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

Department of Mining and Materials Engineering

Faculty of Engineering

Prince of Songkla University

Mid-term Examination for Semester: 1 Academic Year: 2014

Date: October 15, 2014 Time: 09.00 - 12.00

Subject: 237-407 Failure Mechanics and Analysis Room: R200

Instructions

1. There are 3 problem sets (9 pages including cover page). Please do all of them. Write your answers in the space provided.
2. Dictionary and calculator are allowed.
3. Text books and course notes are not allowed.
4. This mid-term exam is accounted for 25% of total grade.

Asst. Prof. Dr. Thawatchai Plookphol

Problem no.	Full score	Student's score
1	40	
2	40	
3	40	
Total	120	

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Problem 1 (40 points)

Explain the following terms: (please give example and/or draw picture, diagram to support your answer)

1.1 Griffith's fracture theory for brittle materials (10 points)

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1.2 Irwin's concept of stress intensity factor K (10 points)

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1.3 Fracture toughness, K_{IC} (10 points)

1.4 Plastic zone (10 points)

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Problem 2 (40 points)

2.1 Calculations based on the cohesion force suggest that the tensile strength of glass should be 10 GPa. However, a tensile strength of only 1.5 % of this value is found experimentally. Griffith supposed that this low value was due to the presence of cracks in the glass. Calculate the size $2a$ of a crack normal to the tensile direction in a plate. (20 points)

Given: Young's modulus $E = 70$ GPa

Surface tension $\gamma_s = 0.5$ J/m^2

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2.2 A plate made of maraging steel has a tensile strength of 1900 MPa. Calculate the reduction in strength caused by a crack in this plate with a length $2a = 3$ mm oriented normal to the tensile direction. (20 points)

Given: Young's modulus $E = 200$ GPa

Surface tension $\gamma_s = 2$ J/m^2

Plastic energy per unit crack surface area $\gamma_p = 2\times10^4$ J/m^2

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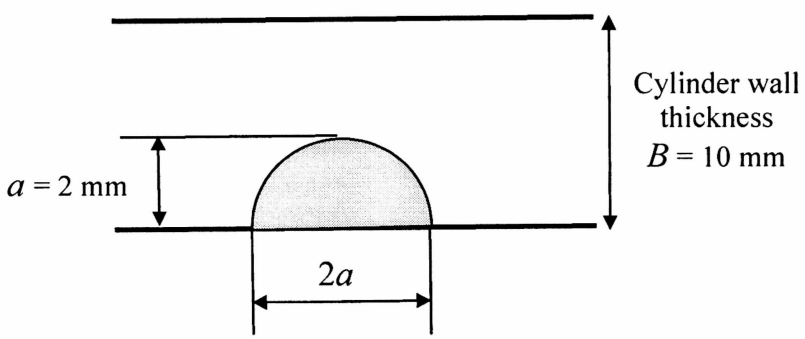
Problem 3 (40 points)

A 7049-T73 aluminum forging is the material of choice for an 8-cm-internal-diameter hydraulic actuator cylindrical housing that has a wall thickness of 10 mm. After manufacture, each cylinder is subjected to a safety check, involving a single fluid overpressurization that generates a hoop stress no higher than $50\%\sigma_{YS}$. The component design calls for an operating internal fluid pressure, corresponding to a hoop stress no higher than $25\%\sigma_{YS}$. Prior to overpressurization, a 2-mm-deep semicircular surface flaw that was oriented normal to the hoop stress direction was discovered in one cylinder. Given that $\sigma_{YS} = 460\,\text{MPa}$ and $K_{IC} = 23\,\text{MPa}\sqrt{\text{m}}$, would the cylinder have survived the overpressurization test? Please show your calculation to support your answer.

For a semicircular surface crack: $K_I = 1.1(\frac{2}{\pi})\sigma\sqrt{\pi a}$



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