



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

FRACTURE MECHANICS AND FAILURE ANALYSIS

I Semester: AE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
BAEE03	Elective	L	T	P	C	CIA	SEE	Total
		3	-	-	3	40	60	100
Contact Classes: 45	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 45			

Prerequisite: Aircraft structures

I. COURSE OVERVIEW:

Fracture mechanics and fatigue are essential to understanding the structural performance of real-world materials. Fracture mechanics is the study of the complex stress field around the tip of a crack and can be used to determine if an existing crack will propagate or arrest. Fatigue analysis is the study of fracture behavior under repeated cyclic loading. High cycle and low cycles fatigue are used in designing machine members courseed to various fatigue load conditions. Crack growth under fatigue and realistic conditions are analyzed which is used in the industries.

II. COURSE OBJECTIVES:

The students will try to learn:

- I. The concept of Endurance limit and methods to increase the endurance limit used in design of machine elements.
- II. The Low cycle and High cycle Fatigue used in design of machine members.
- III. The behavior of materials under static load and fatigue loads.
- IV. The Strength of a cracked bodies under fatigue and static load conditions.

III. COURSE OUTCOMES:

After successful completion of the course, students will be able to:

- CO 1 Apply the concept of stress and number of cyclic loadings on a given specimen for deterring the endurance limit.
- CO 2 Analyze the behavior of a specimen under High cycle and Low cycle fatigues for design against fatigue failure
- CO 3 Apply the mathematical principles to High cycle and Low cycle fatigues for determining the failure loads
- CO 4 Analyze the influence of crack growth under fatigue loads and surface roughness for designing the member to withstand the crack
- CO 5 Analyze the various methods involved in crack detection techniques for identifying the surface cracks.
- CO 6 Illustrate the various methods involved in fatigue testing for determining the Endurance limit.

IV. COURSE CONTENT:

MODULE-I: FATIGUE OF STRUCTURES (09)

S.N. curves, Endurance limit, Effect of mean stress, Good man, Gerber and Soder berg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, plastic stress concentration factors, Notched S-N curves.

MODULE-II: STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR (09)

Low cycle and high cycle fatigue, Coffin-Manson "relation, Transition life, Cyclic Strain hardening and softening Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner's theory, other theories.

MODULE-III: PHYSICAL ASPECTS OF FATIGUE (09)

Propagation of 1D stress pulse - Coaxial collision of bars, Reflection and superposition - Navier's equations - Dilatational and shear waves - Rayleigh and Lamb waves
Quasi-static material test - Pendulum impact test - Drop weight impact test - Split-Hopkinson's bar test - Taylor impact test - Dynamic buckling of beams

MODULE-IV: FRACTURE MECHANICS (09)

Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin, Orwin extension of Griffith's theory to ductile materials, Stress analysis of cracked bodies, effect of thickness on fracture toughness, stress intensity factors for typical geometries.

MODULE-V: FATIGUE DESIGN AND TESTING (09)

Safe life and fail-safe design philosophies, importance of fracture mechanics in aerospace structure, application to composite materials and structures.

V. TEXT BOOKS:

1. D. Brock, "Elementary Engineering Fracture Mechanics", Noordh off International Publishing Co., London, 1994.
2. J. F. Knott, "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London, 1983.

VI. REFERENCE BOOKS:

1. W. Barrois and L. Ripley, "Fatigue of Aircraft Structures", S Pergamon Press, Oxford, 1983.
2. C. G. Sih, "Mechanics of Fracture", Vol.1 Sijth off and Noordh off International Publishing Co., Netherland, 1989.

VII. ELECTRONICS RESOURCES:

1. <http://ocw.mit.edu/courses/materials-science-and-engineering/3-35-fracture-and-fatigue-fall-2003>.
2. <http://www.eng.ox.ac.uk/solidmech/research/fatigue-fracture-mechanics>.
3. <http://www.fatiguefracture.com>

VIII. MATERIALS ONLINE

1. Course template
2. Assignments
3. Tutorial question bank
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations