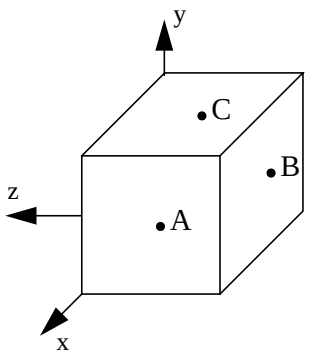
EXAM 1 MEEM 4150 Oct. 7th, 2003

Answers are at of this exam.

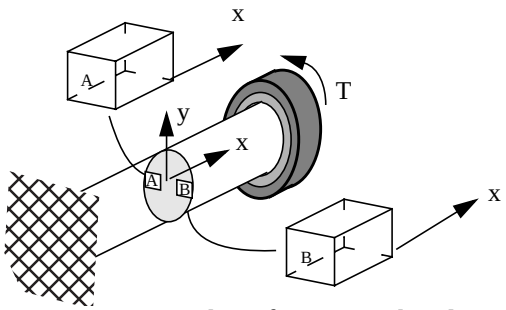
1.

(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.

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



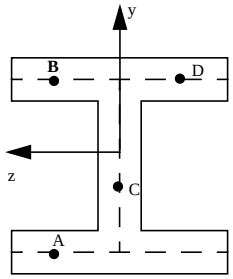
(b) Draw the shear stress due to torsion on the stress cubes at points A and B. Is the shear stress positive or negative? Circle the appropriate answers



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

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

(c) Assuming a positive shear force $\boldsymbol{V_y}$ 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

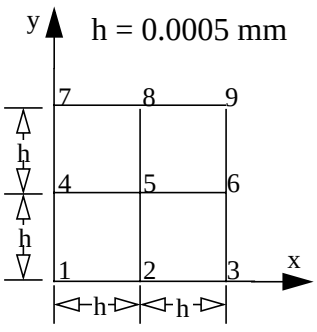
$(\tau_{xy})_C$ or $(\tau_{xz})_C$ positive / negative/ zero

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

(d) The axial strain in a 20 in. long rod is given by $\varepsilon_{xx} = \dfrac{0.2}{(40-x)^2}$. Determine the elongation of the rod.

(e) 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.Using central difference, determine the shear strain γ_{xy} at point 5.

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			



2. The stress at a point is given by the stress matrix: $\begin{bmatrix} 40 & -20 & 10 \\ -20 & 30 & 0 \\ 10 & 0 & \sigma_{zz} \end{bmatrix}$ ksi

The three principal stresses of the matrix are: σ_1 = 56.21 ksi(T) σ_2 = 14.95 ksi(T) σ_3 = 51.16 ksi(C)

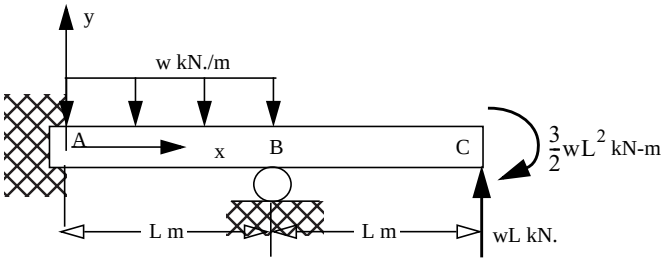
(a) Determine the three stress invariants. (b) Determine the stress σ_{zz}.

(c) Determine the orientation of principal direction associated with principal stress 14.95 ksi (T).

(d) The material yield stress is 120 ksi in tension. Determine the factor of safety at the point using octahedral shear stress theory

(e) A crack was discovered on a plane that has an outward normal at angles of 36.87^o, 60.0^o, and 70.63^o with the x, y and z axis respectively. The critical stress intensity factor for the material is $22 ksi\sqrt{in}$, what would be the critical crack length on that plane.

3. A beam is loaded and supported as shown. Determine the slope and the reaction force at point B in terms of w, L, E, and I. Use the coordinate system shown.(BE METHODICAL)



Answers

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

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

1d. Elongation = 0.005 in 1e. γ_{xy} = 128 μ rads

2a. I_1= 20 ksi I_2= - 2800 ksi^2 I_3= - 42991.8 ksi^3.

2b σ_{zz} = 50 ksi (C) 2c. $\theta_x = 53.2^o$ or 126.8^o $\theta_y = 37.29^o$ or 142.7^o $\theta_z = -84.8^o$ or 95.2^o

2d. K=1.27 2e. $2a_{crit}$ = 0.4305 in

3. slope= $-\left(\frac{5wL^3}{48EI}\right)$ rads force= $\frac{wL}{8}$ kN