Ph.D. Qualifying Examination

Mechanics of Materials

Spring 2016

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

A thin-walled sphere of diameter d is filled with gas at pressure p.

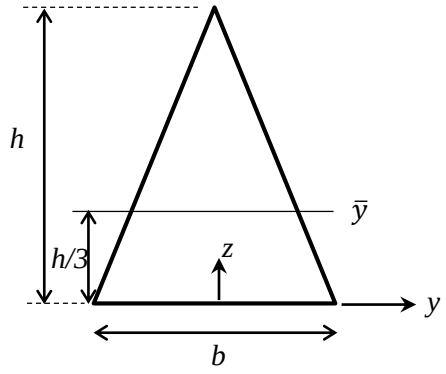
(a) Derive the equation relating pressure p, diameter d, wall thickness, and the circumferential stress experienced by the wall.

(b) In a given situation d = 17 m, p = 520 kN/m^2, and the allowed circumferential stress is 90 MPa. Calculate the required wall thickness.

(c) Show that the radial stress is insignificant in (b).

Problem 2

Determine the moment of inertia (second moment) of the triangle, shown below, (a) about its base (y axis), and (b) about its centroidal axis $\bar{y}$ parallel to the base. Show procedures, and express the results in terms of b and h.



Problem 3

Consider a cylindrical bar that is made of Al 2014-T6 with a diameter of 20 mm. The bar is subjected to a tensile load of 700N that deforms it elastically. Determine the absolute max shear strain in the rod at a point on its surface. Assume that the bar experiences no stress perpendicular to the load. ($E = 73.1$ GPa and $\nu = 0.35$)

Problem 4

In reality the bar of Problem 3 experiences Poisson Contraction and a strain perpendicular to the applied load. Removing the assumption that there is 'no stress perpendicular to the load' determine the following:

a) If the bar is pulled in uniaxial tension along its length L, what is the bar's change in diameter?
b) Now assume that the bar has plastically deformed from its tensile load and has a residual strain ε_r. What is the ratio of the bar's initial volume to its plastically deformed volume?