EXAM 2 MEEM 2150 April 1, 2004

To get FULL CREDIT you must draw free body diagram any time you use equilibrium equations to determine forces or moments.

1 In (a) and (b) circle the correct answer

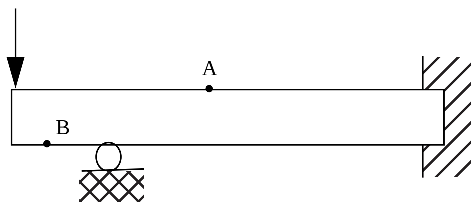
(a) The formula $\tau_{x\theta} = \frac{T\rho}{J}$ *can* be used for finding the shear stress on a cross-section of a tapered shaft.

True / False

(b) The formula $\phi_2 - \phi_1 = \frac{T(x_2 - x_1)}{GJ}$ *can* be used for finding the relative rotation of a segment of a tapered shaft.

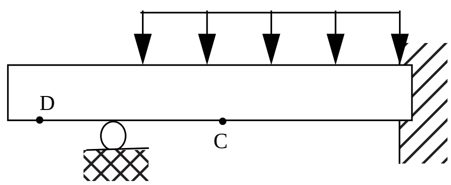
True / False

(c) 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

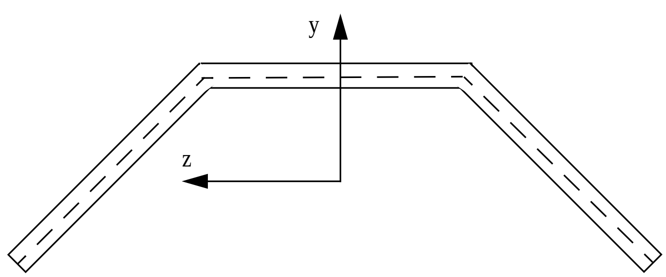
σ_B= Tension / Compression/ Zero



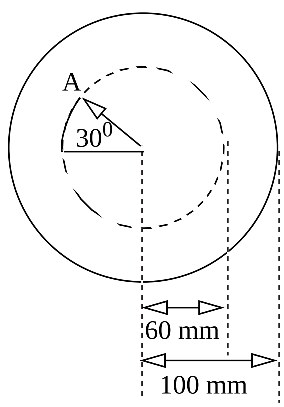
σ_C= Tension / Compression/ Zero

σ_D= Tension / Compression/ Zero

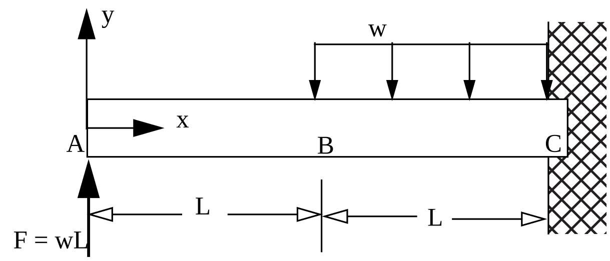
(d) Sketch the direction of the shear flow along the center-line on the thin cross-sections shown, assuming a positive shear force V_y



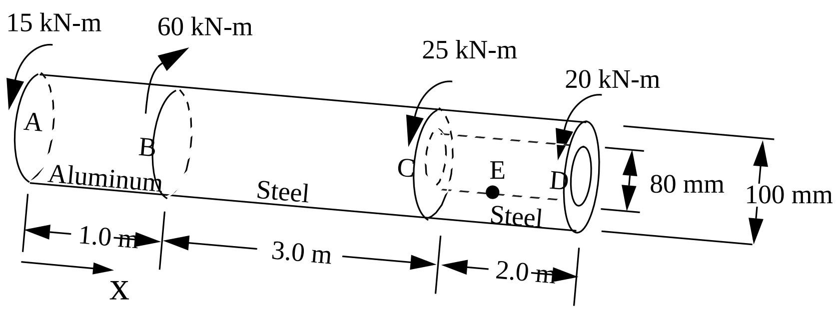
(e) The torsional shear stress at point A on a solid circular cross-section was found to be τ_A= 120 MPa. Determine the maximum shear stress on the cross-section.

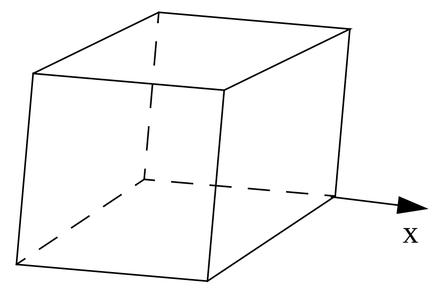


(f, g) Determine the internal shear force and bending moment as a function of w,L, and x in the interval BC. Use the coordinate system shown.

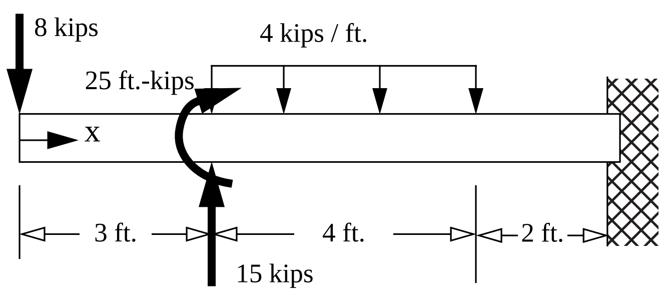


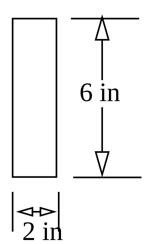
2 A circular steel (G_s = 80 GPa) shaft and an aluminum (G_{al} = 28 GPa) shaft are attached and loaded as shown. Determine: (a) the angle of rotation of section at D with respect to section at A. (b) The torsional shear stress at point E and show it on the stress cube given.



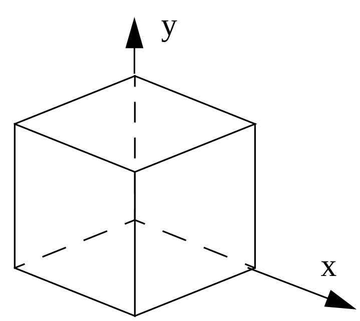


3 (a) Draw the shear force and bending moment diagram for the beam and loading shown. Clearly mark the numerical values and write the nature of the curve (convex, concave, linear). (b) Determine the bending normal stress $(\sigma_{xx})_A$ and shear stress $(\tau_{xy})_A$ at point A. Point A is on the cross-section 2 ft. from the left end and 1 inch from the top. Show your result on the stress cube given.





Beam Cross-section



ANSWERS

1. (a) True (b) False (c) σ_A= Tension; σ_B= Compression; σ_C= Tension ; σ_D= Zero (e) τ_{max} = 200 MPa

2. $\phi_D - \phi_A$ = 0.204 rads CCW τ_E = 138 MPa

3. $(V_y)_{max}$ = 9 kips $(M_z)_{max}$ = -24 ft-kips $(\sigma_{xx})_A$ = 10.7 ksi (T) $(\tau_{xy})_A$ = +0.555 ksi