



C.U.SHAH UNIVERSITY

WADHVAN CITY

FACULTY OF: - Technology & Engineering
DEPARTMENT OF: - MECHANICAL ENGINEERING
SEMESTER: - VI
CODE: - 4TE06FFM1
NAME: – Fatigue Failure and Fracture Mechanics

TEACHING & EVALUATION SCHEME:-

Subject Code	Name of the Subject	Teaching Scheme (Hours)				Credits	Evaluation Scheme							
		Th	Tu	Pr	Total		Theory				Practical (Marks)			Total
							Sessional Exam		University Exam		Internal		University	
							Marks	Hours	Marks	Hours	Pr/Viva	TW	Pr	
- 4TE06FFM1	Fatigue Failure and Fracture Mechanics	3	0	0	3	3	30	1.5	70	3	---	---	---	100

Objectives:-

- To provide an introduction to the principles and methods of fracture and fatigue design with application to metals.
- The objective of this subject is to introduce the mathematical and physical principles of fracture mechanics and their applications to engineering design.
- The application of fracture mechanics are emphasised for the selection of materials for the required applications
- To familiarize the student with the techniques for solving fatigue problems and develop expertise in the area of enhancing fatigue life of engineering components
- To study the concepts of estimation of the endurance and failure mechanism of components
- It will also expand the student's knowledge on experimental methods to determine the fracture toughness and develop the students understanding on the design principle of materials and structures using fracture mechanics approaches.

Prerequisites:-

- Basic and Analytical Knowledge of design principles of fracture mechanics and material selection and mathematics.
- Basic and Analytical Knowledge of Machine Design and Industrial Drafting.

Course outline:-

Sr. No.	Course Content	No. of Hours
1	Introduction: Mechanism of elastic action, Linear and non linear elastic properties, Plastic deformation, Dislocation theory, Inelastic action, Yielding in crystals, polycrystals and amorphous materials, Strain hardening, Plastic range, Discontinuous yielding, Stress and Strain	06
2	Fracture of metals: Conventional and true stress strain curves for polycrystalline materials, Basic modes of fracture, Fracture Behaviour of Metals And Alloys, Cohesive Strength of metals, Cleavage fracture, Yielding and fracture, Ductile-Brittle transition, Notch effect and sensitivity, strain ageing, Work hardening, Bauschinger effect, Season cracking, Recovery and growth. Analysis of Fracture: Fracture mechanics, Irwin's modification for materials, Griffith theory of brittle fracture theories of linear elastic fracture mechanics, J-Integral methods, R-curve analysis, Fracture toughness and design, Testing procedures, Practical applications.	12
3	Fatigue of metals: Introduction, fatigue, Importance of fatigue in engineering, characteristics of fatigue, fatigue limit, mechanism of fatigue, factors affecting fatigue, Fatigue crack propagation, fatigue crack growth rate curve, Crack growth and application of fracture mechanics to fatigue, Micro structural models of crack initiation. Stage I, II and III crack growth, Environmental fatigue: corrosion fatigue, fretting fatigue, low temperature and high temperature fatigue.	10
4	Analysis of Fatigue: The empirical laws of fatigue failure. Fatigue tests and stress life approach: endurance limit, fatigue fracture under combined loading, S-N curves, factors influencing fatigue life, fatigue controlling factors, effect of stress concentrations, notch sensitivity, and cumulative fatigue damage concepts and Miner's law of damage summation, High cycle-low strain fatigue, Low cycle fatigue, Basquin's law, Influence of superimposed static stresses: Goodman, Soderberg and Gerber mean stress corrections, Safe life and fail safe design philosophies, Infinite life, Damage tolerance analysis, Testing procedures, Practical applications.	10
5	Creep and stress rupture: Definition and concept, Creep fracture, Creep curves, mechanism of creep, Creep properties, Creep-fatigue interaction, Creep integrals, creep-stress-time temperature relations, creep relaxation theories; creep in tension, bending, torsion and combined loading; creep buckling; creep in piping and high temperature pressure vessel systems, Stress rupture test, Corrosion: Mechanism and effect of corrosion, prevention of corrosion.	07

Learning Outcomes:-

- Students will be able to calculate the stress-strain and load-displacement fields around a crack tip, identify and formulate stress intensity factor, strain energy release rate, and the stress and strain fields around a crack tip for linear and non linear materials, define and predict fracture toughness of materials and be familiar with the experimental methods to determine the fracture toughness, and design materials and structures using fracture mechanics approaches.
- Apply the fundamental knowledge of Applied Mechanics, Strength of Materials, and Engineering Materials for actual analysis problems.
- Able to use design data books and different codes for design materials and structures using fracture mechanics.

Text Books:

- 1 Mechanical Metallurgy by **George E. Dieter**; McGraw-Hill Book Co. Kogakusha Co. Ltd.
- 2 Engineering Materials science by **Cedric W. Richards**, Prentice-hall of India

- (private) limited, New Delhi.
- 3 Elements of fracture mechanics by **Prasanth Kumar** – Wheeter publication
 - 4 Fatigue of Metals by **PG Forrest**; Pergammon Press.
 - 5 Material science and Metallurgy by **V.D.Kodgire and S.V.Kodgire** , Everest Publishing House.
 - 6 Machine design by **Abdul Mubeen**; Khanna Publishers
 - 7 Design of Machine Elements by **V. B. Bhandari** , Tata McGraw Hill Publishing Co.1994

Reference Books :

- 1 Fracture Mechanics Fundamentals and Applications by **TL Anderson**; CRC Press.
- 2 Fracture of Structural Materials by **AS Tetelman and AJ McEvily**; John Wiley and sons.
- 3 Deformation and Fracture mechanics of Engineering Materials by **Richard W Hertz** , Wiley
- 4 Engineering Fracture Mechanics by **D.R.J. Owen and A.J. Fawkes** , Pincridge press, Swansea, U.K.
- 5 Fracture in engineering materials by **Knott, J.F.**, “Butterworth, 1973
- 6 Machine Design by **R.K.Jain** , Khanna publications.
- 7 Material science by **Abdul Mubeen**; Khanna Publishers
- 8 Mechanical Behaviour **Materials** by **Marc Andre Meyers**, K.K. Chawla, PHI
- 9 Elementary Engineering Fracture Mechanics by **David and Bruck**; Norelco.
- 10 **P.S.G Design data book** (PSG college of engg. & Tech.).DPV Printers, Coimbatore, 2000