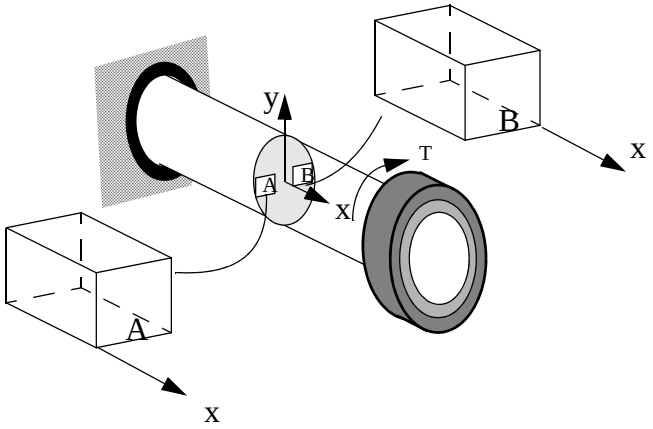
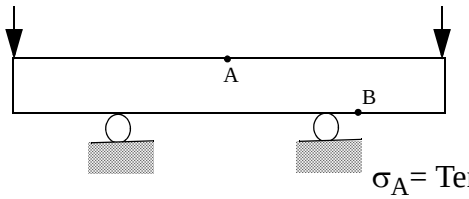
EXAM 2 MEEM 2150 April 9th, 2003

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

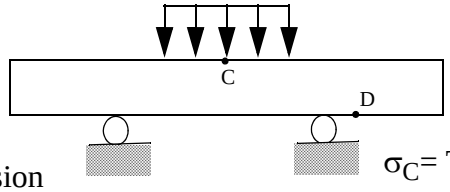


(b) By inspection determine whether the normal stress at the points shown is tension or compression. Circle the correct answers.



σ_A= Tension/Compression

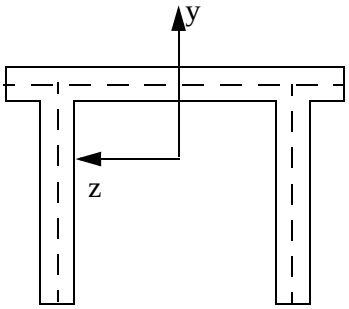
σ_B= Tension/Compression



σ_C= Tension/Compression

σ_D= Tension/Compression

(c) Sketch the direction of the shear flow along the center-line on the thin cross-sections shown, assuming a positive shear force $\boldsymbol{V_y}$



In (d) and (e) answer circle the correct answer

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

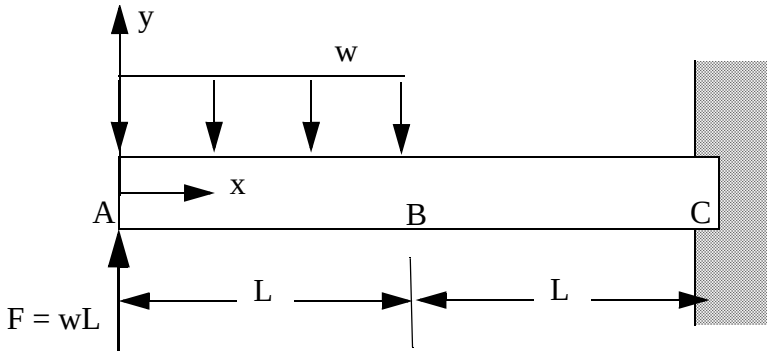
True / False

(e) 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

(f) and (g) Determine the shear force and bending moment as a function of w,L, and x in the interval AB. Use the

coordinate system shown.

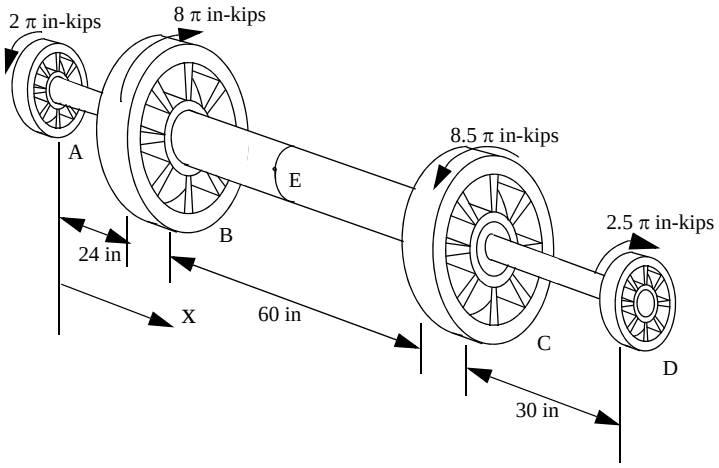


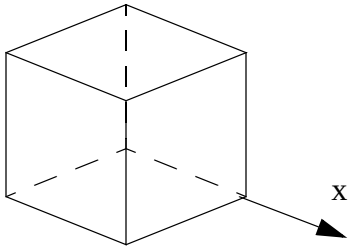
2. A solid circular steel (G_s = 12,000 ksi) shaft of variable diameter is acted upon by torques as shown. The diameter of the shaft between wheels A and B, and between wheels C and D is 2 inches, and the diameter of shaft between wheels B and C is 4 inches. Determine:

(a) the rotation of wheel D with respect to wheel A. $\phi_D - \phi_A$ = ————————

(b) the maximum shear stress in the shaft. τ_{max} = ————————

(c) the shear stress at point E and show it on a stress cube. τ_E = ————————





Point E

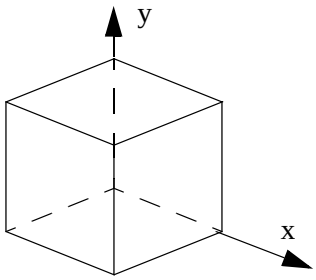
3 (a) Draw the shear force and bending moment diagram for the beam and loading shown. Clearly mark the numerical values and write the nature of the curve (convex, concave, linear).

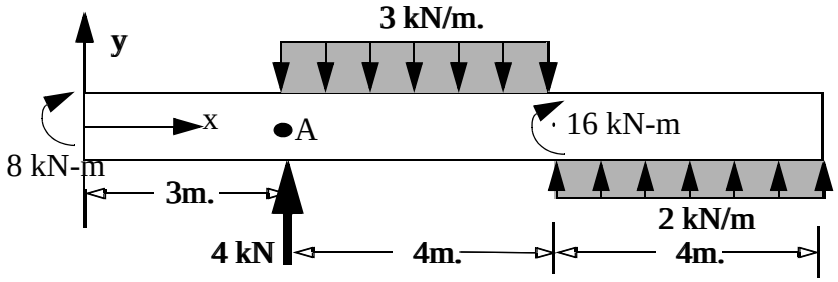
(b) the magnitude of maximum bending normal stress and shear stress.

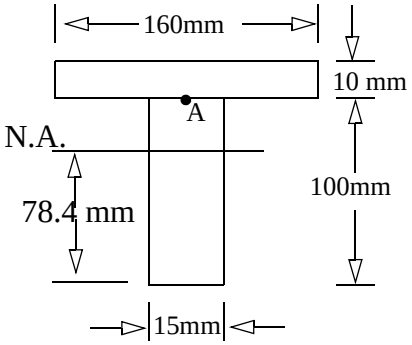
(c) the bending normal $(\sigma_{xx})_A$ and shear stress $(\tau_{xy})_A$ at point A. Point A is just below the flange on a cross-section *just right* of the 4kN force. Show your results on the stress cube.

$|\sigma_{max}|$ = ---------- $|\tau_{max}|$= ----------

$(\sigma_{xx})_A$ = ----------( ) $(\tau_{xy})_A$ = ----------







$I_{NA} = 3.6\ (10^6)\ mm^4$

Answers

1b σ_A= Tension σ_B= Compression σ_C=Compression σ_D=zero

1d True 1e False

1f, g $V_y = (wx - wL)$ $M_z = wLx - wx^2/2$

2. $\phi_D - \phi_A = 0.017 rads\ CW$ $\tau_{max} = 5 ksi$ $\tau_E = 1.5\ ksi$

3 $|\sigma_{max}| = 348$ MPa $|\tau_{max}| = 6.8$ MPa

$(\sigma_{xx})_A = 48$ MPa(C) $(\tau_{xy})_A = -3.15$ MPa