Ph.D. Qualifying Examination

Mechanics of Materials

Fall 2018

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 beam shown below is subject to a load $P$ at point $D$. The beam has a circular cross section, with diameter $d$. Determine the maximum tensile stress at point $A$ (the support end). Write your answer in terms of the given parameters $P$, $b$ and $d$. 

![Diagram of the beam with load at point D, dimensions AB, BC, and BD labeled with 5b, 2b, and 2b, respectively. The beam is supported at point A and has a load at point D.]}
Problem 2:

Determine the moment of inertia (second moment) of the shaded area (i) about the $x$ axis and (ii) about the $y$ axis.
Problem 3: A simple beam AB supports a uniform load of intensity $q$ acting over the middle region of the span. Determine the angle of rotation $\theta_A$ at the left-hand support and the deflection $\delta_{\text{max}}$ at the midpoint.
Problem 4: An element in uniaxial stress is subjected to tensile stresses $\sigma_x = 55$ MPa, as shown in the figure. Using Mohr’s circle, determine:

(a) the stresses acting on an element oriented at an angle $\theta = -30^\circ$ from the x axis (minus means clockwise)

(b) the maximum shear stresses and associated normal stresses.

Show all results on sketches of properly oriented elements.