2009 MIDTERM 2 FOR ME 85/CE 30 SECTION (Zohdi)

(NO CALCULATORS/100 POINTS)

(BE NEAT and turn in this test sheet in with your work!)

RETURN YOUR TEST WITH YOUR SOLUTIONS!

FAILURE TO DO SO WILL RESULT IN AN F!

WARNING: DUE TO THE FACT THAT THERE ARE A FEW PEOPLE WHO ARE TAKING THE TEST A BIT LATER, DUE TO EXCEPTIONAL UNIVERSITY REASONS AND SCHEDULING CONFLICTS, I ASK FOR YOUR SIGNATURE INDICATING THAT YOU WILL NOT COMMUNICATE THE CONTENTS OF THIS EXAM, IN ANY WAY POSSIBLE, TO ANYONE WHO HAS NOT ALREADY TAKEN IT. IF YOU DO, THIS MAY RESULT IN AN AUTOMATIC FAILING GRADE FOR YOU AND THE PERSON(S) THAT YOU HAVE COMMUNICATED TO.

NAME: L

SIGNATURE:

TEST NUMBER: 74

Q	Score
1	14
2	4
3	9
4	7

29

REMARK: Ignore "end-effects" in all problems.

PROBLEM 1 (30 points)

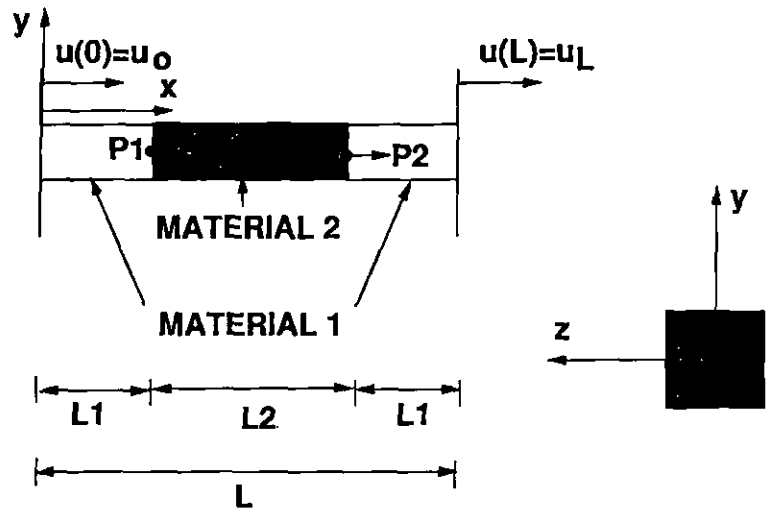


Figure 1: Problem 1.

Consider the bar in Figure 1 experiencing the given axial loads and NON-ZERO boundary displacements. It is statically INDETERMINANT. The material properties for material 1 are $\mathbb{E}_1$ and ν_1 and for material 2 they are $\mathbb{E}_2$ and ν_2. The bar has a cross-sectional of area A.

(a) Neatly draw a freebody diagram.
(b) Determine the reactions.
(c) Determine the displacement in the x direction at $x = \frac{L}{2}$
(d) Determine the stress matrix/tensor on the cross-section at $x = \frac{L}{2}$.
(e) Determine the strain matrix/tensor on the cross-section at $x = \frac{L}{2}$.

PROBLEM 2 (30 points)

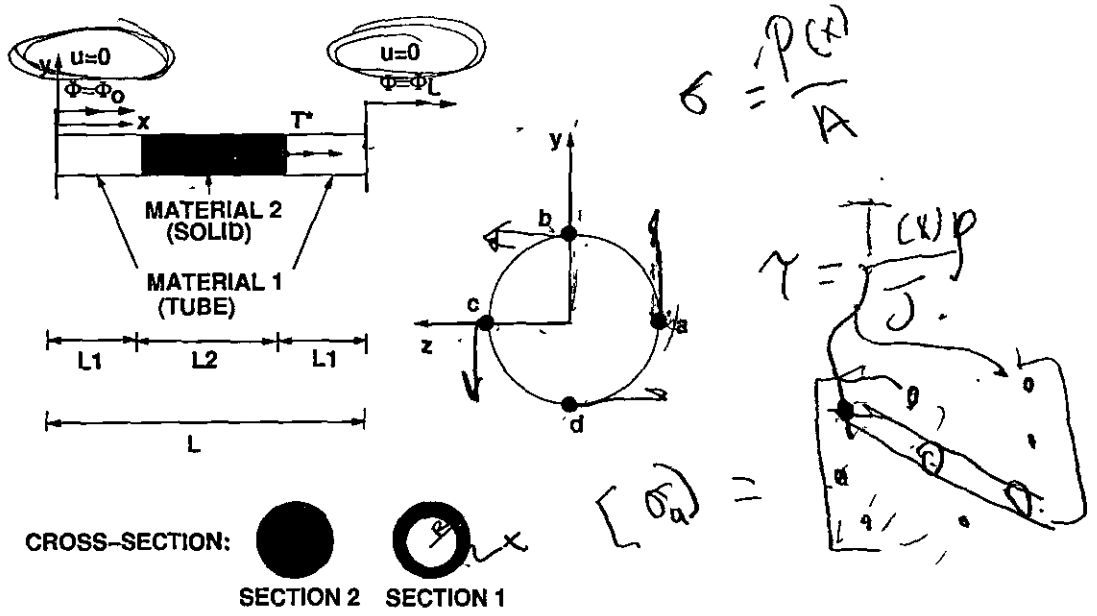
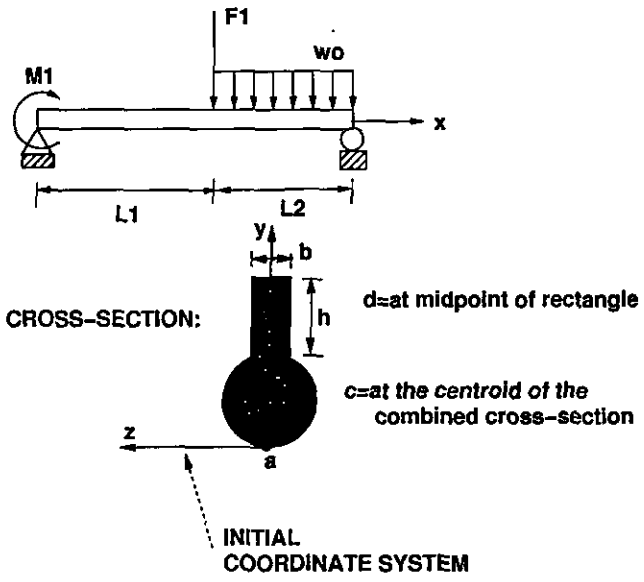


Figure 2: Problem 2.

Consider the bar in the Figure 2 experiencing given torsional loading and NON-ZERO boundary angle of twists. The two outer sections are tubes of thickness t and outer radius R. The inner section is a solid shaft of outer radius R. The entire system is also being heated up by $\Delta\theta$ (temperature change). The overall axial displacement is zero, since the ends are fixed, but being twisted. (It is statically INDETERMINANT.) The material properties for material 1 are $\mathbb{E}_1$, ν_1, $G_1 = \mu_1$ and α_1 and for material 2 they are $\mathbb{E}_2$, ν_2, $G_2 = \mu_2$ and α_2.

(a) Neatly draw a freebody diagram.
(b) Determine the reactions.
(c) Determine the angle of twist at $x = \frac{L}{2}$.
(d) Determine the stress matrix/tensor for points a, b, c and d at $x = \frac{L}{2}$.
(e) Determine the strain matrix/tensor for points a, b, c and d at $x = \frac{L}{2}$.

PROBLEM 3 (30 points)



C IS the centroid

Figure 3: Problem 3: For a circular (radius=R): $I_{zz} = \frac{\pi R^4}{4}$ about its centroid. For a rectangle (base=b, height=h): $I_{zz} = \frac{1}{12}bh^3$ about its centroid.

Consider the bar in the figure under the given loading. It is statically DETERMINANT.

(a) Neatly draw a freebody diagram.

(b) Determine the *reactions*.

(c) Determine the centroid of the cross-section, with the initial coordinate system given. Afterwards, shift your coordinate system to the centroid.

(d) Determine the moment of inertia of the cross-section with respect to the neutral axis. (Place the coordinate system origin at c.)

(e) Determine the combined stress matrix/tensor for points a, c and d due to bending and due to shear at $x = \frac{L_1}{2}$. You are allowed to leave any "hard" integrals over a circular section, in terms of an integral. However, not for a rectangle.

(f) Determine the combined strain matrix/tensor for points a, c and d due to bending and due to shear at $x = \frac{L_1}{2}$.

PROBLEM 4 (10 points)

A general structure (not shown) deforms under some applied loading. Given the following displacement field at a point in a structure (x, y, z):

$$\begin{aligned} u_x &= A(x+y) \\ u_y &= B(x-2z) \\ u_z &= C(z+3x) \end{aligned} \tag{1}$$

where A, B and C are constants that are not a function of position.

(a) Determine the components of the strain and put them in matrix form.
(b) Determine the components of the stress and put them in matrix form.