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

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

Final Examination for Semester: 2 Academic Year: 2010
Date: February 25, 2011 Time: 09.00-12.00
Subject: 237-508 Structures and Mechanical Properties of Materials Room: A401

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 and course notes are not allowed.
3. Dictionary, calculator and stationery are allowed.
4. This final exam is counted for 30% of the total grade.

Asst. Prof. Dr. Thawatchai Plookphol

Problem No.	Full Score (points)	Student's Score (points)
1.	20	
2.	20	
3.	20	
Total	60	

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1. Explain the following terms:

1.1 Work hardening (2 points)

1.2 Bauschinger effect (2 points)

1.3 Hall-Petch effect (2 points)

1.4 Polymer crazing (2 points)

1.5 Crack resistance, $\mathcal{G}_C$ (2 points)

1.6 Fracture toughness, K_{IC} (2 points)

1.7 High cycle fatigue (2 points)

1.8 Paris law (2 points)

1.9 Power law creep (2 points)

1.10 Diffusional creep (2 points)

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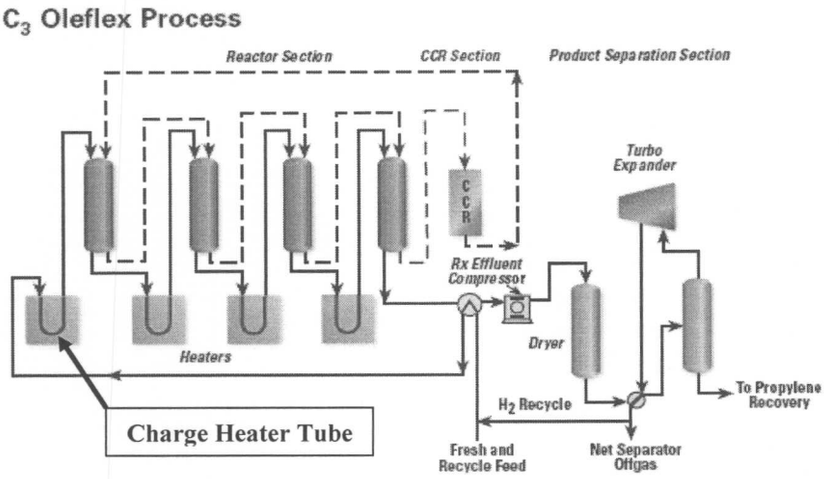
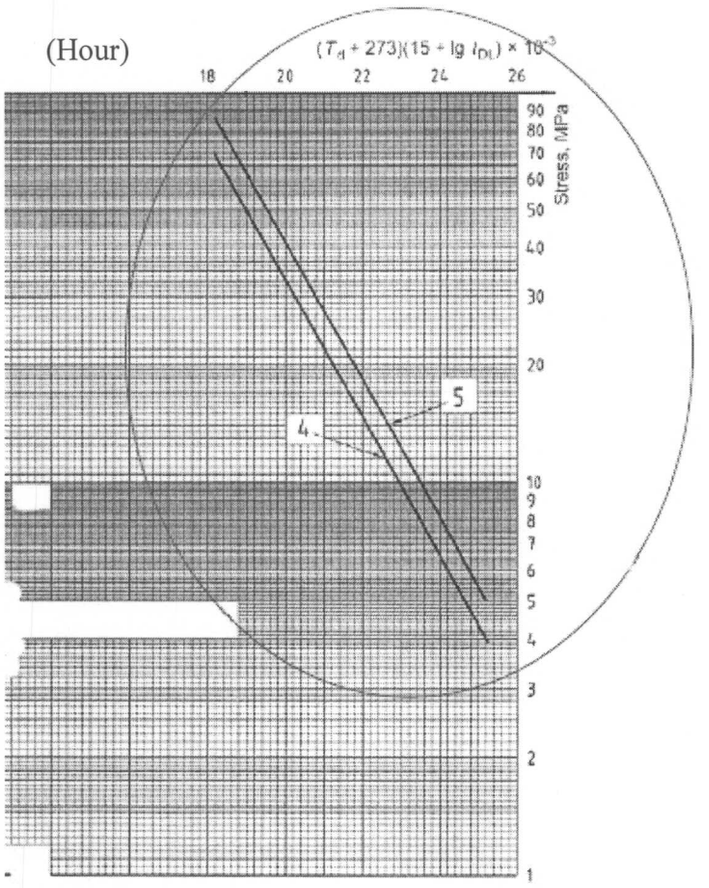
2. The SS347 alloy is used for making charge heater tube in Oleflex petrochemical plant at Maptaput, Rayong, Thailand. The charge heater tube is designed to operate at internal pressure (p) of 0.55 MPa, T = 750 °C. The tube has diameter (D) of 70 mm and thickness (t) of 3.0 mm. Design safety factor = 2.



The Larson-Miller plot for SS347 alloy is given below. Note that curve 4 is the lower limit and curve 5 is the upper limit for new material.



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2.1 Determine the design stress. (5 points)
2.2 What is the maximum life of the tube if it is operated at the design conditions? (15 points)

Assuming a thin-walled pressure vessel, the hoop stress is given by

$$\sigma_{hoop} = \frac{pD}{2t}$$

where, p = the internal pressure (MPa)
D = the diameter of the tube (mm)
t = thickness of the tube (mm).

Larson-Miller Parameter (LMP) for SS347 alloy is given by

$$LMP = (T_d+273)(C + \log t_{DL})$$

where, T_d = Design temperature (°C)
C = Material constant (C = 15 for austenitic stainless steels)
t_{DL} = Design life time (hour).

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3. A deformation mechanism map is helpful for estimating creep rate. Figure 3 shows the deformation mechanism map for pure aluminum of grain size 1 mm. If you are planning to perform high temperature creep test on the aluminum at the following test condition: uniaxial creep stress, σ_1 = 80 MPa, T = 300° C. Estimate the creep rate for the given test condition. Please show your work clearly. (20 points)

Given: $$\sigma_s = \frac{\sigma_1}{\sqrt{3}}$$

at 300° C, $\mu = 2.17\times10^4$ MPa

$T_m = 660$ °C

where, σ_s is the shear stress,
σ_1 is the uniaxial creep stress,
μ is the shear modulus,
T_m is the melting temperature.

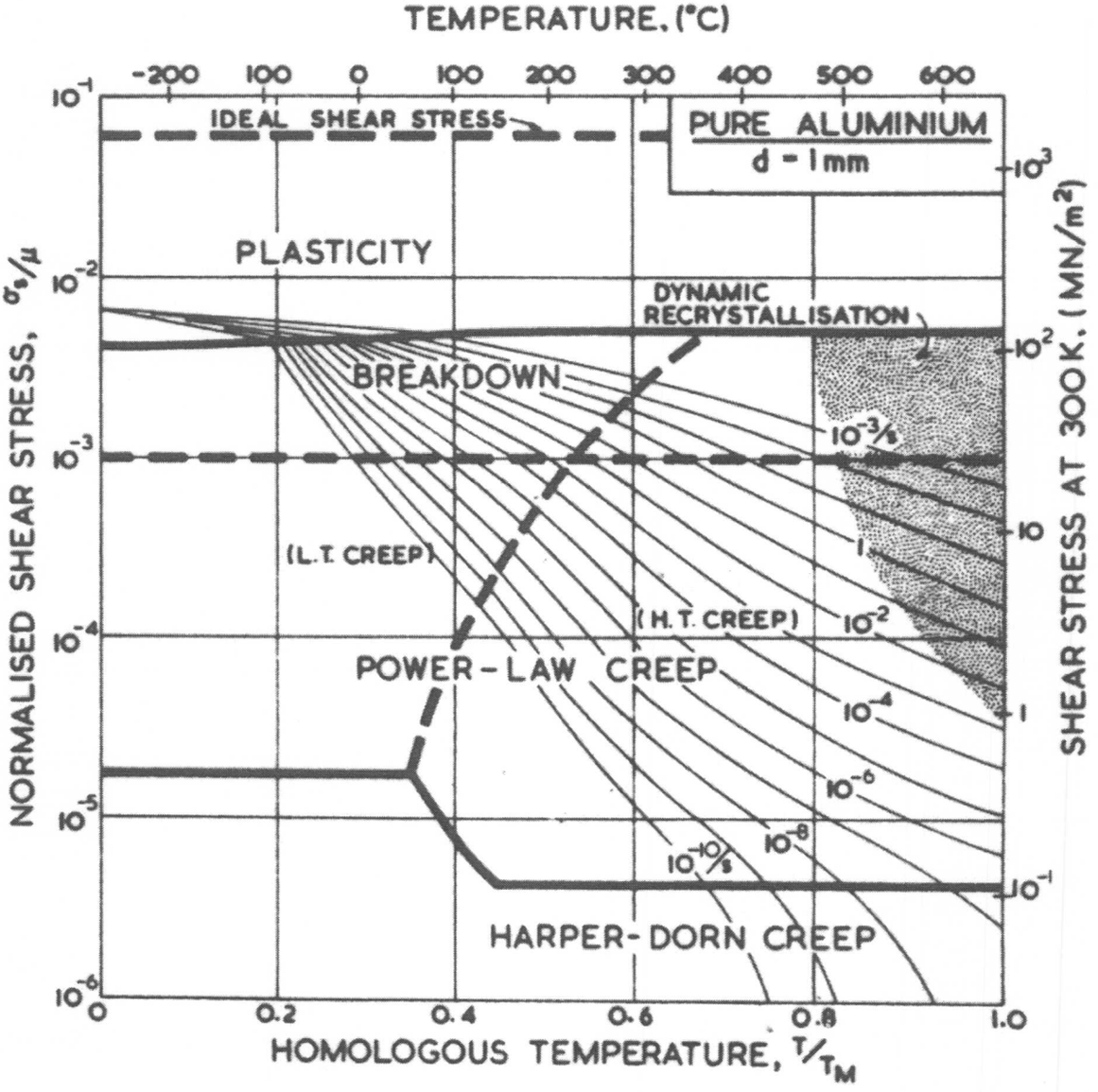

Figure 3 Deformation mechanism map of pure aluminum of grain size 1mm.