UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2011/2012

COURSE NAME	:	FATIGUE AND FRACTURE
COURSE CODE	:	BDC 40303
PROGRAMME	:	SARJANA MUDA KEJURUTERAAN MEKANIKAL DENGAN KEPUJIAN
DATE	:	JANUARY 2012
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTIONS	:	ANSWER FOUR (4) OF SIX (6) QUESTIONS

THIS PAPER CONTAINS SEVEN (7) PRINTED PAGES

Q1 Fracture surfaces of the material as shown in **Figure Q1**.

(a) Describe the features of fracture?

(6 marks)

(b) Explain the process of fracture for the material has extensive plastic deformation.

(9 marks)

(c) Explain and determine the mechanical properties of material form engineering stress-strain curve for a ductile material. Give an example of the application for this failure mode.

(10 marks)

Q2 (a) Define the following concepts in your own words:

(i) Fracture toughness, K_{IC}

(ii) Strain energy release rate, G

(iii) Mode I, II and III

(9 marks)

(b) A centre-cracked plate of AISI 1144 as shown in **Figure Q2**, has dimensions b = 40 mm and t = 15mm. For a safety factor of three against brittle fracture, what is the maximum permissible force P on the plate if the crack half-length, a is 10mm. If the safety factor of design application is 2, determine the critical crack length, a_c for the fracture of this material.

Given $F=(1-0.5\alpha+0.32\alpha^2)/(1-\alpha)^{1/2}$ *for* $h/b \geq 1.5$

(16 marks)

Q3 The effects of yield strength and temperature on fracture toughness for nuclear pressure of A533B steel are plotted in graph is shown in **Figure Q3**.

(a) Explain the behavior of material A533B steel.

(10 marks)

(b) Obtain the approximately values of fracture toughness K_{IC} and yield strength σ_o for this material at temperatures of -150°C and +10°C and comment for this results.

(15 marks)

Q4 (a) Describe in details the term as below:-

(i) Linear Elastic Fracture Mechanics (LEFM)

(ii) Cleavage Fracture

(iii) Fatigue Limit

(iv) Fatigue Crack Growth

(8 Marks)

(b) For a low carbon steel with yield strength of 1000 MPa and fracture toughness K_{IC} of 50 $MPam^{0.5}$. Determine the allowable defect size if the design stress is half of the yield strength. Also, indicates two possibilities of countermeasure to fracture by non-destructive test where the size of defect is 10mm.

(17 marks)

Q5 (a) A plate center cracked tension type is subjected to a maximum stress of 160 MPa and a minimum of -20 MPa. Determine and sketch the stress cycles:-

(i) Mean stress
(ii) Stress amplitude
(iii) Stress range
(iv) Stress ratio

(12 marks)

(b) The AISI 4340 steel is subjected with the cyclic loading with stress ratio R = -1, the fatigue fracture was occurred after 10^5 cycles at σ_a = 350 MPa and 10^7 cycles at σ_a = 200 MPa. Determine the number of cycles to failure when σ_a = 280 MPa is applied.

(13 marks)

Q6 (a) The fatigue crack growth rate behavior of 7075-T6 Al is shown in **Figure Q6**.

(i) Describe the stages of fatigue crack growth behavior and effect the r-ratio on the fatigue crack growth rate.

(6 marks)

(ii) Determine the coefficient and exponent of the Paris equation for stage II fatigue crack growth rate region, as shown by the curve.

(9 marks)

(iii) Calculate the critical length of a through-thickness edge crack for fast fracture of the plate under fatigue loading with stress amplitude of 110 MPa. Assume the geometry factor, $Y = 1.12$.

(10 marks)

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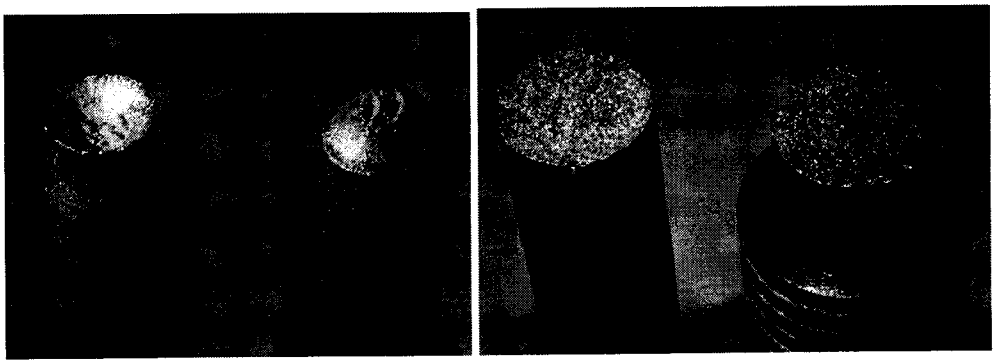

(a) (b)

FIGURE Q1

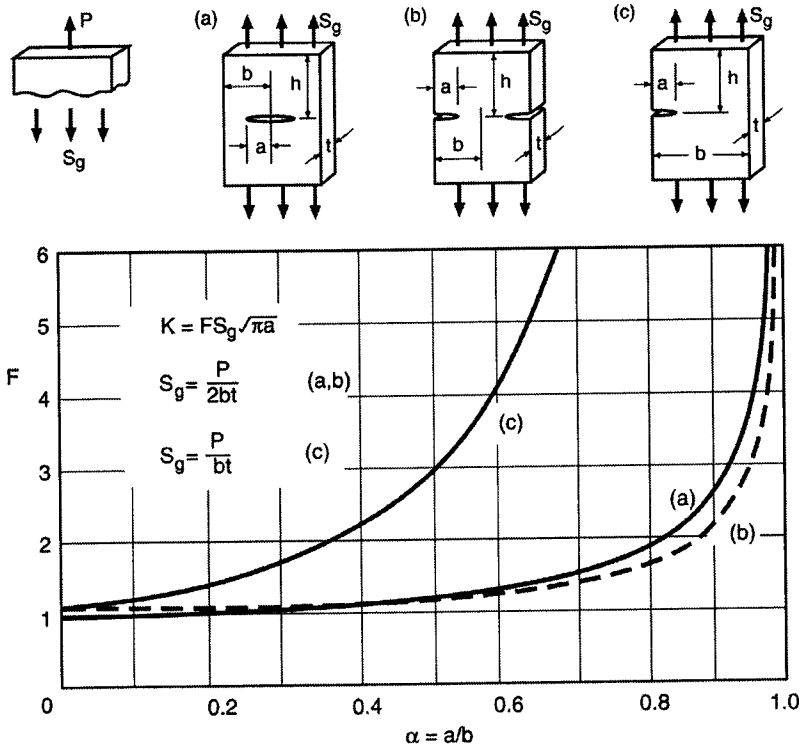

FIGURE Q2

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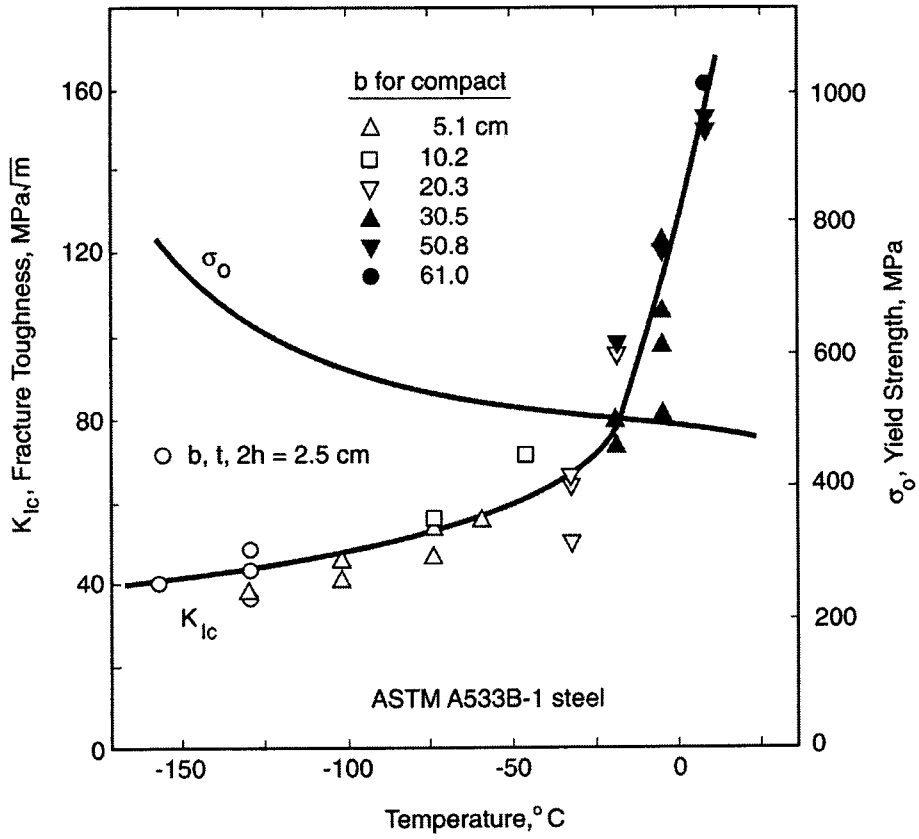

FIGURE Q3

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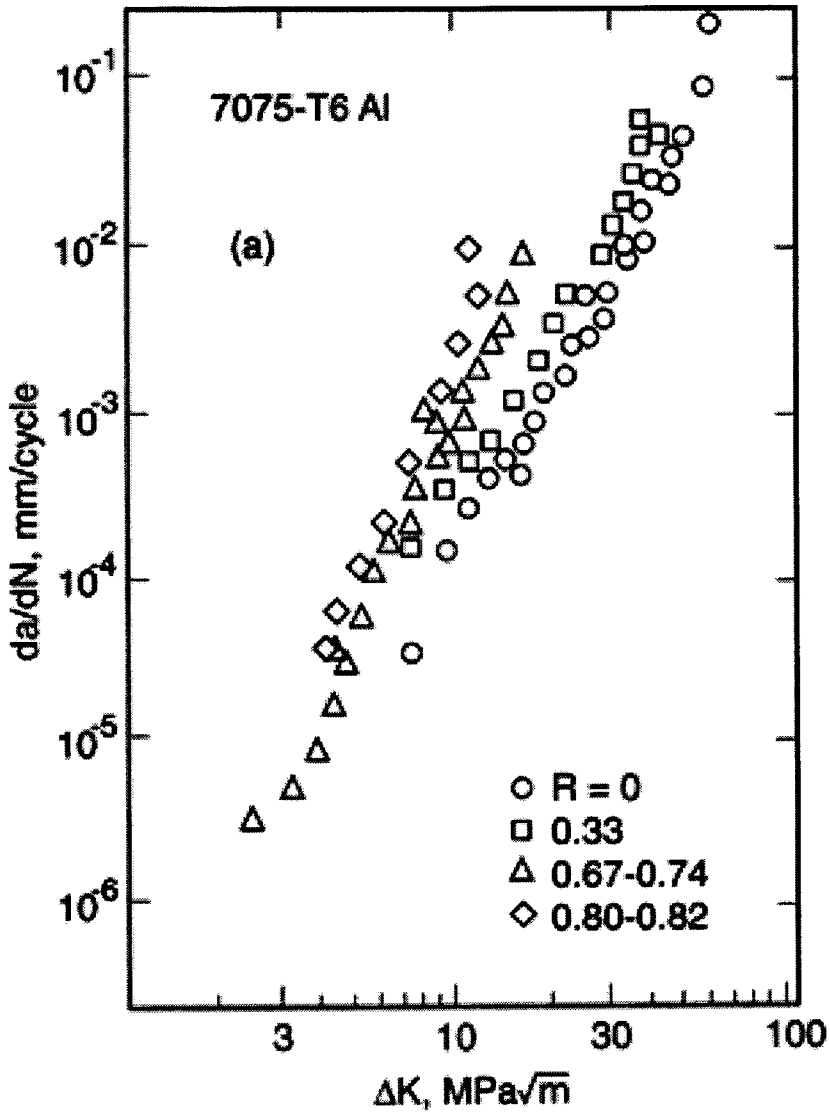

FIGURE Q6