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

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

Final Exam for Semester: 2 Academic Year: 2015
Date: May 2, 2016 Time: 09.00-12.00
Subject: 237-320 Mechanical Behavior of Materials Room: A400

For student

1. There are 5 problems. Please do all of them. Write your answers on the exam booklet provided.
2. Text books, course notes 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 exam booklet for every student.

Asst. Prof. Thawatchai Plookphol, Ph.D.

Problem No.	Full Score (points)	Student's Score (points)
1.	30	
2.	30	
3.	30	
4.	30	
5.	30	
Total	150	

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1. Explain the following strengthening methods in metals and alloys (please draw diagram or picture to support your answer).

1.1 Solid-solution strengthening (10 points)

1.2 Precipitation strengthening (10 points)

1.3 Grain-boundary strengthening (10 points)

2. Explain the following creep mechanisms. (please draw diagram or picture to support your answer).

2,1 Solute drag creep (10 points)

2.2 Dislocation glide-climb creep (10 points)

2.3 Diffusional creep (10 points)

3. A fatigue specimen made of aluminum alloy with diameter of 6 mm is subjected to cyclic axial load that varies from a maximum of 10,000 N tension to a minimum of 5,000 N compression. Calculate the following fatigue stress parameters:

3.1 The maximum stress, σ_{max} (5 points)

3.2 The minimum stress, σ_{min} (5 points)

3.3 The stress range, σ_r (5 points)

3.4 The alternating stress, σ_a (5 points)

3.5 The stress ratio, R (5 points)

3.6 The amplitude ratio, A (5 points)

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4. The following data were obtained from creep tests at a constant temperature of 250 °C on 7075-T651 aluminum alloy.

σ (MPa)	$\dot{\varepsilon}_{ss}$ (s^{-1})
40	1.6×10^{-7}
60	5.9×10^{-7}
80	2.0×10^{-6}
100	6.6×10^{-6}
120	2.4×10^{-5}

The steady state creep rate $\dot{\varepsilon}_{ss}$ can be expressed as

$$\dot{\varepsilon}_{ss} = A\sigma^{n} \exp(-\frac{Q_c}{RT})$$

4.1 What are the parameters A, n, and Q_c? (6 points)

4.2 Evaluate the value of n. (20 points)

4.3 What creep mechanism can be concluded from the experiments? Explain reason to support your answer. (4 points)

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5. An engineering part made of A356 aluminum alloy was designed to operate at stress of 120 MPa and temperature of 100 °C. Larson-Miller plot of A356 alloy is given in Figure 5.

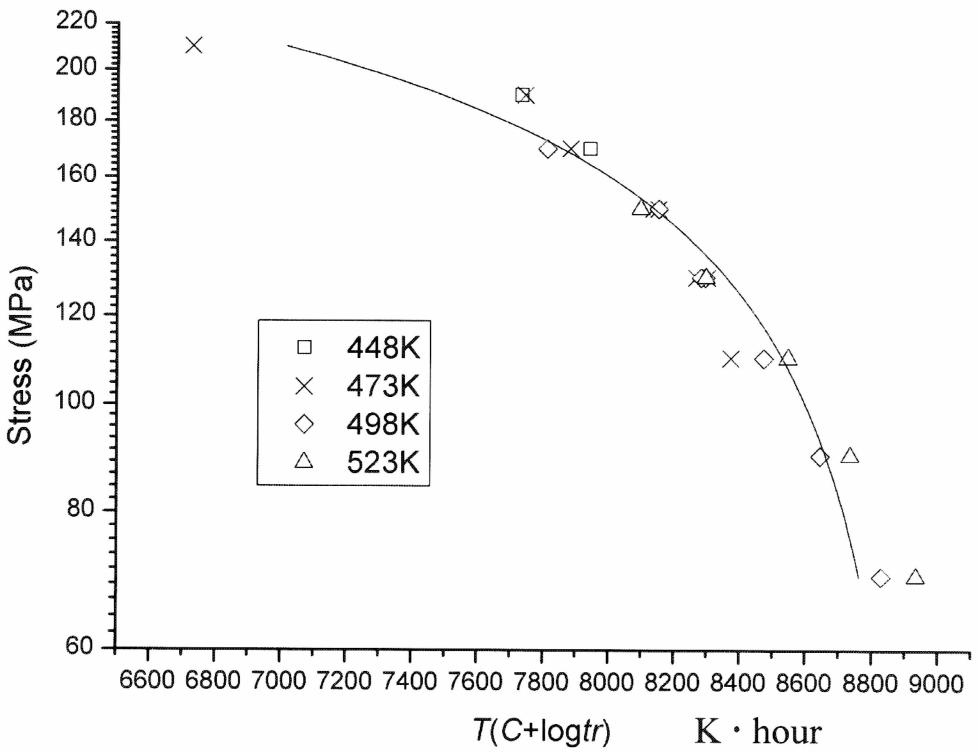

Figure 5. A Larson-Miller plot of A356 aluminum alloy. T is the absolute temperature in K; $C = 16.4$; t_r is the rupture time in hour.

5.1 For the original design, calculate service life of the part (in hour) (15 points)

5.2 If the part is re-designed to operate at temperature of 120 °C and for the service life of 100,000 hours, what is the maximum allowable stress (in MPa)? (15 points)