FALL 2023
CEE 575–AE 521 Fracture and Fatigue

Instructors: John Lambros, Professor in AE
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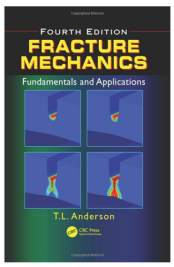
Class times: Monday and Wednesday, 2:00pm-3:20pm in 3310 Newmark

Office hours: Tuesday and Thursday, 2:00-3:00 pm online via Zoom

Textbook:



There is no required textbook. The recommended textbook is "Fracture Mechanics: Fundamentals and Applications" by T. L. Anderson, 4th edition, CRC Press.
Copies of the slides presented during the lectures can be found on the course Canvas web site (https://canvas.illinois.edu/courses/39062). You are encouraged to download and/or print them prior to the lectures. The slides contain primarily the theoretical part of the course. Many of the illustrative examples will be solved in class on the board.

Prerequisites: TAM 451 or CEE 471 or TAM 551 (or equivalent). A knowledge of 3D linear elasticity is required, preferably with use of indicial notation and tensor analysis. Helpful, though not required: Some knowledge of plasticity is helpful. We will also deal briefly with complex number calculus so having taken a course on the subject is advantageous. Finally, knowledge of wave propagation in solid media is helpful in the section on Dynamic Fracture Mechanics. A small overview of each of these three subjects (complex calculus, plasticity, wave propagation) will be given at the appropriate sections in the course.

Homework, exam, and project: A series of homework problems will be handed out approximately every second week. You are expected to do the homework and hand it in in a timely fashion. You may work in groups toward the solution of the homework exercises, but each student must hand in their own homework that they themselves have put together on their own (i.e., you cannot copy someone else's homework). An in-class exam will be held sometime between the midpoint and end of the semester. There will also be a project which will consist of a paper review and report assignment related to fracture mechanics. More details on the project will be provided in class a few weeks into the semester. There is no final exam.

Grading:

Homework	40%
Exam:	40%
Final Project (paper review):	20%

OUTLINE

1) Introduction – Historical Perspective of Fracture

2) Linear Elastic Fracture Mechanics (LEFM)

- Review of elasticity theory and complex calculus
- Stress concentration and stress singularity
- Asymptotic K fields
- Computation of stress intensity factors
- Energy approach
- Conservation integrals
- Stability of crack propagation
- Cohesive fracture
- Numerical aspects

3) Linear Elastic Interfacial Fracture Mechanics (LEIFM)

- Physical relevance
- Dundurs parameters
- Oscillatory index, Small scale contact
- Interfacial fracture toughness

4) Elasto-plastic fracture mechanics (EPFM)

- Review of plasticity theory
- Estimation of plastic zone, Small-Scale Yielding (SSY), shape of plastic zone
- HRR asymptotic fields, *J*-*Q* theory, mixed mode
- Experimental determination of *J*
- Elastic-plastic crack growth
- Material Behavior

5) Fatigue Failure

- Physical mechanisms
- Crack growth models – Paris "law"
- Crack closure

6) Dynamic Fracture Mechanics (if time allows)

- Review of elastodynamics
- Steadily moving dynamic crack
- Dynamic loading of a stationary crack
- Energetics of a dynamically propagating crack