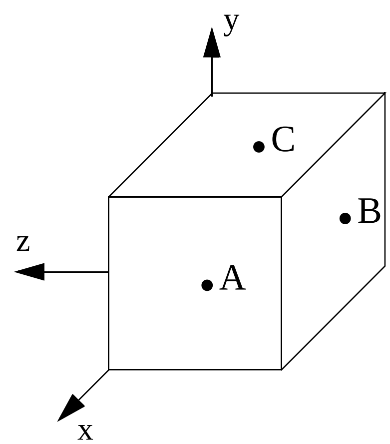
Final MEEM 2150 December 19th, 2007

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

1

(a) Show the non-zero stress components on the A,B, and C faces of the cube. Use the coordinate system that is given only.

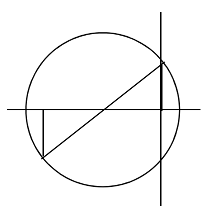
$$\begin{bmatrix} \sigma_{xx} = 80\text{MPa(T)} & \tau_{xy} = -30\text{MPa} & \tau_{xz} = 0 \\ \tau_{yx} = -30\text{MPa} & \sigma_{yy} = 0 & \tau_{yz} = 70\text{MPa} \\ \tau_{zx} = 0 & \tau_{zy} = 70\text{MPa} & \sigma_{zz} = 40\text{MPa(C)} \end{bmatrix}$$

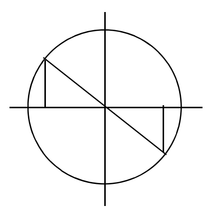


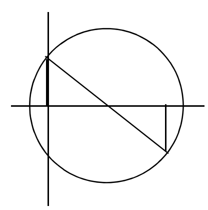
(b) Associate the stress states with the appropriate Mohr's circle for stress.

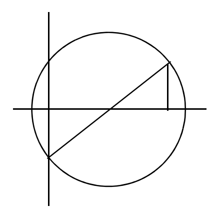
State 1	State 2
σ_{xx} = 30 ksi(C)	σ_{xx} = 60 ksi(T)
σ_{yy} = 30 ksi(T)	σ_{yy} = 0
τ_{xy} = 25 ksi	τ_{xy} = –25 ksi

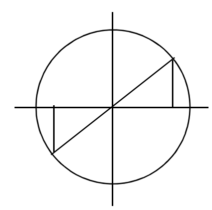
Stress State	Circle
1	
2	

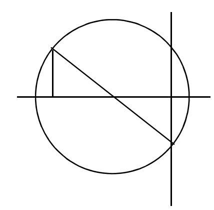

circle A


circle B

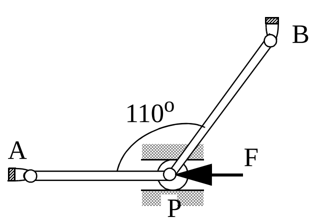

circle C


circle D

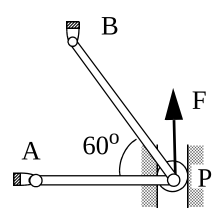

circle E


circle F

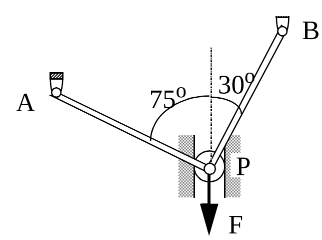
(c) Identify the members in the two bar structures that you would check for buckling. Circle the correct answers.



Structure 1



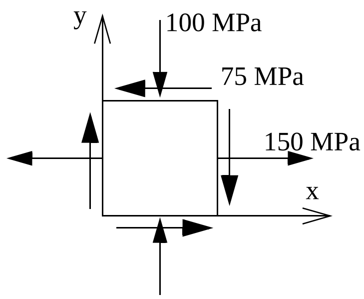
Structure 2



Structure 3

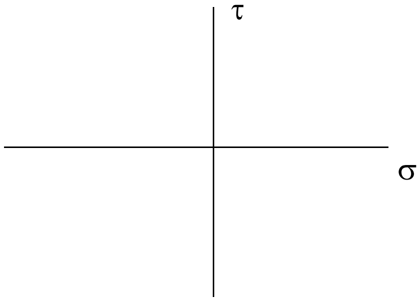
Structure 1	AP	BP	Both	None
Structure 2	AP	BP	Both	None
Structure 3	AP	BP	Both	None

(d) At a point on a free surface the stresses were found to be as shown below.The modulus of elasticity of the material is 200 GPa and the Poisson's ratio is 0.25. Determine the normal strain in the x -direction.



Normal strain in the x-direction=-----------------------

(e) Draw the Mohr's circle and determine principal stress one and two and the maximum shear stress for the state of stress shown in part (d).



Principal stress 1=--------------( )

Principal stress 2=--------------( )

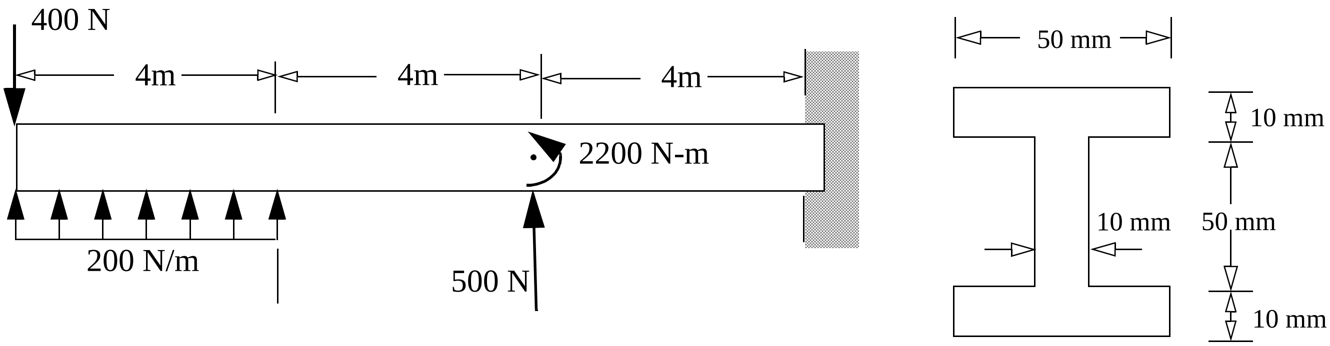
Maximum shear stress=----------------

2 Circle the correct answer

(i) Stress components are opposite in direction on the two surfaces of an imaginary cut.	True / False
(ii) Stress components have opposite signs on the two surfaces of an imaginary cut.	True / False
(iii) When angle increases from right angle we obtain positive shear strain.	True / False
(iv) In isotropic materials the stress and strain relationship is same in all directions.	True / False
(v) Planes of maximum shear stress are always 45^{o} to the principal planes.	True / False
(vi) Principal planes are always at 90^{o} to each other.	True / False
(vii) In plane strain there are two principal strains, but in plane stress there are three principal strains.	True / False
(viii) A column can be made to buckle by applying sufficient tensile axial force.	True / False
(ix) Increasing slenderness ratio increases the critical buckling load of a column.	True / False
(x) Buckling occurs about an axis that has the largest area moment of inertia of the cross section.	True / False

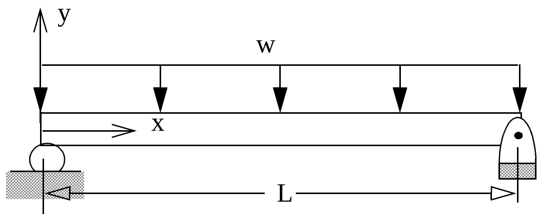
3 (a) Draw the shear force and bending moment diagram for the beam and loading shown. Clearly mark the numerical values and write the nature of the curve (convex, concave, linear).

(b) Determine the maximum bending normal σ_{xx} and maximum bending shear stress τ_{xy} in the beam.

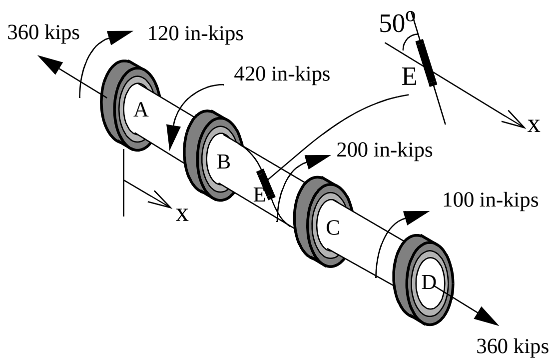


Beam cross-section

4 In terms of w, L, E, and I determine (a) the equation of the elastic curve. (b) the deflection of the beam at mid point. Use the coordinate system shown.



5 A 4 in diameter steel shaft is loaded as shown. The modulus of elasticity and Poisson's ratio of steel is 30,000 ksi and 0.28, respectively. Determine the strain recorded by the strain gage at E that is oriented as shown.



ANSWERS

(1b) 1-E; 2-D (1c) AP; BP; None (1d) 875 μ. (1e) 170.8 MPa(T); 120,2 MPa (C); 145.8 MPa

2. (i) True (ii) False (iii) False (iv)True (v) True (vi) True (vii) False (viii) False (ix) False (x) False

3. $(\sigma_{xx})_{max}$ = 103.7 MPa (C) or (T) $(\tau_{xy})_{max}$ = -1.61 MPa

4. $v_{mid} = -(5/384)(wL^4/EI)$

5. ε_E = -765.5 μ.