Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University, Manipal - 576 104

II SEM. M. Tech. (CAMDA) DEGREE END SEMESTER EXAMINATIONS MAY 2016

SUBJECT: FRACTURE MECHANICS APPROACH TO LIFE PREDICTION (MME-502)

Time: 3 Hours MAX.MARKS: 50

Instructions to Candidates:
- Answer **ANY FIVE FULL** questions.
- Additional data required, if any, may be appropriately assumed.
- Hand Book of Fracture is permitted

1A) Consider a circumferentially cracked cylinder of 480 mm internal diameter, 24 mm wall thickness and 3mm long crack all around the circumference. The material follows the Ramberg-Osgood equation with the material constants as: σ_{ys} = 800 MPa, E = 207 GPa, α = 8.6, n = 3. The cylinder is subjected to axial tension. If J_p = 150 kJ/m^2, determine the maximum axial tensile stress. Neglect J_e. (5)

1B) Derive the relation between energy release rate and stress intensity factor. (5)

2A) Explain the Walker model of FCG. For 2024-T3 aluminum (σ_{ys} = 353 MPa, K_{IC} = 34 MPa$\sqrt{m}$, $C^{'}$ = 1.42 x 10^{-8} MPa^x mm^y, $m^{'}$ = 3.59, γ = 0.68) estimate da/dN vs ΔK equation for both R = 0.3 and R = 0.6 . Given that C' = C(1-R)$^{m(1-\gamma)}$. (5)

2B) Explain the significance of CTOD and J-intergral. By derivation, obtain the relationship between CTOD and J-integral. (5)

3A) For finding material constants of Paris law it was found that an already nucleated centre crack grows from a=2.8 mm to a=3.5 mm in 1000 cycles of a constant amplitude load. When the same load is continued, the crack grows from a=16 mm to a=18.4 mm in 1400 cycles. If σ_{max} = 180 MPa and σ_{min} = 90 MPa, find constants C and m. (5)

3B) Discuss about the size and shape of the plastic zone. Derive an expression for plastic zone shape based on Mises yield criterion. (5)

4A) On a large plate, used as a component of a machine, amplitude of fatigue load shifts several times in a sequence of every 1000 cycles as: 200 cycles @ 0-60 MPa, 400 cycles @ 0-120 MPa, 200 cycles @ 0-160 MPa, 200 cycles @ 0-60 MPa. The material follows Paris law with $C = 2.2 \times 10^{-12}$ $MPa^{-3.4}$ $m^{-0.7}$, m= 3.4 . Determine how many load sequences are needed to cause the failure if initial crack of 2a = 7.2 mm detected near centre of plate & K_{IC} = 80 MPa$\sqrt{m}$. (5)

4B) Discuss the plane stress and plane strain conditions around the crack tip. Explain with necessary conditions, determination of the plane strain fracture toughness (K_{IC}) value of a material. (5)

5A) What is energy release rate? Discuss critical energy release rate in case of plane stress and plane strain conditions. What are the limitations to apply energy release rate for design of components. (4)

5B) What is surface crack and how it is modeled? Show that surface crack grows deeper into thickness rather than sideways on the surface. (3)

5C) Explain the design features of CT specimen used for fatigue crack growth rate test. Explain in brief how Paris constants are determined in FCG rate test. (3)

6) Discuss the following:

i) LEFM and Westergaard approach for SIF
ii) Threshold stress intensity factor range
iii) Leak before break
iv) Crack closure

(10)