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: 2004

Date: December 19, 2004 Time: 13.30-16.30

Subject: 237-221 Mechanical Metallurgy Room: R300

Instruction

1. There are 4 problem sets. Please do all of them and write your answers on the space provided after each problem set. If you need more space, you can write the answer on the back of the problem set.
2. Only two (2) pieces of A4-size note are allowed. You may write on both sides of them. Please return them with your answers.
3. Dictionary, calculator, and stationery are also allowed.
4. Text books and other studying materials are not allowed.
5. This mid-term exam is accounted for 30% of the total grade point.

Dr. Thawatchai Plookphol

Problem No.	Full Score (points)	Student's Score (points)
1.	30	
2.	30	
3.	30	
4.	30	
Total	120	

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1. A 50-mm-long aluminum rod with diameter of 5 mm is loaded with a 5000 N force. If the diameter decreases to 4.9 mm, compute the following:

(a) The final length of the rod (state any assumption you may make). (10 points)
(b) The engineering stress and engineering strain at this load. (10 points)
(c) The true stress and true strain at this load. (10 points)

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2. The following stresses are applied relative to an x-y coordinate system:

$$\sigma_{xx} = +100 \text{ MPa}; \quad \sigma_{yy} = -200 \text{ MPa}; \quad \tau_{xy} = -50 \text{ MPa}$$

(a) Calculate the principal normal stresses and their orientations. (15 points)

(b) Determine the maximum shear stress and the orientation of the plane on which it operates with respect to the x-y system. (10 points)

(c) Construct a Mohr's circle of stress for this two-dimensional stress state. (5 points)

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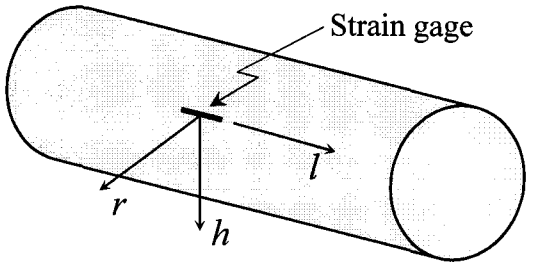
3. A long, thin-walled cylindrical tank has a radius of 60 mm and a wall thickness of 5 mm. It is constructed from a metal with $E = 210$ GPa and $\upsilon = 0.31$. Its ends are closed and when pressurized, the strain gage mounted to the outside surface in a direction parallel to the axis of the tank (l-direction) measures a strain $\varepsilon_l = 0.003$.

(a) What is the pressure in the tank? (25 points)

(b) If a strain gage were placed on the surface in the h-direction, what would its reading (ε_h) be at this pressure? (5 points)



Hint: h is the circumferential direction;
l is the longitudinal direction; and
r is the radial direction.

$$\sigma_h = \frac{Pr}{t}$$

$$\sigma_l = \frac{Pr}{2t}$$

$$\sigma_r = 0$$

where,

P = pressure in the tank

r = radius of the tank

t = the wall thickness

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

$C_{11} = 10.82\times10^{10}$ Pa $\quad S_{11} = 1.57\times10^{-11}$ Pa^{-1}
$C_{12} = 6.13\times10^{10}$ Pa $\quad S_{12} = -0.57\times10^{-11}$ Pa^{-1}
$C_{44} = 2.85\times10^{10}$ Pa $\quad S_{44} = 3.51\times10^{-11}$ Pa^{-1}

Determine the following elastic constants:

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