

## FUNDAMENTALS OF FRACTURE –BMEG/CVEG/MEEG 5953

Fall Semester 2022

**Instructor:** Ashok Saxena, 1020 Clubland Point, Marietta, GA 30068,  
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**Pre-requisite:** Graduate standing in Mechanical, Civil, Aerospace, Biomedical Engineering

**Textbook:** Ashok Saxena, Basics of Fracture Mechanics and Its Applications, CRC Press, 2023 (in press)- Chapters of the books are provided to registered students at no cost.

**Course Description and Objectives:** The field of fracture involves understanding why load-bearing elements in mechanical systems sometimes fail catastrophically and how that risk can be minimized by:

- proper selection of materials,
- good design practices that reduce stress concentrations
- specifying appropriate maintenance and inspection criteria and intervals and,
- making timely run/repair/retire decisions that ensure safe operation of the fracture critical parts.

The approach to predicting and understanding fracture in a wide variety of materials that are used in load-bearing, structural applications must, by their very nature, be multidisciplinary. The fracture mechanics concepts have been applied in various fields of engineering such as mechanical, biomedical, electrical, civil, and aerospace engineering.

The primary learning objectives of the course are to understand the basic concepts of linear-elastic fracture mechanics (LEFM) and fatigue of materials for predicting fracture in metallic, ceramic, polymeric parts, and in composite materials. The course will include (a) discussion of the mechanics under-pinning of the fracture mechanics concepts (b) a discussion of the experimental test methods for determining material properties that are an integral part of the fracture mechanics analyses and (c) applications of fracture mechanics to real components.

I can be reached by e-mail and would be happy to assist with any portion of the lecture material and provide guidance on homework.

**Grading Policy:** Term grades will be based on homework assignments (25%), two midterm examinations each of one-hour duration (20% each) and a final take-home comprehensive examination that will count for 35% of the grade. There will be a total of six homework assignments of which the assignment with the lowest grade will be dropped. Thus, each homework assignment will count for 5% of the grade. The mid-term examinations will be closed book but, you will be provided formulas that you will need to answer the questions. The exams will be conducted through Proctor U and it is your responsibility to schedule the exam ahead of the dates noted on the syllabus. You should bring a simple scientific calculator with no internet capability and several sheets of blank paper to the exam.

**Reference Books: (None required)**

1. T. L. Anderson, Fracture Mechanics: Fundamentals and Applications –Second edition, CRC Press, 1995, ISBN 0-8493-4260-0
2. Ashok Saxena, Advanced Fracture Mechanics and Structural Integrity, CRC Press, 2019
3. R.J. Sanford, Principles of Fracture Mechanics, Prentice Hall, 2003, ISBN 0-13092992-1
4. E.E. Gdoutos, Fracture Mechanics – An Introduction, Kluwer Academic Publishers, ISBN 0 – 7923 -1932 -x, 1993

**Schedule**

Week	Topic	Reading Assignment
Week 1: 08/22- 08/26	Fracture in Structural Components  Early Theories of Fracture	Chapter 1  Chapter 2
Week 2: 08/29 – 09/02	Early theories of fracture  Theoretical Basis for Linear Elastic Fracture Mechanics	Chapter 2  Chapter 3 (Section 3.8 optional)
<b>09/04</b>	<b>Homework # 1- Chapter 2 due Problems 1,2,3,6,8</b>	
Week 3: 09/05 – 09/09	Theoretical Basis for Linear Elastic Fracture Mechanics (Continued)  Crack Tip Plasticity	Chapter 3  Chapter 4
<b>09/11</b>	<b>Homework #2 – Chapter 3 due Problems 1,2,4,5,9</b>	
<b>09/14 -09/16</b>	<b>First Mid-term Examination- Chapters 1 to 3  (Schedule the exam with Proctor U)</b>	
Week 4: 09/12 -09/16	Fracture Toughness and its Measurement	Chapter 5
<b>09/18</b>	<b>Homework # 3 Chapter 4 due Problems 1,2,4,5,9</b>	
Week 5: 09/19 – 09/23	Fatigue Crack Growth	Chapter 6
<b>09/25</b>	<b>Homework #4- Chapter 5 due</b>	

	<b>Problems 1,2,4, 5,7</b>	
Week 6: 09/26 – 09/30	Environment Assisted Cracking	Chapter 7
<b>10/02</b>	<b>Homework # 5 Chapter 6 due Problems 1,2,3,6,8</b>	
Week 7: 10/03 – 10/07	Mixed-Mode Fracture Elastic-Plastic Fracture Time-dependent Fracture	Chapter 8 (Optional) Chapter 9 Chapter 10
<b>10/04 -10/06</b>	<b>Second Mid-term Examination- Chapters 4, 5, and 6 (Schedule exam with Proctor U)</b>	
<b>10/07</b>	<b>Homework # 6 Chapter 7 due Problems 1,2,3,4,6 Chapter 7</b>	
Week 8: 10/10 -10/11	<b>Work on Take Home Final Examination Due 10/11 (Based on all Chapters)</b>	