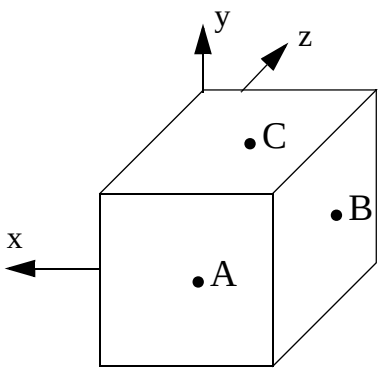
EXAM 1 MEEM2150 Oct. 9th, 2007

To get Full credit you must draw free body diagram any time you use equilibrium equations to determine forces or moments.

1.

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

$$\begin{bmatrix} \sigma_{xx} = 100\text{MPa(C)} & \tau_{xy} = -50\text{MPa} & \tau_{xz} = 0 \\ \tau_{yx} = -50\text{MPa} & \sigma_{yy} = 40\text{MPa(T)} & \tau_{yz} = 70\text{MPa} \\ \tau_{zx} = 0 & \tau_{zy} = 70\text{MPa} & \sigma_{zz} = 0 \end{bmatrix}$$



In problems (ii) through (ix) circle the correct answer.

(ii) You can measure stress directly with an instrument the way you measure temperature with a thermometer. True / False

(iii) In plane stress, the stress at a point has 4 components. True / False

(iv) In plane stress, the stress at a point has 3 independent components. True / False

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

(vi) In Eulerian strain we use the original geometry as the reference geometry. True / False

(vii) Positive shear strain results in a decrease of angle from right angle. True / False

(viii) The normal strain will be positive if the left end of a rod moves more than the right end in the negative x direction. True / False

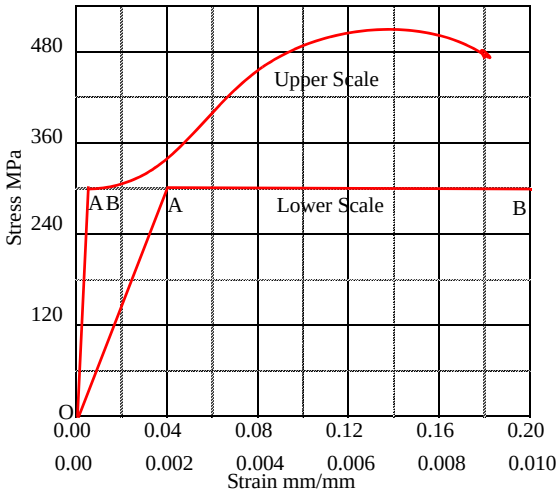
(ix) The most general anisotropic material has 36 material constants that relate stress and strain linearly. True / False

(x) The normal stresses at a point were found to be $\sigma_{xx} = 200$ MPa (C), $\sigma_{yy} = 100$ MPa (C). The material has a modulus of elasticity of E = 200 GPa and Poisson's ratio $\nu = 0.25$. Determine ε_{xx} assuming *Plane Strain*:

(xi) The axial displacement of a bar was found to be $u(x) = [-50x + 2x^2](10^{-6})$ mm

Determine the axial strain ε_{xx} at x = 150 mm

2. A tensile test specimen having a diameter of 10 mm and a gage length of 50 mm was tested to fracture. The stress-strain curve from the tension test is shown below. The lower plot is the expanded region OAB and associated with the strain values given in the lower scale.



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

(i) Modulus of elasticity. ----------

(ii) Proportional limit ----------

(iii) Rupture stress ----------

(iv) Secant modulus at stress level of 420 MPa ----------

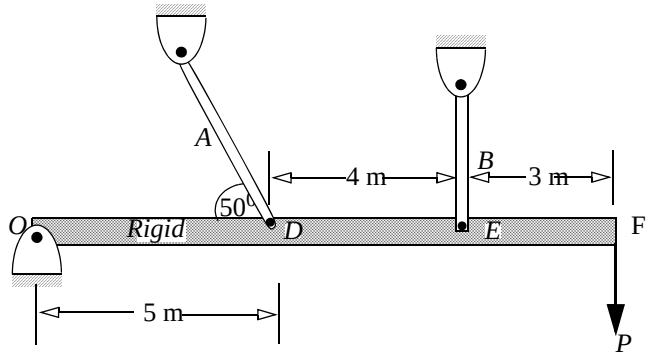
(v) Tangent modulus at stress level of 420 MPa ----------

(vi) Determine the plastic strain at stress level of 420 MPa. ----------

(vii) If the shear modulus of the material is 55GPa, determine the Poisson's ratio assuming the material is isotropic. ----------

(viii) Determine the axial force acting on the specimen when it is extended by 0.2 mm ----------

3. Two steel bars A, and B have lengths of L_A=4 m and L_B=3 m respectively. The bars have a modulus of elasticity of E = 200 GPa, yield stress of σ_{yield} = 200 MPa, and cross-sectional area of 500 mm ^{2}. Due to force *P* the strain in bar *B* was found to be 600 μ. Determine (a) the applied force P and (b) the factor of safety for the system if yielding is to be avoided in both bars.



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

K_{safety} = ----------

ANSWERS

1. (ii) False (iii) True (iv) True(v) False (vi) False(vii) True (viii) True (ix) False
(x) ε_{xx} = -781.3μ (xi) ε_{xx} = 550μ

2. (i) 150 GPa (ii) 300 MPa (iii) 480 MPa (iv) 6.46 GPa (v) 2.57 GPa(vi) 0.0622 (vii) 0.36 (viii) 23.6 kN

3. P=51.1kN K_{safety} = 1.67