Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
A Constituent Institute of Manipal University, Manipal

I SEMESTER M.TECH. (COMPUTER AIDED ANALYSIS & DESIGN)
END SEMESTER EXAMINATION – NOV./DEC. 2016
SUBJECT: FATIGUE OF MATERIALS (MME 5104)
REVISED CREDIT SYSTEM
01-12-2016

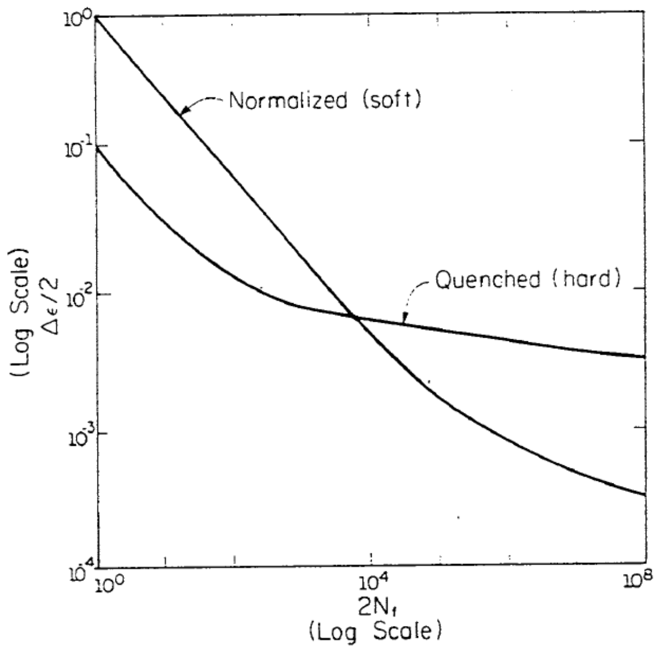
Time: 3 Hour **Max. Marks: 50**

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

1A. Analyse the significance of high cycle and low cycle fatigue phenomena. How stress-life and strain-life approaches are applied considering their strengths and weaknesses. 05

1B. Discuss about the different fatigue life extension methods. 03

1C. Fatigue phenomenon is material dependent. Justify this statement, considering the strain-life curve for a medium carbon steel material as shown in the figure. 02



2A. A component undergoes a cyclic stress with a maximum value of 700 MPa and a minimum value of 250 MPa. The component is made of steel with an ultimate strength of 1100 MPa, yield strength 800 MPa, endurance limit of 500 MPa and has fully reversed stress at 1000 cycles as 900 MPa. Using Soderberg, Goodman and Gerber relation, predict the life of component. Interpret the predicted life considering these three different relations. Also fit an S-N equation. 05

2B. i) Evaluate the influence of notch and mean stress on the fatigue behavior of ductile materials? 05

ii) A steel [S_u = 760 MPa, S_y = 640 MPa, σ_f = 900 MPa, $S_n = 855N^{-0.064}$ (correspond to axial zero mean stress)] plate with a hole (k_t = 2, k_f = 1.88) is subjected to axial fatigue loading such that the mean stress is 305 MPa. If the local stress at the hole is limited to yield point stress determine the fatigue loading for a life of 3×10^5 cycles.

3A. Load sequence influences fatigue life. Justify. 03

3B. Analyse the salient features of following Cumulative damage theories. 04
i) Marco-Starkey ii) Manson double linear damage rule.

3C. Explain as how cycle counting method is used to interpret a given variable amplitude loading for fatigue life prediction. 03

4A. Given below are the results of constant amplitude strain-controlled tests. The material has a modulus of elasticity, E of 200 GPa. 06

Total strain amplitude ($\Delta\varepsilon/2$)	Stress amplitude $\Delta\sigma/2$ (MPa)	Reversals to failure ($2N_f$)
0.00202	261	416714
0.0051	372	15894
0.0102	428	2671
0.0151	444	989

Determine

i) Cyclic stress-strain properties (K', n')
ii) Strain-life properties (σ_f', ε_f', b, c)
iii) Transition life ($2N_t$)
iv) Fatigue life at strain amplitude ($\Delta\varepsilon/2$) of 0.0075

4B. A notched component has a theoretical stress concentration factor of 2.8. The component is loaded to cause a nominal stress, of 220 MPa. Determine the resulting notch root stress and strain at this loaded state. The component is then unloaded to a nominal stress of 20 MPa. Determine the residual stress at the notch root when unloaded. The strain life properties for this material are E = 105 GPa, σ_f' = 1000 MPa, ε_f' = 1.0, b = -0.08, c = -0.60. 04

5A. Discuss about multiaxial fatigue with specific reference to critical plane approach. 04

5B. Explain thermomechanical fatigue with the help of hysteresis curve 03

5C. With an example highlight the significance of the study of fatigue of weldments. Explain the methods by which weldment fatigue resistance is improved? 03