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

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

Final Examination for Semester: 2 Academic Year: 2015
Date: April 26, 2016 Time: 09.00 – 12.00
Subject: 238-500 Advanced Mechanical Behavior of Materials Room: A200

For student

1. There are 4 problems. Please do all of them. Write your answers on the answering booklet provided.
2. Text books and other studying materials are not allowed.
3. Dictionary, calculator and stationery are allowed.
4. This final exam is counted for 25% of the total grade.

For instructor

Please distribute an answering booklet for every student.

Asst. Prof. Thawatchai Plookphol, Ph.D.

Problem No.	Full Score (points)	Student's Score (points)
1.	50	
2.	20	
3.	20	
4.	20	
Total	110	

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1. Explain the following terms. (Please draw picture or diagram to support your answer)

1.1 Theoretical Fracture Strength (5 points)

1.2 Crack Resistance, G_C (5 points)

1.3 Fracture Toughness, K_{IC} (5 points)

1.4 Crack Tip Plastic Zone (5 points)

1.5 Hall-Petch Effect (5 points)

1.6 Fatigue Endurance Limit (5 points)

1.7 High Cycle Fatigue (5 points)

1.8 Solute Drag Creep (5 points)

1.9 Dislocation Glide-Climb Creep (5 points)

1.10 Diffusional Creep (5 points)

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2. An engineering component made of heat-resisting Fe-Cr-Ni-Co alloy S-590 is subjected to service temperature of 600 °C. The working life of the component was designed for 100,000 hours. According to the Larson-Miller data shown in Figure 2 below, what is the maximum stress the component can carry? (20 points)

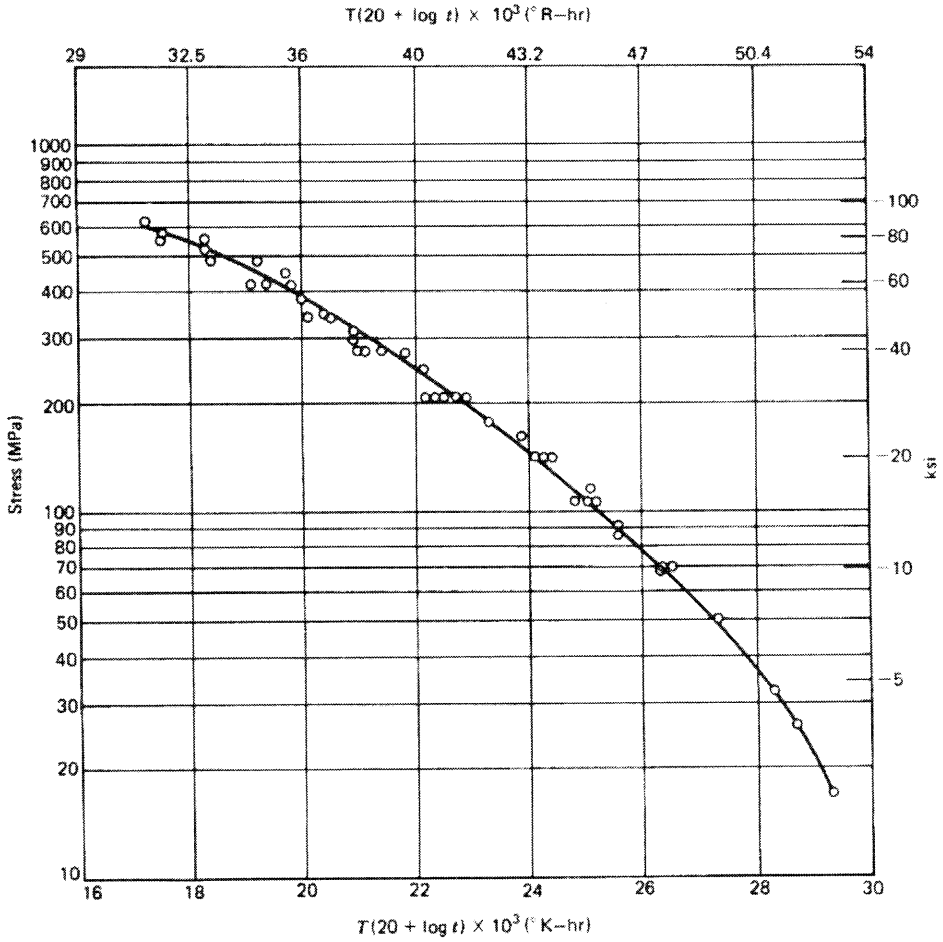

Figure 2 Larson-Miller Plot of Alloy S-590

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3. The linear relationship between crack growth rate ($\frac{da}{dN}$) and stress intensity range (ΔK) on the log-log scale can be explained by the Paris' law,

$$\frac{da}{dN} = C(\Delta K)^p .$$

From the fatigue crack growth data of a zinc alloy as shown in Fig. 3 below, estimate the value of constants C and p. Please use the upper solid line data for the estimation. (20 points)

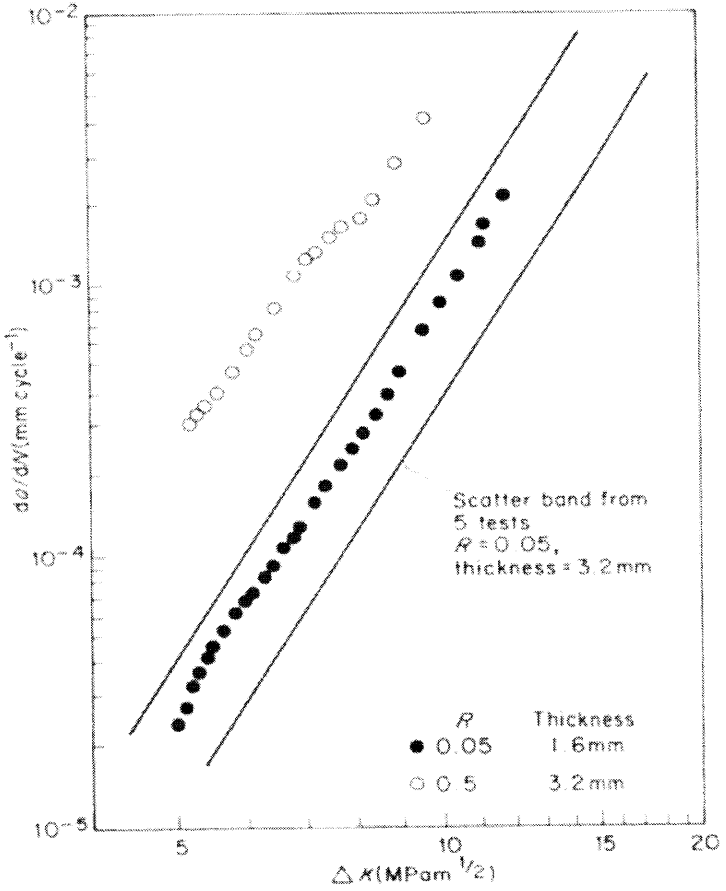

Fig. 3. Crack growth rate da/dN versus stress intensity range ΔK for $R = 0.05$ and $R = 0.5$

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4. Suppose you are planning to perform creep experiment on polycrystalline rock salt (NaCl) and you are interested in the power-law creep behavior of this material. Please use the deformation-mechanism map given below to design the experimental conditions, e.g. what are temperature and stress ranges in which creep experiment will be performed? Show your calculations and explain the reasons to support your answer. (20 points)

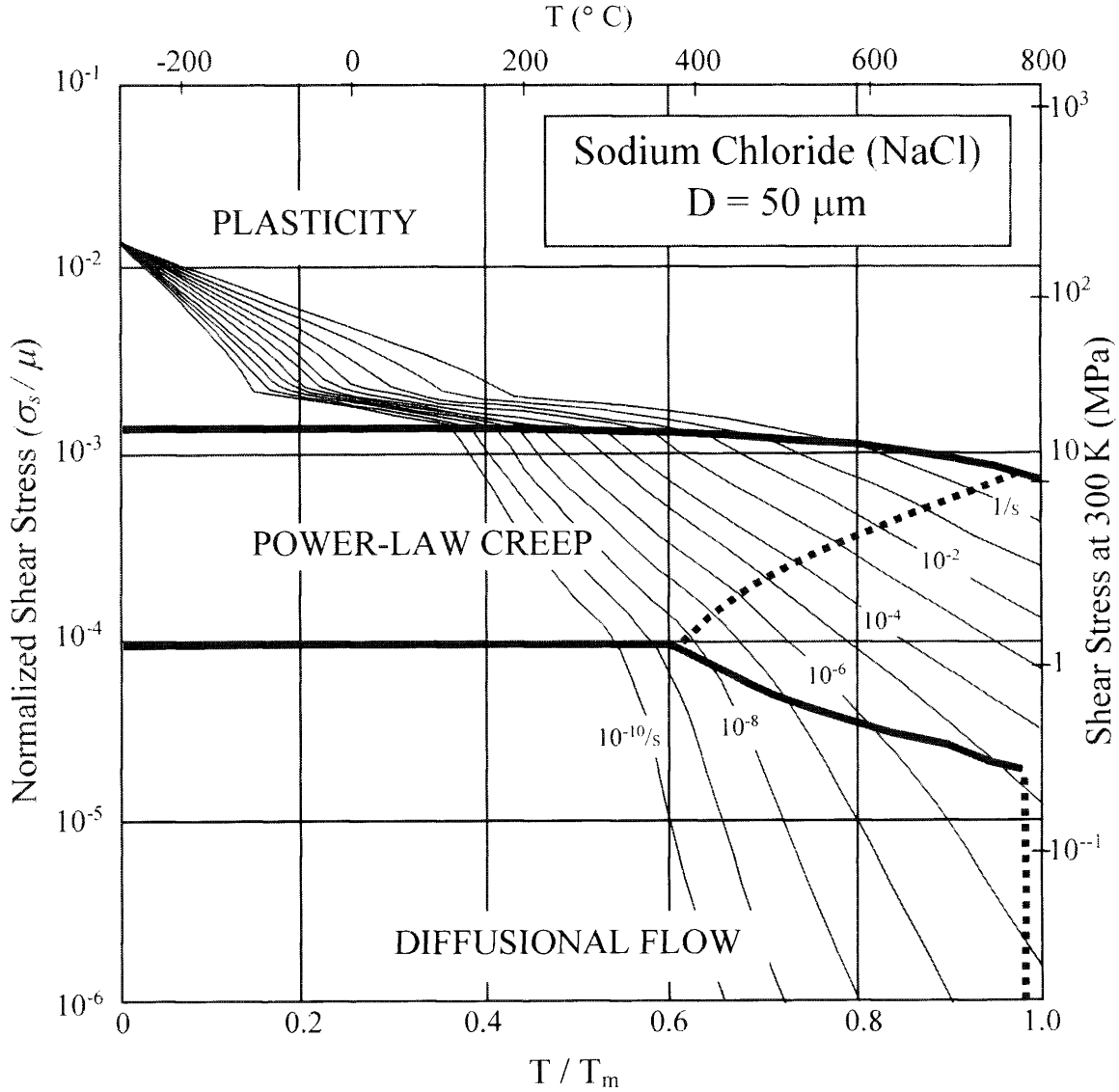

Figure 4 Deformation-mechanism map for sodium chloride (NaCl) of grain size 50 μm. [Redrawn from Frost and Ashby, 1982]

Given:

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

where σ_s is shear stress, and

σ_1 is normal stress.

T_m = 797 °C

μ ≅ 10,000 MPa