## Department of Mining and Materials Engineering Faculty of Engineering Prince of Songkla University

Mid-term Examination for Semester: 2

Academic Year: 2007

Date: December 25, 2007

Time: 9.00-12.00

Subject: 237-508 Structures and Mechanical Properties of Materials

Room: A400

## Instructions

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 one (1) piece of A4-size note is allowed. You may write on both sides of he note. Please return it 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 counted for 30% of the total grade.

Asst. Prof. Dr. Thawatchai Plookphol

Problem No.	Full Score (points)	Student's Score (points)
1.	10	
2.	10	
3.	20	
4.	30	
Total	70	

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1. For a continuum solid material, explain the following terms in brief:	
1.1 Homogenous (2 points)	
	••
1.2 Isotropic (2 points)	
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1.3 Anisotropic (2 points)	
	<b>.</b>
	• • •
1.4 Linear Elastic (2 points)	
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1 5 Non linear Floatic (2 noints)	
1.5 Non-linear Elastic (2 points)	
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2. According to Hooke's law for isotropic, elastic materials, <b>expand the following relation</b> . (10 points)
$\sigma_{ij} = 2G\varepsilon_{ij} + \lambda\varepsilon_{kk}\delta_{ij} \qquad \text{Where } \delta_{ij} = \begin{cases} 0 \text{ if } i \neq j \\ 1 \text{ if } i = j \end{cases} \text{(Kroenecker } \delta\text{)}$
Hint: Write six independent linear equations.

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3. The 3-D state of stress is given by:

$$\sigma_{ij} = \begin{bmatrix} 200 & 100 & 0 \\ 100 & 200 & 0 \\ 0 & 0 & -300 \end{bmatrix}$$
 MPa

- 3.1 Determine the principal stresses ( $\sigma_1$ ,  $\sigma_2$ ,  $\sigma_3$ ). Please show your work. (10 points)
  - **3.2 Draw the 3-D Mohr's circle,** using the convention that  $\sigma_1 \ge \sigma_2 \ge \sigma_3$ . (5 points)

	3.3 What is the maximum shear stress ( $\tau_{\text{max}}$ )? (5 points)
Given	: _
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4. A single cubic crystal experiences the state of stress of

$$\sigma_{ij} = \begin{bmatrix} 100 & 50 & 20 \\ 50 & 100 & 10 \\ 20 & 10 & -200 \end{bmatrix}$$
 MPa

Elastic constants of the cubic crystal are given by:

$$E_{11} = 60 \text{ GPa}, \qquad G_{12} = 30 \text{ GPa}, \qquad v_{12} = 0.3$$

- **4.1 Determine the compliance matrix** [S] (i.e. compliance tensor) for the single crystal (10 points)
- **4.2 Determine the engineering strain**  $[\varepsilon]$  in the single crystal by assuming deformation is linear elastic. (20 points)

Given:	$S_{11} = \frac{1}{E_{11}},$	$S_{12} = -\frac{v_{12}}{E_{11}},$	$S_{44} = \frac{1}{G_{12}}$
		$ \begin{aligned}     [\varepsilon] &= [S][\sigma] \\     \varepsilon_{ij} &= S_{ijkl} \sigma_{kl} \end{aligned} $	or
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