MECH 5328: Fracture Mechanics

Spring 2024

Instructor:	Armanj D. Hasanyan	**Time:**	MW 1:30 pm to 2:50 pm
Email:	adhasanyan@utep.edu	**Place:**	Liberal Arts Building 304

Office Hours: Regular office hours will be held on **Fridays, 11:00 am to 12:00 pm at A106, or by appointment**. If you want to meet Dr. Hasanyan outside of the office hours, please send an email at least 24 hours in advance for arrangements. Unexpected visits without an appointment or on short notice cannot be guaranteed.

Objectives: The course will provide an introduction into analyzing structures with flaws, derive the conditions for crack initiation, and stability analysis for crack propagation. Advanced mathematical theories will be outlined to characterize and predict fracture in materials ranging from very brittle to ductile. The student will have the knowledge to experimentally characterize the properties of interest (fracture toughness) and to design against fracture.

Prerequisites: This course is intended for graduate and upper level undergraduate students. Initial background in Solid Mechanics I or II (MECH 5302 and MECH 5312), or equivalent is required. These include topics such as stresses, strains and/or displacement, compatibility conditions, constitutive relations, solving boundary value problems, etc.

Required Textbook:

- T. Anderson, *Fracture Mechanics: Fundamentals and Applications*, CRC press.

Computational Software: MATLAB or Mathematica will be required to do homework.

Homework: Homework is due at the beginning of class. **Late submissions will not be accepted**. Collaborations are allowed, but copying homework will be strictly prohibited. In your homework, please box the final answer of each problem, so that grader can easily grade your homework. Illegible solutions will be deducted. Make sure handwriting and plots are made clear. Homework solution will be posted online after submission.

Midterm Exams: Two midterm exams will be held during class hours.

Final Exam: All students must take the final exam at the time and place designated by the university. Do not make travel plans that conflict with the final exam date.

Classroom Attendance: In-person student attendance is essential and expected. There will not be online lectures available. Excessive unexcused absences (over 10 times) are not acceptable and will automatically result in F.

Course Grade: Homework (40%), Midterm (30%), Final (30%). The grade scale is as follows:

100 - 90 %	A
90 - 80 %	B
80 - 70 %	C
70 - 60 %	D
less than 60 %	F

Misconduct: Lack of knowledge of the academic honesty policy is not a reasonable explanation for a violation. Please refer to the UTEP academic misconduct policy.

Other Policies: Be on time in the classroom. Turn off your cell phone during the classes.

Important Dates: Please note, there will be **no class on January 23 and 25!** Tentative dates for exams:

Midterm ..... March 1
Final Exam ..... To Be Announced

Topics Covered:

1. **Review of Solid Mechanics:** Stress, strain and/or displacement, compatibility conditions, solving BVP, Airy stress function, 2D simplifications (plane stress vs plane strain), stress concentration factors, etc.

2. **History of Fracture Mechanics:** Limitations of classical elasticity (crack tip singularity), Griffith, Inglis (1913) vs. Griffith (1921) approaches, materials with flaws, crack tip plasticity, and various fracture mechanics theories.

3. **Linear Elastic Fracture Mechanics (LEFM):** Stress intensity factors, crack tip solutions, energy release rate and fracture energy, fracture modes (I, II, and II), crack growth instability analysis (R-curves), LEFM testing.

4. **Elastic-Plastic Fracture Mechanics (EPFM):** Crack tip opening displacement (CTOD), Rice's J-integral approach, brittle vs. quasi-brittle vs. ductile material testing, etc.

5. **Additional Fracture Mechanics Topics:** Interface toughness of composites and/or bonded joints, time-dependent fracture mechanics (fatigue crack propagation, Paris' law, viscoelasticity, and dynamic crack propagation)