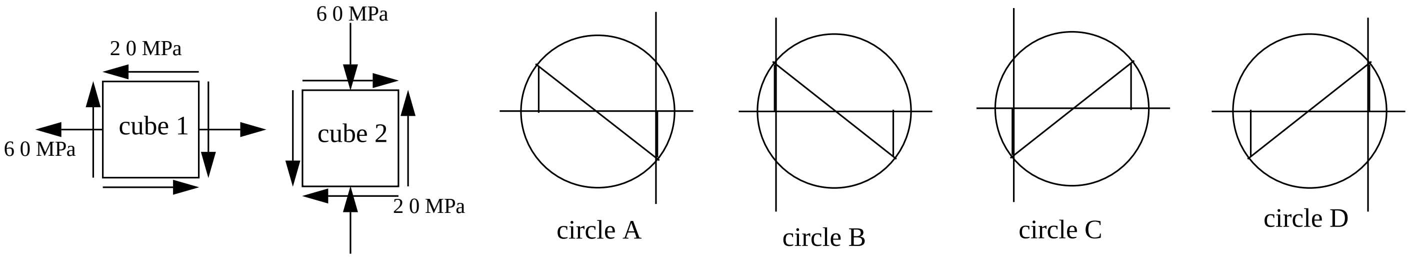
MEEM 2150 **FINAL EXAM** **NAME:__________________**

May 7th, 2003

1. (a) Associate the stress cubes with the appropriate Mohr's circle.



Cube	Circle
1	
2	

(b) Associate the beams below with ALL appropriate conditions necessary for solving for the beam deflection v(x). Same conditions may be applicable to both beams.

beam A beam B

(a) $v_1(0) = 0$ (b) $v_1(L) = 0$ (c) $v_2(L) = 0$ (d) $v_2(3L) = 0$

(e) $\frac{dv_1(0)}{dx} = 0$ (f) $\frac{dv_1(L)}{dx} = 0$ (g) $\frac{dv_2(L)}{dx} = 0$ (h) $\frac{dv_2(3L)}{dx} = 0$

(i) $v_1(2L) = v_2(2L)$ (j) $\frac{dv_1(L)}{dx} = \frac{dv_2(L)}{dx}$ (k) $\frac{dv_1(2L)}{dx} = \frac{dv_2(2L)}{dx}$ (l) $\frac{dv_1(3L)}{dx} = \frac{dv_2(3L)}{dx}$

Beam	Applicable conditions
A	
B	

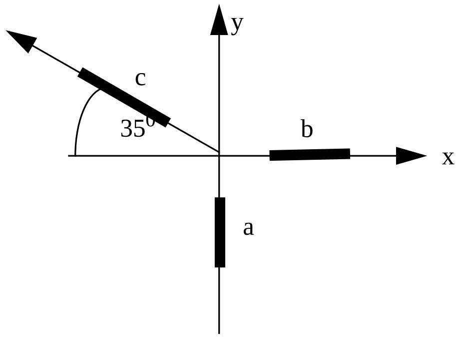
(c) At a point in plane stress of a material (E=25,000 ksi, ν= 0.25) the normal stresses were found to be σ_{xx} = 10 ksi(T) and σ_{yy} = 20 ksi(C). What is in normal strain ε_{xx} at the point.?

(d), (e) In a material (E=25,000 ksi, ν= 0.25) the two in-plane principal stresses were found to be σ_1 = 30 ksi(T) and σ_2 = 20 ksi(T). What is the maximum shear stress at that point for the two cases below.

(d) Plane stress τ_{max} = ------------------

(e) Plane strain τ_{max} = ------------------

(f) The strain at a point were found to be ε_{xx} = - 1000 μ, ε_{yy} = + 2000 μ, and γ_{xy} = + 2500 μ. Determine the strains recorded by the three strain gages.

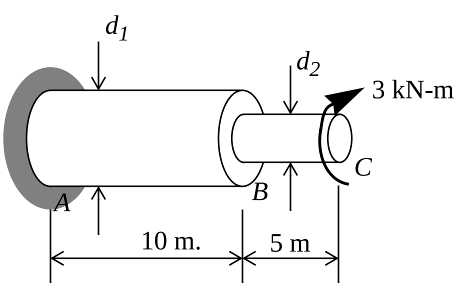


ε_a = -----------

ε_b = -----------

ε_c = -----------

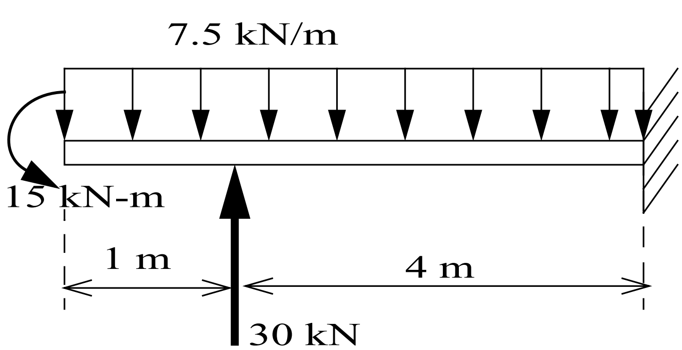
2. A stepped steel shaft AC (E = 210 GPa, G = 80 GPa) is attached to a rigid wall at A and subjected to a torsional load at C as shown in the figure. The diameters are $d_1 = 75$ mm and $d_2 = 50$ mm.
   (a) Determine the angle of twist of the section at C with respect to the section at A.
   (b) What are the principal strains and the maximum shear strain in segment BC?

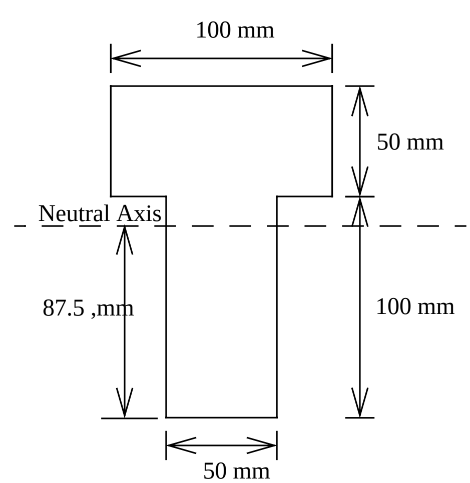


3. For the beam, loading and cross-section shown, find (a)the maximum bending normal stress in the beam and state where it occurs and b) the maximum bending shear stress and state where it occurs.The area moment of inertia about the neutral axis is $I_{NA} = 19.27(10^6)\ mm^4$

σ_{max} = ------------------------------ @ Location -----------------

τ_{max} = ------------------------------ @ Location -----------------

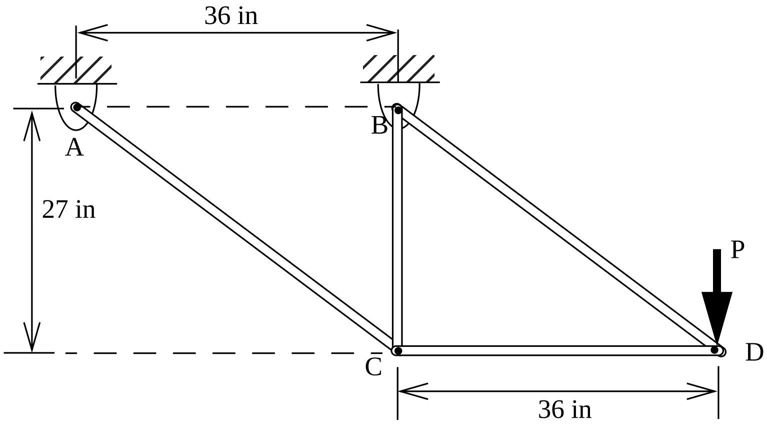


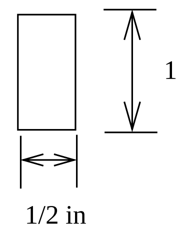


4. Determine the maximum load P, such that member AC does not buckle. Use modulus of elasticity of

29,000 ksi.

P_{max} = --------------------





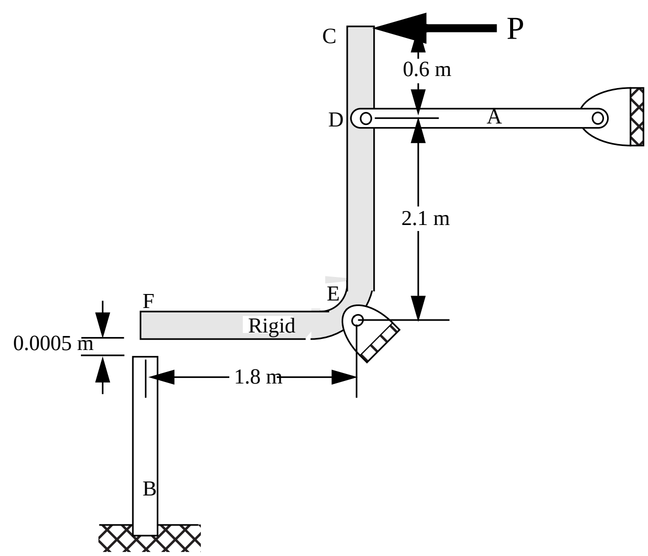
Cross-section of the bars

5. Steel (E = 200 GPa and ν = 0.3) bars A and B have lengths of L_A = 2.8 m and L_B = 2 m and area of cross-sections of A_A = 40 mm^2 and A_B = 60 mm^2. Before the force P is applied there exists a gap of 0.0005 m between the rigid bar and bar B as shown. Due to the action of force P it was observed that point C moved by 0.0045 m in the direction of P. Determine

(a) the applied force P, and
(b) the contraction of bar B.

P = --------------

δ_B = --------------



ANSWERS

1a. C and A 1b. Beam A: d, h, i,k; Beam B: b,c,j, d

1c. ε_{xx} = 600 μ. 1d. τ_{max} = 15 ksi 1e. τ_{max} = 8.75 ksi

1f. ε_a = 2000 μ. ε_b = - 1000 μ. ε_c = -1187.6 μ.

2. ϕ_c = 0.4263 rads CW ε_1 = 762.5 μ. ε_2 = -762.5 μ. γ_{max} = 1525 μ

3. σ_{max} = 85.14 MPa (C) @ Location x=1 and bottom of beam

τ_{max} = 4.49 MPa @ Location x=1 and neutral axis

4. P_{max} = 883 lb

5.P = 17.8 kN δ_B = 0.0025 m