| | | |
|---|---|---|
| **Menoufiya University**<br>**Faculty of Engineering**<br>**Shebin El- Kom**<br>**Final Term Examination**<br>**Academic Year: 2013 – 2014**<br>**Date: 14/6/ 2014** | | **Dept. : Production Engineering**<br>**Year Third Year**<br>**Subject: Fracture Mechanics**<br>**Code : PRE 322**<br>**Time Allowed: 3 hr.**<br>**Total Marks: 85 Marks** |
| **Allowed Tables and Charts: None** | | |

**Answer all the following Questions**

(Any missing data can be reasonably assumed)

**Question (1)** **(5+5+5 Marks)**

a) Explain Griffith theory of brittle fracture and derive Griffith's equation for determining the stress required to propagate a crack in a brittle material.

b) Describe how the critical stress intensity, $K_C$, depends on the thickness and discuss the factors that affect the plane strain fracture toughness

c) A material has a yield strength of 345 MPa and a plane strain linear elastic fracture toughness of 120 MPa$\sqrt{m}$. Determine the minimum specimen dimensions ( B, a, W ) required to perform a valid $K_{IC}$ test on this material. Comment on the feasibility of testing a specimen of this size

**Question (2)** **(7+8 Marks)**

a) Describe a test procedure for determining the plane fracture toughness indicating how to determine the critical load, $P_Q$, the relationship for computing the provisional fracture toughness, $K_Q$, and the validity requirements for $K_Q = K_{IC}$.

b) Assume that a component in the shape of a large sheet is to be fabricated from 0.45C-Ni-Cr-Mo steel. It is required that the critical flaw size be greater than 3 mm. A design stress equal one-third the tensile strength. To save weight, an increase in the tensile strength from 1500 MPa to 2100 MPa is suggested. At the 1500 MPa strength level, it is found that the $K_{IC}$ value is 66 MPa$\sqrt{m}$, while at 2100 MPa $K_{IC}$ drops sharply to 33 MPa$\sqrt{m}$. Is such a strength increment allowable? Comment on your results.

**Question (3)** **(4+3+4+4 Marks)**

a) From your study to some cases, list the main reasons that cause failure in metallic components and the suggested corrections?

b) Explain graphically the concept of ductile to brittle transition temperature.

c) Explain the differences between the ductile and brittle fracture; list the factors that increase the tendency for brittle fracture.

d) Describe an estimate of crack tip plastic zone size indicating its effect on the effective stress intensity level $K_{eff}$.

**Question (4)** **(6+3+6 Marks)**

a) Explain two approaches for estimating the fatigue life.
b) Describe the failure characteristics due to fatigue.
c) A large center-cracked plate containing an initial crack of length $2a_o$ = 16 mm is subjected to a constant amplitude cyclic tensile stress ranging between a minimum value of 80 MPa and a maximum of 160 MPa. Assuming the fatigue crack growth rate is governed by the equation

$$\frac{da}{dN} = 0.42 \times 10^{-11}(\Delta K)^3 \qquad \text{(m/cycle)}$$

Assuming that the relevant fracture toughness is 50 MPa$\sqrt{m}$.
Estimate the number of cycles to failure.

**Question (5)** **(3×5 Marks)**

Explain the differences between the following expressions showing your answer graphically:

i) Primary cooling and secondary cooling.
ii) Fine precipitations and coarse precipitations.
iii) Fast cooling and slow cooling.
iv) Solution temperature and test temperature.
v) Vacuum casting and air casting.

**Question (6)** **(2×5 Marks)**

i) Explain the effect of temperature oscillation on the hot ductility of both Nb and Ti steels?
ii) Explain the three regions of hot ductility curve (HDL, Trough and HDH).

## Good Luck

| This exam contributes "by measuring ILOs" in achieving Programme Academic Standards according to NARS | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Question Number** | Q1-a | Q2-a | Q3-a | Q5 | Q6 | Q2-a | Q2-b | Q3-b | Q5 Q4-b | Q6 | Q2-b | Q2-b | Q3-b | Q4-a, | Q4 -c |
| **Skills** | a5-1,2 | a5-1,2 | a15-2 | a15-2 | a15 -2 | b1-1 | b1-1 | b1-1 | b1-1 | b1-1 | c1-1 | c1-1 | c1-1 | c1-1 | c1-1 |
| | Knowledge & Understanding Skills | | | | | Intellectual Skills | | | | | Professional Skills | | | | |