BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE
SECOND SEMESTER 2019-20
Course Handout Part II

Date: 28/11/2019

In addition to part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the courses.

Course No **:** DE G514
Course Title **:** FRACTURE MECHANICS
Instructor-in-charge **:** **AMOL VUPPULURI**

Course Description: Introduction, energy release rate, stress intensity factor and complex cases, anelastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

Scope and objective of the course: Recently, the study of fracture, crack propagation in metals plays a significant role. It is crucial for design engineers to understand the various critical parameters of fracture, their evaluation method and way to restrict the crack propagation. The scope of the course is to understand various experimental and analytical method of fracture parameter determination. The basic objective of the course to strength the knowledge base and analytical abilities of students related to various concepts of fracture mechanics.

Text Book:

1. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2009.

Reference Book:

1. T.L. Anderson, Fracture Mechanics Fundamental and Applications, CRC Press, IInd Edition.
2. C.T. Sun and Z.C. Jin, Fracture Mechanics, Academic Press, Elsevier Publication, Ist Edition, 2012.

Course Plan:

Lect. No.	Learning Objectives	Topics to be covered	Ref. Chap./Sec.
1-2	Background	Kinds of failure and history	TB-Ch.1
3-5	Energy release rate	Dilemma of Griffith, Surface energy, Griffith's realization Griffith's analysis, Mathematical formulation, Thin plate vs thick plate Critical energy release rate.	TB- Ch.2
6-9	Stress intensity factor (SIF)	Linear elastic fracture mechanics (LEFM) Stress and displacement fields in isotropic elastic materials, Elementary properties of complex variables	TB- Ch.3
10-13	SIF of more complex cases	Application of the principle of superposition, Crack in a plate of finite dimensions, Edge cracks, Embedded cracks, Relation between G_I and K_I	TB- Ch.4
14-16	Anelastic deformation at the crack Tip	Approximate shape and size of the plastic zone, Effective crack length, Effect of plate thickness.	TB- Ch.5

17 - 20	J-Integral	Relevance and scope, Definition of J-Integral, Path independence Stress-strain relation, Further discussion on J-Integral, Engineering approach-A short cut.	TB- Ch.6
21 - 24	Crack tip opening displacement (CTOD)	Relationship between CTOD, K_I and G_I for small scale yielding Equivalence between CTOD and J.	TB- Ch.7
25 - 28	Test methods	K_{IC} test techniques, Test methods to determine $J_{IC,}$ Test methods to determine G_{IC} and G_{IIC}, Determination of critical CTOD.	TB- Ch.8
29 - 33	Fatigue failure and Environment-assisted fracture	Terminology, S-N curve, Crack initiation, Crack propagation, Effect of an overload, Crack closure, Variable amplitude fatigue load.	TB- Ch.9
34 - 36	Finite Element Analysis of cracks in solids	Direct and Indirect method to determine fracture parameters,	TB- Ch.10
37 – 39	Mixed mode crack initiation and growth	Fracture surface, Mixed mode crack propagation criteria, Crack growth.	TB- Ch.11
40 - 42	Crack detection through NDT	Visual, LPI, Magnetic Methods, Radiography, Ultrasonics	TB- Ch.12

Evaluation Scheme:

EC No.	Evaluation Component	Duration (min)	Weightage (%)	Date, Time & Venue	Nature of Component
1.	Mid-semester Examination	90	20	4/3 9.00 - 10.30AM	Closed Book
	Project and Case studies	-	15	To be announced by IC	Continuous Assessment (Open Book)
2	Lab Components	-	15	To be announced by IC	Continuous Assessment (Open Book)
	Class assessment	-	10	To be announced by IC	Continuous Assessment (Closed Book)
3	Comprehensive Examination	180	40	06/05 AN	Partially Closed Book (20% - Closed Book, 20% - Open Book)

- **Chamber Consultation Hours**: To be announced in the class.
- **Notices:** Notices will be displayed on CMS.
- **Make-up Policy:** Make-up will be granted only to genuine cases with prior permission from the IC. For cases related to illness, proper documentary evidence is essential. No makeup is allowed for class assessment (surprise quizzes).
- **Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-charge
(DE G514)