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: 2011

Date: December 20, 2011   Time: 09.00-12.00

Subject: 237-221 Mechanical Behavior of Materials   Room: S201, S203

Instruction

    1. There are 3 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. Text books, course notes and other studying materials are not allowed.

    3. Dictionary, calculator, and stationery are allowed.

    4. This mid-term exam is accounted for 25% of the total grade.

Asst. Prof. Dr. Thawatchai Plookphol

Problem No.	Full Score	Student's Score
1.	30	
2.	55	
3.	15	
Total	100	

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1. A force-extension curve from tensile test of aluminum alloy is given below.

Specimen dimensions:
Original gage length (l_0):   30 mm
Original gage diameter (D_0):   6 mm

Calculate the following properties:
    1.1 The ultimate tensile strength. (5 points)
    1.2 The 0.2% yield strength. (5 points)
    1.3 The fracture strength. (5 points)
    1.4 The total % elongation at break. (5 points)
    1.5 The Young's modulus. (10 points)

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2. A spherical pressure vessel made of steel has radius of 0.4 m and wall thickness of 2×10^{-3} m. The vessel is pressurized with argon gas to pressure of 5 MPa. Young's modulus and Poisson's ratio of the steel are 210 GPa and 0.3 respectively.

        2.1 Calculate the principal stresses in the wall of the pressure vessel. (10 points)

        2.2 Determine the three principal strains. (15 points)

        2.3 Evaluate the radius and thickness of the vessel when the internal pressure is 5 MPa. (20 points)

        2.4 Explain the results (the radius and thickness of the vessel) you get in 2.3. (10 points)

For thin-walled pressure vessel:

$$\sigma_1 = \sigma_2 = \frac{pr}{2t}$$

$$\sigma_3 = 0$$

where, p = internal pressure

        r = radius of the vessel

        t = wall thickness of the vessel

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3. A brass (70% Cu, 30% Zn) specimen is compressed by stresses both in x- and y-directions. In z-direction it is confined with two rigid walls so that it cannot expand in this direction. The compressive stresses are given as

$$\sigma_x = -60 \text{ MPa}$$
$$\sigma_y = -100 \text{ MPa}$$ '

Young's modulus and Poisson's ratio of brass are 101 GPa and 0.35 respectively. Assuming that the material is elastically isotropic and homogenous, please calculate:

    3.1 The stress in the z-direction (σ_z). (5 points)

    3.2 The strains in the x- and y-directions (ε_x and ε_y). (10 points)

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Formula
(For Linear Elastic, Isotropic and Homogenous Solid)

Plane stress conditions: $\sigma_3 = 0, \quad \varepsilon_3 \neq 0$

$$\varepsilon_1 = \frac{1}{E}\left[\sigma_1 - v\sigma_2\right]$$

$$\varepsilon_2 = \frac{1}{E}\left[\sigma_2 - v\sigma_1\right]$$

$$\varepsilon_3 = -\frac{v\left(\sigma_1 + \sigma_2\right)}{E}$$

Plane strain conditions: $\varepsilon_3 = 0, \quad \sigma_3 \neq 0$

$$\varepsilon_3 = \frac{1}{E}\left[\sigma_3 - v\left(\sigma_1 + \sigma_2\right)\right] = 0 \quad \rightarrow \quad \sigma_3 = v\left(\sigma_1 + \sigma_2\right)$$

$$\varepsilon_1 = \frac{1}{E}\left[\left(1 - v^2\right)\sigma_1 - v\left(1 + v\right)\sigma_2\right]$$

$$\varepsilon_2 = \frac{1}{E}\left[\left(1 - v^2\right)\sigma_2 - v\left(1 + v\right)\sigma_1\right]$$