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

Final Exam for Semester: 2 Date: February 25, 2009

Subject: 237-221 Mechanical Behavior of Materials

Academic Year: 2008 Time: 09.00-12.00

Room: R300

Instructions

1. There are 4 problem sets. Please do all of them. Write your answers in the space provided after each problem set. If you need more space, you can write on the back of the paper.

2. Only two pieces of A4-size note are allowed. You may write on both sides of the note. Please return them with your answers.

3. Dictionary, calculator, and stationery are allowed.

4. Text books, course notes, and other studying materials are not allowed.

5. This final exam is counted for 25% of the total grade.

Asst. Prof. Dr. Thawatchai Plookphol

Problem No.	Full Score (points)	Student's Score (points)
1.	20	
2.	20	
3.	20	
4.	20	
Total	80	

237-221 Final Exam

237-221 Final Exam

Page 3 of 10

NameStudent I	.D
---------------	----

3. A plate made of AISI 4340 steel is subjected to constant amplitude uniaxial fatigue loads to produce stresses varying from $\sigma_{max} = 525$ MPa and $\sigma_{min} = 175$ MPa. The static properties of steel are $\sigma_y = 1255$ MPa, $\sigma_{UTS} = 1296$ MPa., E = 210 GPa and $K_{lc} = 130$ MPa \sqrt{m} . If the plate contains an initial through thickness edge crack of 1 mm, how many fatigue cycle will be require to break the plate. (20 points)

We can assume an infinite wide plate, for which $\alpha = 1.12$. For AISI 4340 steels, a general correlation gives

$$\frac{da}{dN} \text{ (m/cycle)} = 1.095 \times 10^{-12} \left(\Delta K \right)^{3.24} \text{ (MPa} \sqrt{\text{m}})^{3.24}.$$

Given:

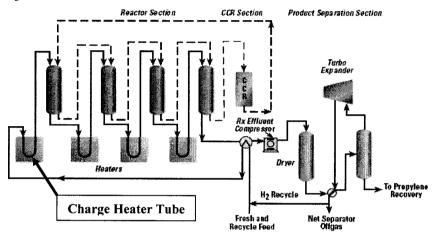
$$N_f = \frac{a_f^{-(p/2)+1} - a_i^{-(p/2)+1}}{(-(p/2)+1)A\sigma_r^p \pi^{p/2}\alpha^p}$$

$(-(p/2)+1)A\sigma_{r}^{r}\pi^{r}\alpha^{r}$			
At failure:	$K_{Ic} = \alpha \sigma_{max} \sqrt{\pi a_f}$		
	·		
<u> </u>			
			

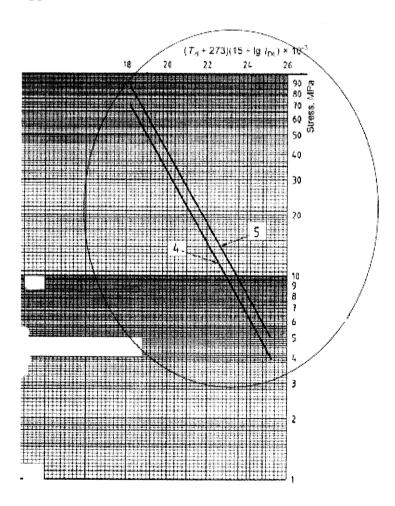
Name.....Student I.D....

4. The SS347 alloy is used for charge heater tube in Oleflex petrochemical plant at Maptaput, Rayong, Thailand. The charge heater tube was designed to operate at internal pressure (p) of 550 kPa, T = 754 °C. The tube has diameter (d) of 73 mm and thickness (t) of 3.05 mm.

C₃ Oleflex Process



A 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.



Given: For a thin-walled pressure vessel,

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

Larson-Miller Parameter (LMP) for SS347 alloy is defined as

$$LMP = T(C + log t)$$

where T =Absolute temperature in K C = Material constant (15 for austenitic stainless steels)t = time in hours