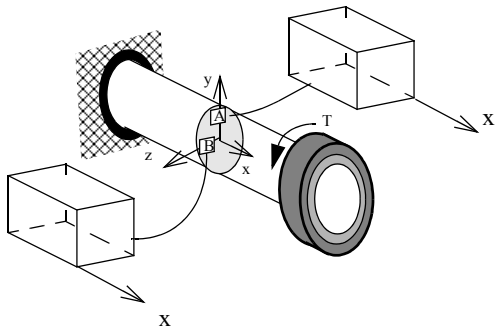
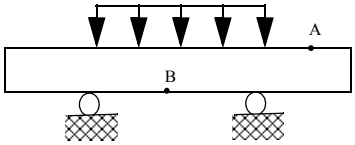
EXAM 2 MEEM 2150 March 29, 2012

1

(a) Show the direction of shear stress (**on all relevant surfaces**) at points A and B on the given stress cubes

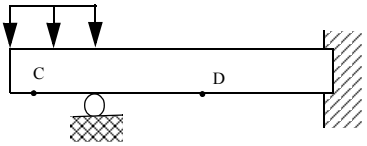


(b) By inspection determine whether the bending normal stress at the points shown is tension, compression or zero. Circle the correct answers.



σ_A= Tension / Compression / Zero

σ_B= Tension / Compression / Zero



σ_C= Tension / Compression / Zero

σ_D= Tension / Compression / Zero

In (c-h) **Circle** the correct answer

(c) Torsional shear *strain* varies linearly across the cross section for a *non-homogenous* material. True / False

(d) Torsional shear *stress* varies linearly across the cross section for a *homogenous* material. True / False

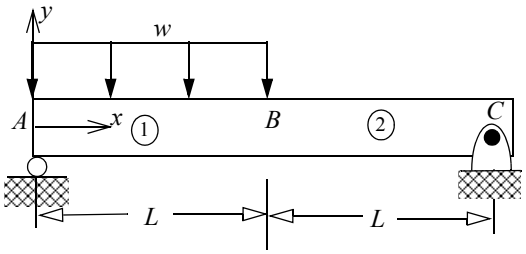
(e) Bending normal *strain* varies linearly across the cross section for a *non-homogenous* material. True / False

(f) Bending normal *stress* varies linearly across the cross section for a *homogenous* material. True / False

(g) The formula $\phi_2 - \phi_1 = \frac{\boldsymbol{T}(x_2 - x_1)}{GJ}$ can be used for finding relative rotation of a segment of a tapered shaft. True / False

(h) The formula $\sigma_{xx} = -\left(\frac{\boldsymbol{M}_z y}{I_{zz}}\right)$ can be used for finding normal stress on a cross-section of a tapered beam. True / False

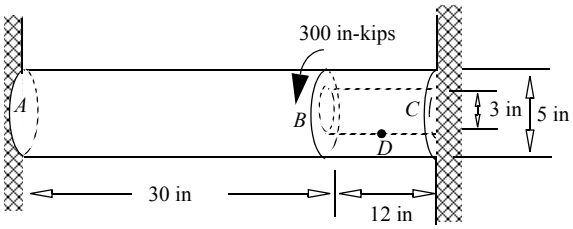
(i) Determine the internal *shear force* and the internal *bending moment* as a function of *w*,*L*, and *x* in the interval *AB*. Use the coordinate system shown.

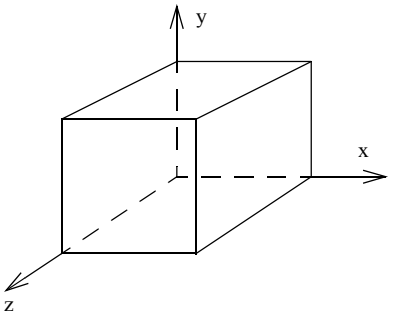


(j) For the beam shown above the internal moment in *BC* was found to be $\boldsymbol{M}_{BC} = wL(2L - x)/4$. Write the boundary value problem for finding deflection at any point. *Do not integrate or solve*

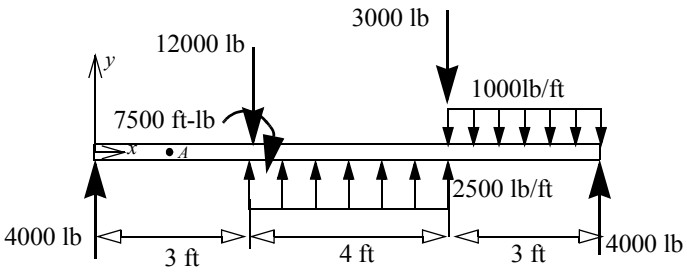
2 A solid steel shaft with a modulus of elasticity of 30, 000 ksi and shear modulus of 12,000 ksi is securely connected to a hollow steel shaft as shown. Determine: (a) the rotation of section at *B*. (b) the torsional shear stress at point *D* and

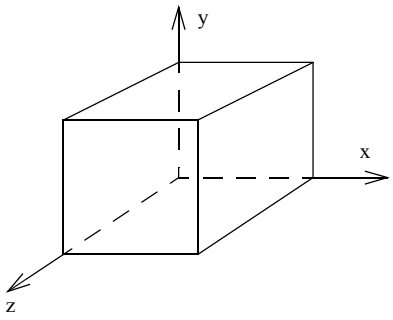
show it on the given stress cube. Point *D* is on the bottom of the inside surface of the shaft.

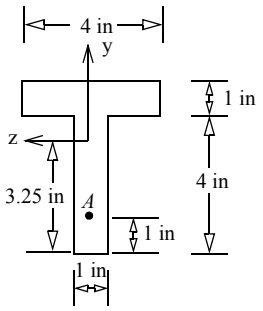




3 (a) Draw the shear force and bending moment diagram for the beam and loading shown. Clearly mark the numerical values and write the nature of the curve (convex, concave, linear). (b) Determine the bending normal stress $(\sigma_{xx})_A$ and shear stress $(\tau_{xy})_A$ at point *A* and show it on the stress cube. Point *A* is on a section that is 2 ft. from the left end.







ANSWERS

1. (b) σ_A Zero; σ_B Tension ; σ_C Compression; σ_D Compression; (c) T; (d) T; (e) T; (f) T; (g) F; (h) T

(i) $V_{AB} = wx - (3wL)/4$; $M_{AB} = \frac{3wLx}{4} - \frac{wx^2}{2}$

2. $\phi_B = 0.0038$ rads CCW ; $\tau_D = -5.772$ ksi

3. $(\sigma_{xx})_A = 11.89$ ksi (T); $(\tau_{xy})_A = -605.5$ psi