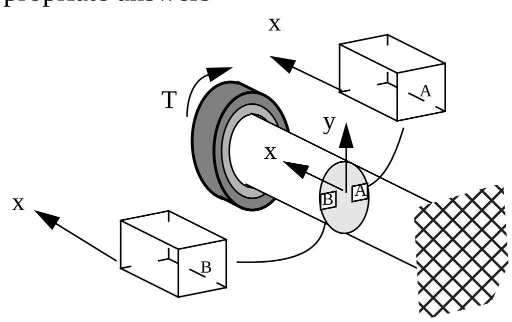
EXAM 1 MEEM 4150 Oct. 6th, 2004

1.

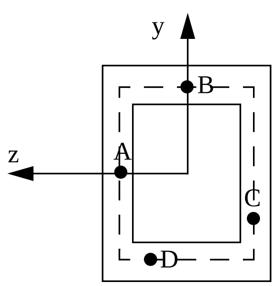
(b) Draw the shear stress due to torsion on the stress cubes at points A and B. Is the shear stress positive or negative? Circle the appropriate answers



$(\tau_{xy})_A$ = positive / negative

$(\tau_{xy})_B$ = positive / negative

(c) Assuming a positive shear force V_y in bending (a) sketch the direction of the shear flow along the center-line on the thin cross-sections shown. (b) At points A, B, C, and D, determine if the stress component is τ_{xy} or τ_{xz} and if it is positive, negative or zero. Circle the appropriate answers



$(\tau_{xy})_A$ or $(\tau_{xz})_A$ positive / negative /zero

$(\tau_{xy})_B$ or $(\tau_{xz})_B$ positive / negative /zero

$(\tau_{xy})_C$ or $(\tau_{xz})_C$ positive / negative /zero

$(\tau_{xy})_D$ or $(\tau_{xz})_D$ positive / negative /zero

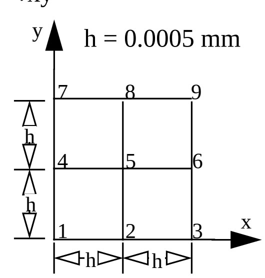
(d, e) The stresses at a point were found to be σ_{rr}= 100 MPa (T), $\sigma_{\theta\theta}$ = 200 MPa (T) and $\tau_{r\theta}$ = 140 MPa . The material has a modulus of elasticity of 80 GPa and Poisson's ratio of 0.25. Determine ε_{rr}

(d) assuming *Plane Stress* ε_{rr} = -----------

(e) assuming *Plane Strain* ε_{rr} = -----------

(f) The displacements u and v in the x and y directions respectively were measured by Moire' interferometry. Displacements of 9 points on the body and are as given below. Determine the shear strain γ_{xy} at point 9.

Point	u (μmm)	v (μmm)	Point	u (μmm)	v (μmm)
1	0.000	0.000	6	-0.080	0.240
2	-0.112	0.144	7	0.128	0.384
3	-0.128	0.256	8	-0.048	0.336
4	0.112	0.176	9	0.128	0.384
5	-0.032	0.224			



γ_{xy} =-------------------

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

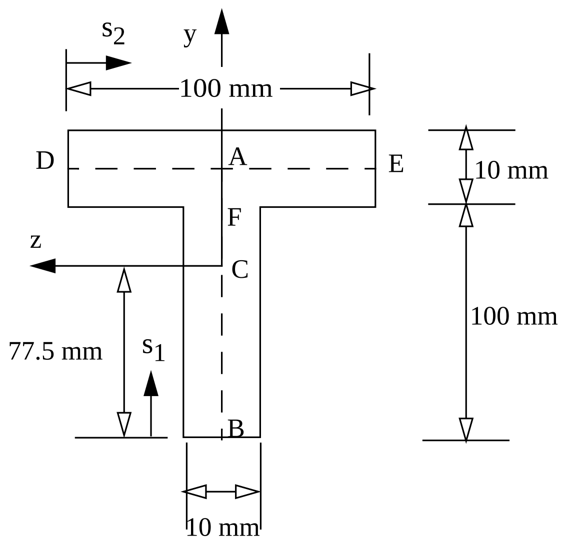
$$\begin{bmatrix} 22.5 & 0 & -10 \\ 0 & 25 & 0 \\ -10 & 0 & 7.5 \end{bmatrix} \text{ksi}$$

(a) Determine the three stress invariants.

(b) Determine the orientation of principal direction associated with principal stress 27.5 ksi (T). Equations you used to solve for the direction must be clearly written.

(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 in the material.

3. A positive shear force of $\boldsymbol{V_y}$=50 kN and a bending moment of $\boldsymbol{M_z}$ = 5 kN-m acts on the thin cross-sections shown (not drawn to scale). (a) Determine the shear flow along center line in terms of s_1 and s_2 for segment BF and DA. (b) The principal stresses at point F on the cross-section. Point F is just below the flange.



q_1 = -----------------------------------

q_2 = -----------------------------------

σ_1 = -----------------------------------

σ_2 = -----------------------------------

σ_3 = -----------------------------------

ANSWERS

1b $(\tau_{xy})_A$ = negative $(\tau_{xy})_B$ = positive

1c $(\tau_{xy})_A$ positive $(\tau_{xz})_B$ zero $(\tau_{xy})_C$ positive $(\tau_{xz})_D$ positive

1d $\varepsilon_{rr} = 625\ \mu$ 1e $\varepsilon_{rr} = 391\ \mu$ 1f $\gamma_{xy} = 512\ \mu$ rads

2.a. I_1= 55 ksi I_2= 818.7 ksi^2. I_3= 1718.7 ksi^3

2b. $\theta_x = 153.4^o$ $\theta_y = 90^o$ $\theta_z = 63.4^o$

2c. $2a_{crit}$ = 0.4074 in.

3. $q_1 = [16.461\ s_1 - 106.2(s_1)^2]\ (10^6)$ N/m $q_2 = [5.84 s_2]\ (10^6)$ N/m

σ_1 = -39.2 MPa(T) $\sigma_2 = 0$ σ_3 =87MPa(C)