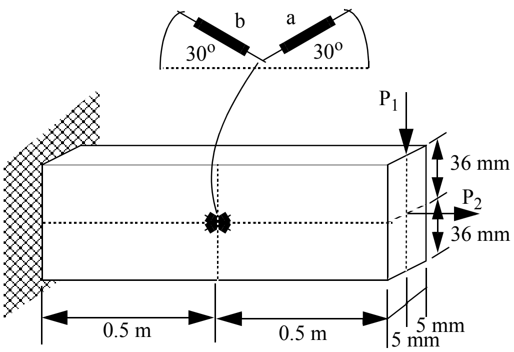
EXAM 1 MEEM 4150 Oct. 11th, 2000

1. The strain gages mounted on the middle surfaces of a cantilever beam recorded the following strain values: $\varepsilon_a = 1333\ \mu$ $\varepsilon_b = 1592\ \mu$. Determine the loads P_1 and P_2. The Modulus of Elasticity is 200 GPa and the Poisson's ratio is 0.3.



P_1= --------------------------- P_2= ---------------------------

2. The stress at a point is given by the stress matrix:

$$\begin{bmatrix} 50 & 0 & 0 \\ 0 & 20 & -20 \\ 0 & -20 & 40 \end{bmatrix} \text{ksi}$$

(a)Determine the three stress invariants.

I_1= --------------- I_2= --------------- I_3= ---------------

(b)Determine the orientation of principal direction associated with principal stress 7.64 ksi (T).

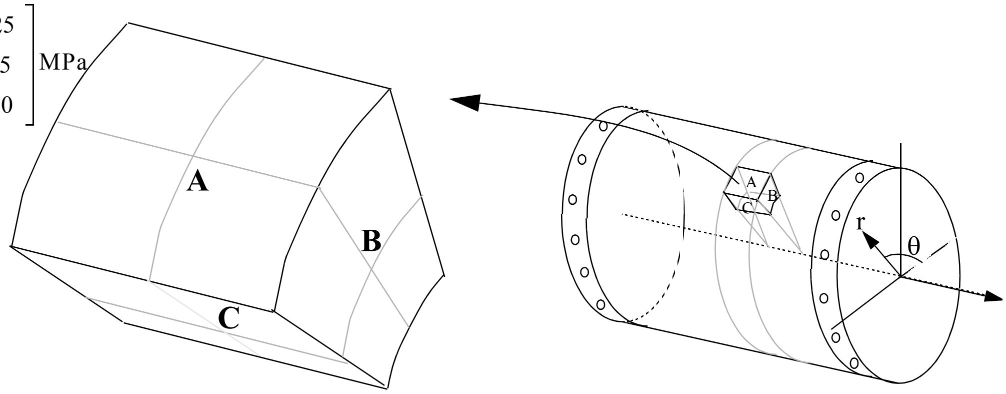
θ_x = -----------θ_y =-------------θ_z =--------------

(c) A crack was discovered on a plane that has an outward normal at angles of 65°, 55°, and 45.4° with the x, y and z axis respectively. The critical stress intensity factor for the material is $22\text{ksi}\sqrt{\text{in}}$, what would be the critical crack length on that plane.

$2a_{crit}$ = -----------------

3. (a)Show the stress components in the r, θ, and x cylindrical coordinate system on the A,B, and C faces of the stress element shown.

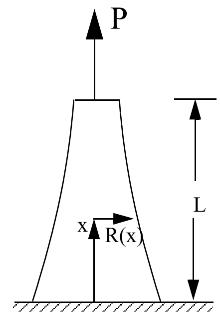
$$\begin{bmatrix} \sigma_{rr} = -145 & \tau_{r\theta} = 100 & \tau_{rx} = -125 \\ \tau_{\theta r} = 100 & \sigma_{\theta\theta} = 160 & \tau_{\theta x} = 165 \\ \tau_{xr} = -125 & \tau_{x\theta} = 165 & \sigma_{xx} = 150 \end{bmatrix} \text{MPa}$$



(b) A thin-walled cylindrical gas vessel has a mean radius of 3 feet and a wall thickness of 1/2 inch. The yield stress of the material is 30 ksi. Using Von-Mises failure criterion determine the maximum pressure of the gas inside the cylinder if yielding is to be avoided.

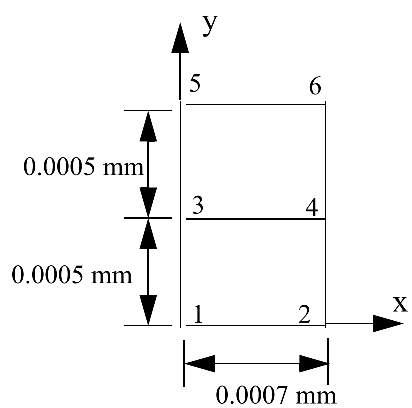
p_{max}= ----------------------------

(c) The radius of a tapered axial rod varies as $R = \sqrt{2L - x}$. Determine the extension of the rod due to the axial force P in terms of the variables P, L and E. Weight is not a consideration in this problem.



(d) The displacement u and v in the x and y direction, respectively, are given at six points as shown. Using finite difference approximation find the normal strains ε_{xx} and ε_{yy} at point 3. *Indicate which finite difference method you used?*

Point	u (μmm)	v (μmm)
1	0.000	0.000
2	-0.112	0.144
3	0.112	0.176
4	-0.032	0.224
5	0.128	0.384
6	-0.048	0.336

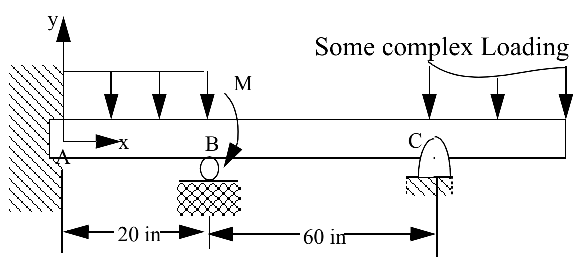


$(\varepsilon_{xx})_3$=----------------

$(\varepsilon_{yy})_3$=----------------

(e) The displacement in the y direction in section AB is given by $v_1(x) = -3(x^4 - 20x^3)(10^{-6})$ in and in BC by $v_2(x) = -8(x^2 - 100x + 1600)(10^{-3})$ in. If the bending rigidity (EI) is 120 (10^6) lbs-in^2. Determine the reaction force at B.

R_B = --------------------------



1. $P_1 = 11$ kN $P_2 = 312$ kN

2a. I_1= 110 ksi I_2= 3400 ksi^2 I_3= 20,000 ksi^3

2b $\theta_x = 90^o$ $\theta_y = 31.7^o$ $\theta_z = 58.3^o$

2c $2a_{crit}$ = 0.422 inch

3b p_{max}= 480 psi

3c $0.221P/(\pi E)$

3d $(\varepsilon_{xx})_3$= -205.7 μ Forward $(\varepsilon_{yyx})_3$= 384 μ Central

3e R_B = 129.6 kips