Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

A Constituent Institute of Manipal University, Manipal

VI SEMESTER B.TECH. (MECHANICAL & IP)
END SEMESTER EXAMINATION - JUNE 2017
SUBJECT: PROGRAM ELECTIVE - IV (FATIGUE AND FRACTURE, MME 4003)
REVISED CREDIT SYSTEM

Time: 3 Hour **Max. Marks: 50**

Note: (i) Answer all the questions
(ii) Missing data, if any, may be appropriately assumed
(iii) Assumptions made must be clearly mentioned

1A	State and explain the factors that influence fatigue life.	03
1B	Explain fatigue failure mechanism.	03
1C	Given a material with ultimate strength of 500 MPa, an endurance limit of 240 MPa and a true fracture strength of 800 MPa, determine the allowable zero to maximum (R=0) stress which can be applied for 10^4 cycles. Make predictions using Goodman and Marrow relations.	04
2A	What is energy release rate? Derive the expression for energy release rate for standard DCB specimen through compliance approach.	04
2B	A notched steel component consists of a bar 25 mm wide and 6 mm thick with two semi-circular edge notches with radii of 2.5 mm. This gives the plate width at the reduced section of 20 mm. Determine the life of the component by using strain life approach when subjected to a fully reversed load with an amplitude of 69 MPa. The steel has an ultimate strength of 790 MPa. (K_t = 2.42; E = 200 GPa; K' = 1065 MPa; n' = 0.123; b = − 0.081; c = − 0.67; σ_f' = 1165 MPa; ε_f' = 1.14)	04
2C	Theoretical stress concentration factor cannot be used to predict notch stress strain behavior. Justify	02
3A	A metal has the monotonic tension properties E = 193 GPa, S_y (0.2 % offset) = 325 MPa, S_u = 650 MPa, σ_f = 1400 MPa, ε_f = 1.73, % RA = 80, n = 0.193. Under cyclic loading will the material harden or soften. Calculate strain reached on the first half cycle for a stress amplitude of 200 MPa. Given that the material has the following cyclic properties. K' = 1660 MPa, n' = 0.287. Determine the stable total strain and plastic strain amplitude for a stress amplitude of 200 MPa.	05
3B	At the transition life $2N_t$, determine the stress and strain amplitude ($\Delta\sigma/2$, $\Delta\varepsilon/2$) in terms of the cyclic stress-strain properties (E, K', n') of a material.	03
3C	What is fatigue damage and how it is quantified?	02

4A	With relevant sketches explain cyclic hardening and softening of the material under fatigue loading.	03
4B	A thin plate has an edge crack of 30 mm length and a far field stress of 320 MPa. If yield strength of the material is 920 MPa determine plastic zone size and effective crack length. Geometry constant, $f(\alpha)$, for edge cracked plate may be assumed as 1.13.	03
4C	Discuss the effect of plate thickness on plastic zone size and stress intensity factor. And explain why plane strain fracture toughness is considered as material property.	04
5A	With neat sketch explain various stages of fatigue crack growth.	03
5B	Compare strain-life and LEFM approaches of life estimation of a component.	03
5C	An edge crack detected on a large plate is of length 3 mm. The plate is subjected to constant amplitude fatigue loading of σ_{max} = 300 MPa and σ_{min} = 160 MPa. If the fracture toughness of this material is 150 MPa$\sqrt{m}$, C= 7 x 10^{-12} and m = 3.2 for the steel material determine crack length at failure and life of the component. Geometry constant $\beta = f(\alpha)$ may be assumed as 1.12.	04