

Approved: 8th senate meeting

Course Name: Fundamentals of Fracture Mechanics

Course Number: ME506

Credit: 2.5-0.5-0-3

Students intended for: UG/PG

Elective or Core: Elective

Semester: Odd/Even

Prerequisite: IC 242 Continuum Mechanics, IC 240 Mechanics of Rigid Bodies, IC 241 Materials Science for Engineers

Course Preamble: The objective of this course is to introduce the physical and mathematical principles of fracture mechanics and their applications in wide range of engineering design. This course will expand the students' 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.

Course Contents:

1. Introduction [4 Lectures]

Why structures fails?, An atomic view, Energy criterion, Stress intensity, Effect of material properties on fracture, Modes of failure.

2.Linear Elastic Fracture Mechanics [10 Lectures]

An atomic view of fracture, Effect of flaws on stress concentration, Griffith theory of fracture, Energy release rate, Instability and the R curve, Stress analysis of cracks, Stress Intensity Factor (SIF) , Determination SIF of different geometries, Crack tip plasticity, Irwin approach, Plane strain fracture, Mixed mode fracture.

3. Elastic-Plastic Fracture Mechanics [10 Lectures]

Crack tip opening displacement (CTOD), J contour integral, Relationship between J and CTOD, Resistance curve, Cleavage fracture, failure criterion, Three-dimensional effect, Crack arrest.

4. Fracture Mechanisms in Metals and Nonmetals [8 Lectures]

Ductile fracture, Void nucleation, Void growth, coalescence, Ductile crack growth, Brittle Fracture, Cleavage, Mechanisms of cleavage initiation,

Transgranular and Intergranular fracture, Fracture Mechanisms in Nonmetals.

5. Fracture Toughness Testing [4 Lectures]

Specimen configurations and orientations, K_{IC} testing, CTOD testing,

Measurement of J-critical, Determination of critical G in Mode I and Mode II.

6. Fatigue Crack Propagation and Environmental Assisted Fracture Failure [4 Lectures]

Fatigue crack growth, Crack closure, A short introduction to environmental assisted fracture failure.

7. Computational Fracture Mechanics [2L]

Modeling and analysis.

Text Book:

1. T.L. Anderson, Fracture Mechanics – Fundamentals and Applications, Taylor and Francis Group, CRC Press; 3 edition (24 June 2005)

Reference Book:

1. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India.
G.E. Dieter, Mechanical Metallurgy, McGraw Hill, 2009