B. E. MECHANICAL ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VIII
Professional Elective-4
FRACTURE MECHANICS

Course Code	18ME826		
Teaching Hours /Week (L:T:P)	3:0:0	CIE Marks	40
Credits	03	SEE Marks	60
		Exam Hours	03

Course Learning Objectives:

- To expose the students to the fundamentals of mechanics of fracture of materials.
- The students will learn about stress / strain and deformation fields near a crack tip, fracture characterizing parameters like stress intensity factor and J integral and kinetics of fatigue crack growth.
- To expose the students to fundamentals of linear elastic fracture mechanics, nonlinear (Elastic-Plastic) fracture mechanics and fatigue crack growth.
- Exposure to experimental methods for determining the fracture toughness (for example, ASTM standard procedure for JIC testing).
- To learn the mechanism of failure of structures by fatigue crack growth.

Module-1

Fracture mechanics principles: Introduction and historical review, Sources of micro and macro cracks. Stress concentration due to elliptical hole, Strength ideal materials, and Griffith's energy balance approach. Fracture mechanics approach to design, NDT and Various NDT methods used in fracture mechanics, Numerical problems. The Airy stress function. Effect of finite crack size. Elliptical cracks, Numerical problems.

Module-2

Plasticity effects: Theory of Plastic deformation, Irwin plastic zone correction. Dugdale's approach. The shape of the plastic zone for plane stress and plane strain cases. The plate thickness effect, numerical problems. Determination of Stress intensity factors and plane strain fracture toughness: Introduction, estimation of stress intensity factors. Experimental method- Plane strain fracture toughness test, The Standard test, size requirements, etc.

Module-3

The energy release rate, Criteria for crack growth. The crack resistance(R curve). Compliance. Tearing modulus. Stability.

Elastic plastic fracture mechanics: Fracture beyond general yield. The Crack-tip opening displacement. The Use of CTOD criteria. Experimental determination of CTOD. Parameters affecting the critical CTOD.

Module-4

J integral: Use of J integral. Limitation of J integral. Experimental determination of J integral and the parameters affecting J integral.

Dynamics and crack arrest: Crack speed and kinetic energy. Dynamic stress intensity and elastic energy release rate. Crack branching. Principles of crack arrest. Crack arrest in practice. Dynamic fracture toughness.

Module-5

Fatigue crack propagation and applications of fracture mechanics: Crack growth and the stress intensity factor. Factors affecting crack propagation. Variable amplitude service loading, Means to provide fail-safety, Paris law, Required information for fracture mechanics approach.

Course Outcomes: At the end of the course the student will be able to:

CO1: Analyse the effects of crack like defects on the performance of Aerospace, Civil, and Mechanical Engineering structures.

CO2: Apply the concepts of fracture mechanics to select appropriate materials for engineering structures to insure damage tolerance.

CO3: Understand mechanics of crack tip fields and appropriate fracture characterizing parameters like stress intensity factor and J integral or nonlinear energy release rate and how to compute them using various methods.

CO4: Apply the concepts of fracture mechanics to determine critical crack sizes and fatigue crack propagation rates in engineering structures leading to life estimation.

CO5: Understand the status of academic research in field of fracture mechanics.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Elements of fracture mechanics	Prasanth Kumar	Wheeter publication	1999
2	Fracture Mechanics: Fundamentals and Applications	Anderson	CRC press	3rd Ed., 2005
Reference Books				
1	Introduction to fracture mechanics	Karen Hellan	McGraw Hill	2nd Edition
2	Engineering fracture mechanics	S.A. Meguid	Elsevier Applied Science	1989
3	Fracture of Engineering Brittle Materials	Jayatilaka	Applied Science Publishers	1979
4	Fracture and Fatigue Control in Structures	Rolfe and Barsom	Prentice Hall	1977
5	Engineering Fracture Mechanics	Broek	MartinusNijhoff publishers	1982
6	Advanced Fracture Mechanics	M.F.Kanninen and C.H.Popelar	Oxford press	1985

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