Name.....Student I.D.....

Department of Mining and Materials Engineering

Faculty of Engineering

Prince of Songkla University

Mid-term Exam for Semester: 2 Academic Year: 2008

Date: December 21, 2008 Time: 09.00-12.00

Subject: 237-221 Mechanical Behavior of Materials Room: R300

Instruction

1. There are 4 problem sets. Please do all of them. Write your answers in the space provided. If you need more space, you can write on the back of paper.
2. Only two (2) pieces of A4-size note are allowed. You may write on both sides of the notes with your own writing. Please return them with your answers.
3. Text books and other studying materials are not allowed.
4. Dictionary, calculator, and stationery are allowed.
5. This mid-term exam is accounted for 25% of the total grade.

Asst. Prof. Dr. Thawatchai Plookphol

Problem No.	Full Score (points)	Student's Score (points)
1.	25	
2.	25	
3.	30	
4.	30	
Total	110	

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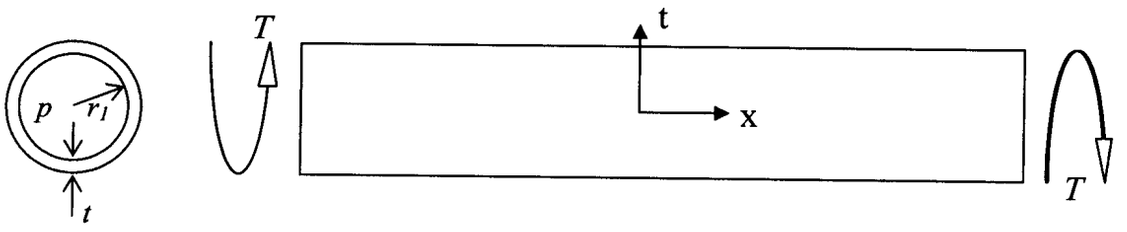
1. A pipe with ends has a wall thickness of 10 mm and inner diameter of 0.6 m. It is filled with a gas at 20 MPa pressure and is subjected to a torque about its long axis of 1200 kN·m.



Given: $\sigma_t = \frac{pr_1}{t}$; $\sigma_x = \frac{pr_1}{2t}$; $\tau_{tx} = \frac{T}{2\pi r_{avg}^2 t}$

where σ_t = tangential or hoop stress
σ_x = longitudinal stress
τ_{tx} = shear stress due to the torsion
T = torque
t = thickness
r_1 = inner radius
r_{avg} = average radius = $r_1+t/2$
p = internal gas pressure

Neglect any effects of the discontinuity associated the end closure.
1.1 Draw a stress element to represent the state of stress of the tube wall (5 points)
1.2 Determine the three normal stresses (15 points)
1.3 Calculate the maximum shear stress (5 points)

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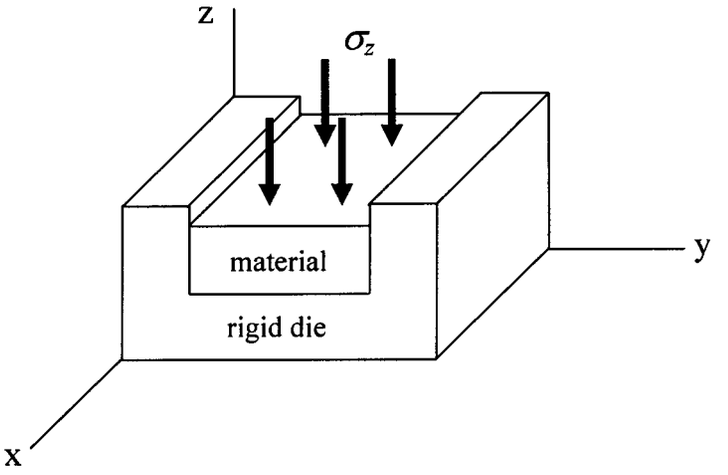
2. A sample of material subjected to a compressive stress σ_z is confined so that it cannot deform in the y-direction as shown in the figure below. Assume that there is no friction against the die, so that deformation can freely occur in the x-direction. Assume further that the material is isotropic and exhibits linear-elastic behavior.



If σ_z has a magnitude of 75 MPa and the material is made of copper alloy E = 130 GPa, and ν = 0.343. Determine the followings:

2.1 The stress that develops in the y-direction (σ_y). (5 points)

2.2 The strain in the z-direction (ε_z). (5 points)

2.3 The strain in the x-direction (ε_x). (5 points)

2.4 The apparent stiffness $E' = \frac{\sigma_z}{\varepsilon_z}$ in the z-direction. Is this apparent modulus equal to the elastic modulus E from uniaxial test on the materials? Why or why not? (10 points)

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3. The three-dimensional state of stress is given by:

$$\sigma_{ij} = \begin{bmatrix} -6 & -3\sqrt{3} & 0 \\ -3\sqrt{3} & 0 & 0 \\ 0 & 0 & 10 \end{bmatrix} \text{ MPa}$$

Determine the followings:
3.1 The magnitude of principal stresses. (15 points)
3.2 The magnitude of maximum shear stress. (5 points)
3.3 The magnitude of the normal and shear stresses on the plane whose normal has the direction x =1, y =1, z = 2 (10 points)

Name.....Student I.D.....

4. An aluminum single crystal has compliance (S) constants as shown below:

$S_{11} = 15.7$ TPa^{-1}
$S_{12} = -5.7$ TPa^{-1}
$S_{44} = 35.1$ TPa^{-1}

Estimate the following elastic constants of the aluminum single crystal:

4.1 Bulk modulus (K). (5 points)
4.2 Shear modulus (G) in the [100], and [110] directions. (10 points)
4.3 Young's modulus (E) in the [100], and [111] directions. (10 points)
4.4 What conclusions can be drawn from the results in (b) and (c)? (5 points)