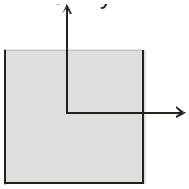
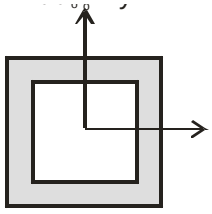
Homework#1

Given: September 19, 2002 Due: October 3, 2002

1. Solve Problem 4.3-2, page 302 in from Gere
   In addition, assume that the beam material has a Young's modulus *E*, shear modulus *G*, and the following a rectangular cross-section



   (a) Determine the deflection curve *w(x)* for the beam.
   (b) Determine the maximum and minimum longitudinal stress σ_{xx} and longitudinal strain ε_{xx} in the beam.
   (c) Determine the maximum and minimum shear stress σ_{xz} and shear strain γ_{xz} in the beam.
2. Solve Problem 4.3-3, page 302 from Gere
   In addition, assume that the beam material has a Young's modulus *E* and shear modulus *G*, as well as the following rectangular cross-section



   (a) Determine the deflection curve *w(x)* for the beam.
   (b) If you are told that the maximum longitudinal stress that the beam can carry in tension before plastic yield is σ_y, what would be the maximum load P_y you can apply on the beam before yield occurs.
   (c) If you were told that the maximum shear stress that the beam can carry before plastic yield is $\tau_y = \sigma_y / \sqrt{3}$, what would be the maximum load P_y^* you can apply on the beam before yield occurs.
   (d) Compare P_y and P_y^* and comment on whether the beam will fail in tension or shear.

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3. Solve Problem 10.6, page 319 from Shames and Pitarresi (*In Fig. P.10.8, change *y* into *z* to in order to have the same convention as in your class notes).

   In addition, assume that the beam material has a Young's modulus *E* and shear modulus *G*, and the same rectangular cross-section as in Question 1 above

   (a) Determine the deflection curve *w(x)* for the beam.
   (b) Suppose that in addition to the normal distributed load, an axial force P_o is applied in the positive *x*-direction at *A*. Will this change the deflection curve you obtained in (a)? If you are told that the yield strain in tension is $\varepsilon_y = 0.02$ for the beam material, what is the maximum axial force P_o^y you can apply (*while keeping the load-distribution the same*) before yield occurs.

4. Solve Problem 10.8, page 319 from Shames and Pitarresi (*In Fig. P.10.6, change *y* into *z* to in order to have the same convention as in your class notes).

   In addition, assume that the beam material has a Young's modulus *E* and shear modulus *G*, and the same rectangular cross-section as in Question 2 above. Determine the deflection curve *w(x)* for the beam and the shear stress distribution σ_{xz} at any section of the beam.

5. Given the plane stress field

$$\sigma_{xx} = Axy,\ \sigma_{xy} = \frac{A}{2}\left(h^2 - y^2\right),\ \sigma_{yy} = 0$$

   (a) Is it in equilibrium under a zero body force?

(b) Determine the strains if the material has a Young's modulus *E* and shear modulus *G*.

(c) Let the strain compatibility condition in 2D be given by

(d)

$$\frac{\partial^2 \varepsilon_{xx}}{\partial y^2} + \frac{\partial^2 \varepsilon_{yy}}{\partial x^2} = \frac{\partial^2 \gamma_{xy}}{\partial x \partial y}$$

Do the strains satisfy the above compatible condition?

(e) Calculate displacements *u* and *v*.

(f) Let the stress tensor be given by

$$\begin{pmatrix} Axy & ? & \sigma_{xz} \\ \frac{A}{2}\left(h^2 - y^2\right) & 0 & \sigma_{yz} \\ \sigma_{zx} & \sigma_{zy} & \sigma_{zz} \end{pmatrix}$$

Determine $\sigma_{xz}, \sigma_{yz}, \sigma_{zz}$ in order that equilibrium condition is satisfied.