$ ,  $U_{BC}$  and  $U_{CD}$  stored, respectively, in AB, BC and CD. For steel,  $E = 30 \times 10^6$  psi and  $G = 11 \times 10^6$  psi.
- (b) Determine the vertical deflection  $\Delta$  of point D. (30%)

