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

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

Final Exam for Semester: 2 Date: May 14, 2015 Subject: 237-320 Mechanical Behavior of Materials Academic Year: 2014 Time: 09.00-12.00 Room: Robot Head

## **Instruction**

- 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. 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.

Asst. Prof. Thawatchai Plookphol, Ph.D.

Problem No.	Full Score (points)	Student's Score (points)
1.	30	
2.	30	
3.	30	
4.	30	
Total	120	

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

1.1 Solid-solution strengthening. (5 points)

1.2 Precipitation strengthening. (5 points)

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1.3 Work hardening strengthening (5 points	)
1.5 work-nardening suchguidning. (5 points	)
1.4 Power-law dislocation creep. (5 points)	

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1.5 Diffusional creep. (5 points)	
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1.6 Low cycle fatigue. (5 points)	
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2. A fatigue specimen made of ZA-27 zinc alloy with diameter of 12.5 mm is subjected to cyclic axial load that varies from a maximum of 20,000 N tension to a minimum of 10,000 N compression. Calculate the following fatigue stress parameters:

2.1 The maximum stress, $\sigma_{\text{max}}$	(5 points)
2.2 The minimum stress, $\sigma_{\min}$	(5 points)
2.3 The stress range, $\sigma_r$	(5 points)
2.4 The alternating stress, $\sigma_a$	(5 points)
2.5 The stress ratio, R	(5 points)
2.6 The amplitude ratio, $A$	(5 points)



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3. The linear relationship between crack growth rate  $(\frac{da}{dN})$  and stress intensity range  $(\Delta K)$  on the log-log scale can be expressed as

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

Estimate the value of constants C and p from the fatigue crack growth data of a zinc alloy die casting as shown in Fig. 3 below. Please use the upper-limit solid line for estimation. (30 points)





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4. An engineering member is made of 23Cr-43Ni alloy with 5/7%W. The Larson-Miller parameter plot of creep data of the alloy is given below (solid line).

4.1 If the member is designed to carry a load of 120 MPa, at a service temperature of 600 °C. Estimate the creep life of the member in hours. (15 points)

4.2 If the member is designed for a creep life of 100,000 hours, at the same service temperature of 600 °C, what is the allowable stress? (15 points)



20.36 Larson-Miller parameter plot of creep data for 23Cr-43Ni alloys with 3%/5%Mo or 5%/7%W.

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