Course-Plan

School : School of Engineering
Department : Mechanical Engineering
Course Code : ME 513
Course Name : Introduction to Fracture Mechanics

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1. Course objectives:

i. To introduce the mathematical and physical principles of fracture mechanics and their applications to engineering design
ii. To develop the ability in students to compute the stress intensity factor, strain energy release rate, and the stress and strain fields around a crack tip for linear and nonlinear materials.
iii. To expand 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.

2. Prerequisite of the course:

Mechanics of Rigid Bodies, Solid Mechanics, Advanced Solid Mechanics.

3. Course Outline and Time Plan

Sl. No.	Topics	Contents	L
1	Introduction to fracture	Failure and fracture, Types of fracture, Modes of fracture failure	3
2	Energy of Fracture	Energy balance during crack growth, Griffith's theory, Crack stability, Fracture criterion, Strain energy release rate.	8
3	Linear Elastic Fracture Mechanics	Analysis of crack tip stress, Irwin's fracture criterion, Determination of stress intensity factor, Fracture toughness	9
4	Elastic-Plastic Fracture Mechanics	Crack tip opening displacement, *J*-Integral and its applications	9

5	Fatigue fracture	Mechanisms of fatigue crack initiation and propagation; Notch sensitivity; Factors influencing fatigue strength, Prevention of fatigue failure	9
6	Computational Fracture Mechanics	Finite element method, Virtual crack extension, Virtual crack closer integral.	4
		Total	**42**

Textbooks

1. Kumar, P. Elements of Fracture Mechanics (Tata McGraw-Hill, New Delhi, 2009).
2. Anderson, T.L. Fracture Mechanics: Fundamentals and applications (3rd ed., CRC Press, 2005).

References

1. Sanford R.J. Principles of Fracture Mechanics (Prentice Hall, 2003).
2. Bolotin V.V. Mechanics of Fatigue (CRC Press, 1999).
3. Broek, D. Elementary Engineering Fracture Mechanics (Kluwer Academic Publishers, 1986).
4. Rolfe S.T. and Barsom J.M. Fracture and Fatigue Control in Structures: Applications of Fracture Mechanics (Butterworth-Heinemann, 2000).
5. Maiti S.K. Fracture Mechanics: Fundamental and Applications (Cambridge University Press, 2015).
6. Kundu T, Fundamental of Fracture Mechanics (CRC Press, Taylor & Francis, 2008).
7. Kuna M. Finite Elements in Fracture Mechanics (Springer, 2013).
8. Gdoutos E. E. Fracture of Nano and Engineering Materials and Structures (Springer, 2006).

1. Evaluation Plan

Test No.	Marks	Duration (minutes)
Test I	10	-
Mid-Semester	30	90
Test II	10	-
End Semester	50	120
Total	**100**	

All the tests will be held as per the schedule notified by the Controller of Examinations, Tezpur University.

2. Pedagogy:

Lectures, study groups and project work, Assignments

3. Course Outcomes:

CO1: To understand and identify the basic fracture and fatigue mechanisms.
CO2: To understand crack resistance and energy release rate for crack criticality.

CO3: To apply Linear Elastic Fracture Mechanics (LEFM) to predict fracture of brittle materials.

CO4: To identify the plane stress and plane strain conditions based on the shape and size of plastic zones. This concept made the students capable to select the type of analysis subjected to plane stress and plane strain condition.

CO5: To evaluate the different fracture parameters, *e.g.*, crack tip opening displacement, stress intensity factor (SIF) and energy release rate and to apply them for fracture design of ductile and brittle materials.