Ph.D. Qualifying Examination

Mechanics of Materials

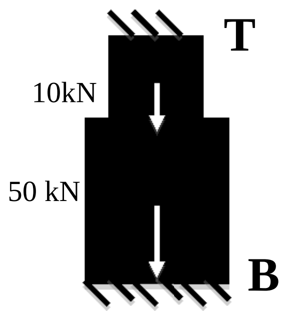
Spring 2015

<u>Notes:</u>

- 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

Find the reactions at the top, T, and bottom, B, of the steel bar shown in the below figure. Note that the top and bottom are fully constrained. The diameter and length of the smaller, top bar are both 3 cm. The diameter and length of the larger, bottom bar are 5 cm and 7 cm, respectively. The two loads shown in the figure are placed at the centers of the two segments of the bars.



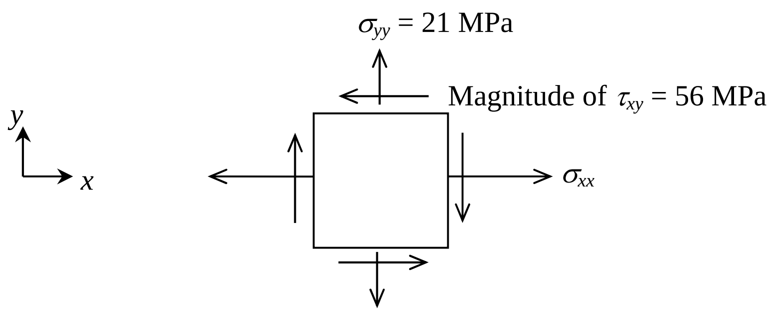
Problem 2

Consider a prismatic bar of material that has a circular cross section. The bar has: Young's Modulus – E, Poisson's Ratio - ν, Length – L, and diameter – d.

1) Determine initial volume of the material (V_i) and the final volume of the material (V_f) after a strain, ε, has been applied to the length, L, of the prismatic bar. Express your answers in terms of only the variables given and assume that the strain is small, i.e. $\varepsilon >> \varepsilon^2$.
2) Determine the Unit Volume Change (Dilatation), e, of the material.
3) Based on the result of 2), what is the plausible range of values for ν?

Problem 3

A material element is under the plane stress state as shown below. It is known that the minimum principal stress is –7 MPa. (a) Determine the stress σ_{xx}. (b) Determine the direction of the maximum principal stress (namely its angles with the *x*- and *y*-axes).



Problem 4

A simply supported beam is under a distributed load *q*, as shown below. (a) Obtain the "elastic curve" (i.e., the expression of *y* as a function of *x* for the beam in the deformed state). (b) Obtain the maximum deflection. The Young's modulus of the beam is *E* and the second moment of the cross section is *I*.