MSE 4105: Deformation and Fracture of Materials
Summer 2026

Instructor: Josh Kacher (josh.kacher@mse.gatech.edu)
Office Hours: By appointment

TA: None

Prerequisites: MSE 2001 – Principles & Applications of Engineering Materials
COE 3001 – Deformable Bodies (Ref: J. Gere, Mechanics of Materials)

Catalog Description: Deformation and fracture of metals, ceramics, polymers and composites, with focus on correlating monotonic- and time-dependent mechanical properties and behaviors with atomic bonding, microstructure, and micromechanics, for applications relevant to material selection and design, mechanical forming processes, and analysis of engineering failures.

Course Objectives: Introduction to deformation and fracture behavior of major classes of materials including metals, ceramics, polymers, and composites, under load-bearing conditions. The emphasis will be on the fundamental understanding of the basic concepts of stress and strain, mechanical properties including stiffness, strength, toughness, etc. and their test methods, and correlations of monotonic and time-dependent deformation and fracture mechanisms with material inherent atomic bonding, microstructure, and micromechanics. The understanding developed will aid students with selection and design of materials, use of criteria and properties for mechanical forming processes, and analysis of failure of engineering materials.

Topics Covered:
(a) Mechanical response and Stress States
(b) Elasticity and viscoelasticity theories, properties, and anisotropy
(c) Yielding and deformation of metals and polymers
(e) Strengthening mechanisms and composites
(f) Time-dependent High Temperature deformation (Creep)
(g) Fracture mechanics theories, toughness, and embrittlement
(h) Ductile/brittle transition phenomenon and microstructure effects
(i) Cyclic stress/strain-controlled fatigue failure and life prediction
(j) Analysis of engineering failures

Recommended Texts and References: Lecture slides will be posted on Canvas prior to each class. The content will be from the various references (texts) listed below:

Mechanical Behavior of Materials (Meyers & Chawla, 2nd ed., Cambridge Press) - main
Deformation & Fracture Mechanics of Engineering Materials, 6th ed. (Hertzberg, 2020);
Mechanical Behavior of Engineering Materials (Rossler, Harders, Baker, Springer);
Introduction to Ceramics (Kingery, Wiley InterScience);
Principles of Polymer Systems (Rodriquez); Mechanical Properties of Composites (Chawla)

Course Outcomes:

1. Students will describe the deformation behavior of major classes of materials, including metals, ceramics, polymers, and composites, in terms of the relationships between their various mechanisms, properties, and applied forces/displacements.
2. Students will demonstrate an understanding of the fundamental principles of linear elastic

fracture mechanics, test methods, and microstructure effects.
3. Students will demonstrate an understanding of material degradation mechanisms.
4. Students will demonstrate the ability to perform basic stress analyses and evaluate performance of design based on stiffness, strength, fatigue resistance, etc.

Attendance: This will be a fast-paced course. Hence, classroom attendance is essential for understanding concepts and for discussions on a range of topics of interest to students. Please inform me if you will be away for any reason.

Course Requirements and Grading:

Assignment	Weightage (Percentage)
Exam 1	25%
Exam 2	25%
Exam 3 (Final)	25%
Homework	15%
Quizzes	10%

Examinations: Held in-class and closed books and notes. Exams will mostly focus on fundamental concepts involving descriptive answers and/or derivations based on content presented in class.
Homework will be given on a regular periodic basis and will be due a week later. Homework will mostly involve solving numerical problems and calculations.
Quizzes: Periodic (10-minute) quizzes (closed books and notes) at start of class and upon completion of major topic/area focusing on key concepts discussed in class. Tentative dates are included in schedule. The lowest quiz grade will be dropped prior to calculating the course grade.
Make up policy: Make-up exams, quizzes, and delayed homework/report will only be permitted due to legitimate reasons. You must inform the instructor and request the make-up exam/quiz/assignment prior to the deadline.

Final Grade: The minimum weighted score grade ranges for the semester are as follows:

A	≥90%
B	80-89.9%
C	70-79.9%
D	60-69.9%
F	<60%

COURSE EXPECTATIONS & GUIDELINES

Academic Integrity: Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. See GT Honor Code: **http://www.catalog.gatech.edu/policies/honor-code/**. Student(s) suspected of cheating/plagiarizing will be reported to Office of Student Integrity.

Accommodations for Individuals with Disabilities: If you have learning needs that require special accommodation, please contact ODS office at http://disabilityservices.gatech.edu/, or (404)894-2563 as soon as possible, to discuss your needs and obtain an accommodations letter. Please also let me know about your special needs.

Student Use of Mobile Devices: Please silence all mobile devices at the beginning of class. Laptops and IPADS may be used during class but only for the purpose of taking notes.

Student-Faculty Expectations: At Georgia Tech we believe that it is important to continually strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See http://www.catalog.gatech.edu/rules/22/ for basic expectations that you can have of me, and that I have of you. Simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. I encourage you to be committed to these ideals while in this class.

Sexual Harassment: MSE is committed to a community that actively resists sexual and gender harassment. If you see or experience any of the following: sexual harassment, domestic and dating violence, sexual assault and stalking, resources are available:

- **Confidential VOICE Advocates** (GT Wellness Center- VOICE) can provide support 24/7 and explore resources and options. If after hours, call 404-894-9000 and ask to speak to the On-Call VOICE Advocate. You do not need to make a report nor provide any information other than your phone number for a VOICE advocate to contact you.
- Sexual violence or harassment can be reported directly to Georgia Tech's **Title IX Coordinator**, Chris Griffin, (404) 385-5583 chris.griffin@gatech.edu.

Please note that faculty, staff, and TAs are mandatory reporters and are required to inform the Title IX Coordinator should they become aware of any student experiencing sexual violence or sexual harassment.