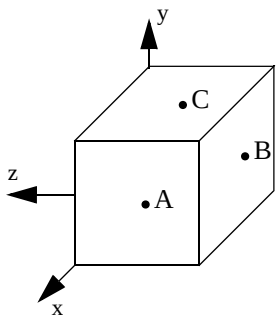
EXAM 1 MEEM2150 Oct. 1st, 2003

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 & c) The normal stresses at a point were found to be σ_{xx} = 200 MPa (T), σ_{yy} = 100 MPa (T). The material has a modulus of elasticity of E = 200 GPa and Poisson's ratio ν = 0.25.

(b) Determine ε_{xx} assuming *Plane Stress*: ε_{xx} = ----------

(c) Determine ε_{xx} assuming *Plane Strain*: ε_{xx} = ----------

(d & e) Answer true or false and justify each answer in one sentence.

(d) Stress components are opposite in direction on the two surfaces of an imaginary cut. True / False
Justification:

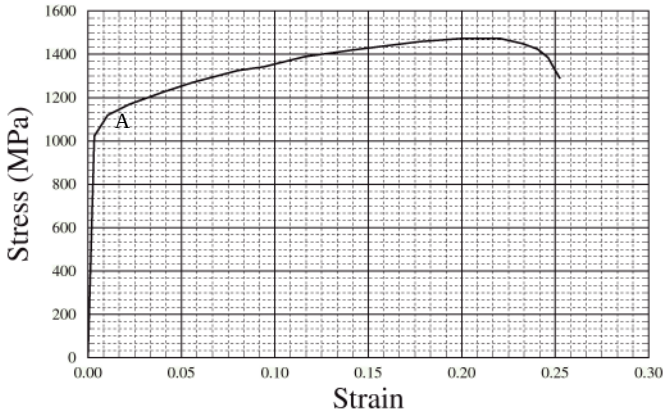
(e) Stress components have opposite signs on the two surfaces of an imaginary cut. True / False
Justification:

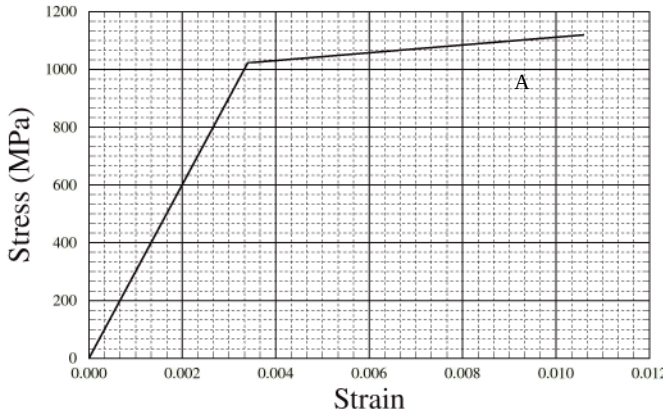
(f) If the left end of a rod moves more than the right end in the negative x direction, will the normal strain be negative or positive? Justify your answer.

(g) 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.

Elongation = ----------

2. A 12 mm x 12 mm square metal alloy having a gage length of 50 mm was tested in tension. The entire stress-strain curve for the material is shown below on the left. On the right is the enlarged graph of region before point A.





Showing your points and construction on graphs and the associated calculations, determine the following quantities

(a) Ultimate Stress ----------
(b) Fracture Stress ----------
(c) Modulus of Elasticity. ----------
(d) Proportional Limit ----------
(e)Yield stress at 0.2% offset ----------
(f)Secant modulus at stress level of 1400MPa ----------
(g) Plastic strain at stress level of 1400MPa ----------
(h) The extension of the specimen when the axial force on the specimen is 90 kN.

(i) If the material has a Poisson's ratio of 0.4, what is the change in length of one of the sides of the cross-section at a stress level of 1400MPa.

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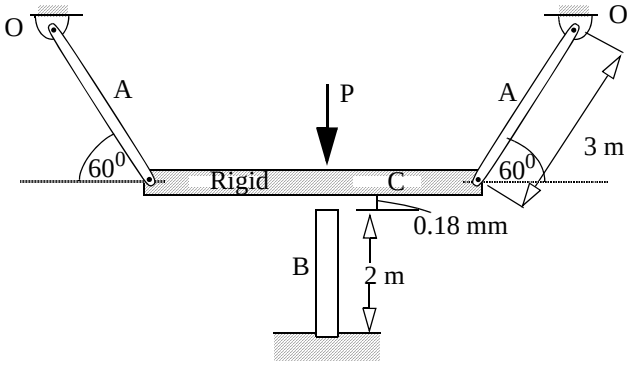
3. A gap of 0.18 mm exists between the rigid plate and bar B before the load P is applied on the system shown below. After load P is applied, the axial strain in rod B is - 2500 μ m/m. The modulus of elasticity of the two bars is E = 200 GPa. The area of cross-sections of the bars are: A_A = 100 mm^2 and A_B = 150 mm^2. Determine the applied load P.

(To get full credit, correct free body diagram and exaggerated deformed geometry must be drawn).

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



ANSWERS

1b ε_{xx} = 875μ 1c ε_{xx} = 781μ

1d TRUE. Stress is an internally distributed force system that is equal and opposite on the two surfaces of the imaginary cut.

1e. FALSE. The sign of stress incorporates the direction of the force and the direction of the imaginary sirface.

1f. POSITIVE. The rod will be elongated. Elongation and contaction are independent of the orientation of the rod.

1g. Elongation = 0.005 inch

2a. 1466.7MPa	2b. 1266.7 MPa	2c. 300 GPa
2d. 1033 MPa	2e. 1066 MPa	2f 11.2GPa
2g. 0.12	2h. 0.1042 mm	2i. -0.6 mm

3. P=126.8 kN