I YEAR M. TECH (MACHINE DESIGN) SECOND SEMESTER

17MEMD2T5A **FRACUTRE MECHANICS** **Credits 4**

Lecture: 4 periods/week **Internal assessment: 40 marks**

Tutorial: - - **Semester end examination: 60 marks**

COURSE OBJECTIVES:

- Fracture phenomena in metals and nonmetals will be discussed
- To characterize brittle and ductile fractures from the macroscopic and microscopic point of view
- Describe basic conditions for crack initiation for the brittle and ductile failure mode.
- To understand the concept of fatigue in the design of engineering structures

COURSE OUTCOMES:

On completion of the course the student should be able to:

1. Understand basic conditions for crack initiation for the brittle and ductile failure mode.
2. Predict material failure for any combination of applied stresses.
3. Distinguish the behavior of materials under Elastic/Plastic zones
4. Determine the stress intensity factor for simple components of simple geometry
5. Predict the likelihood of failure of a structure containing a defect
6. Understand the variation in the material behavior under fatigue loading

UNIT-I

INTRODUCTION:

Fracture behavior of metals and alloys, Definitions of types of fracture and failure, Introduction to stress intensity factor and strain energy release rate, Equivalence of energy approach and stress intensity approach. Brittle and Ductile Fracture, Modes of Fracture Failure, Damage Tolerance

UNIT-II

STRESS INTENSITY FACTOR AND ITS USE IN FRACTURE MECHANICS: Early concepts of stress concentrators and flaws, Ingles solution to stress round an elliptical hole-implications of results. Stress intensity factor for a crack. Westergaard's solution for crack tip stresses. Stresses and displacement in Cartesian and polar coordinates, Linear Elastic Fracture Mechanics. Different modes of crack opening.

UNIT-III

ELASTIC/PLASTIC FRACTURE MECHANICS:

Elastic/plastic fracture mechanics: The crack opening displacement and J-integral approaches, R-curve analysis Testing procedures, Measurement of these parameters, Fail safe and safe life design approaches,

UNIT-IV

FATIGUE:

Importance of fatigue in engineering, Low cycle fatigue, Coffin-Manson law, Cyclic work hardening and softening. Micro structural models of crack initiation. Stage I, II and III crack growth. Analysis of Fatigue: The empirical laws of fatigue failure. High cycle-low strain fatigue, Basquin's law, Goodman, Soderberg and Gerber mean stress corrections, Miner's law of damage summation.

Learning Resources

Text books

1. Elements of Fracture Mechanics by Prashant Kumar, McGraw Hill Education Private Limited, New Delhi, India.
2. Mechanical Metallurgy by Dieter, McGraw Hill.

References:

1. Fracture Mechanics: Fundamental and Applications by Anderson T.L & Boca Raton, CRC Press, Florida, 1998.