

Ph.D. Qualifying Examination

Mechanics of Materials

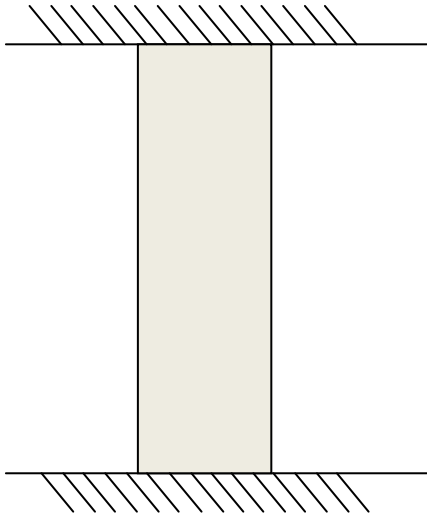
Fall 2014

Notes:

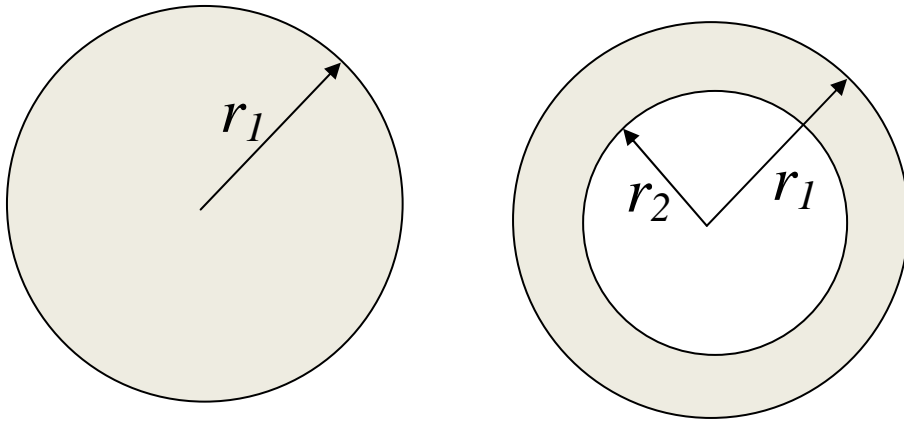
- There are a total of 4 problems.
- Time allowed: 2.5 hours.
- Exam is closed book and closed-notes (one sheet of formulas is allowed)
- Problems count 25 points each (total=100 points).
- Show your work on these exam sheets. (Add additional sheets, if needed.)
- You may use a calculator.
- Laptops and cell phones are not allowed.

Problem 1

The bar shown in the picture has a length of L and a cross-sectional area of A . The bar is being held between immovable supports as shown in the figure. If the temperature increases uniformly by ΔT , express (in terms of any relevant parameters) any longitudinal stress, and the nature of such stress, that might develop. If no longitudinal stress will develop then state so as well. If there is longitudinal stress, is it dependent, i.e. a function of, the cross-sectional area? Define any parameters used in your expression and assume the bar experiences no friction between its ends and the supports. Finally, what is the lateral stress in this case?



Problem 2

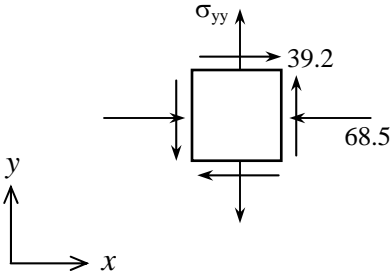


Consider the above two pictures. Each represents the circular cross section of a bar of length L . The left bar is solid while the right bar is hollow. Both bars are subjected to the same torque T . However, they are made of two different materials (material A for the left bar and material B for the right bar). What is the ratio of the shear modulus of elasticity for these two materials, i.e. G_B/G_A , if they were to have the same total angle of twist ϕ ? Remember that the polar moment of inertia is given by $I_p = \int \rho^2 dA$. Finally, $r_2 = 0.5r_1$.

Problem 3

An element in plane stress is subjected to stresses $\sigma_{xx} = -68.5$ MPa and $\tau_{xy} = 39.2$ MPa. It is known that one of the principal stresses equals 26.1 MPa in tension.

- Determine the stress component σ_{yy} .
- Determine the other principal stress, and the orientations of the principal planes.
- Sketch the principal stresses (directions and magnitudes) acting on a properly oriented square element in the xy -plane.



Problem 4

A simple beam AB is under a uniform distributed load q acting over the left half of the span. Write down the bending moment as a function of x , and sketch it.

