Georgia Institute of Technology

ME 7201A/A01 Computational Mechanics of Materials

Fall 2026

Course Information

Instructor: Professor Ting Zhu (ting.zhu@me.gatech.edu)
Lectures: TR, 12:30-1:20pm, Mason 2117
Office hours: Wednesday 4-5pm, Zoom online meeting

Course Description and Learning Outcomes

This course is a graduate course on the theory and implementation of numerical methods for solving solid mechanics problems. The course aims to provide 1) a theoretical foundation in computational methods widely used in modern solid mechanics, and 2) hands-on experience with computational tools for simulating and analyzing the mechanical response of structures and materials.

By the end of the course, students are expected to (1) gain a broad understanding of the theories and numerical methods for materials undergoing elastic, plastic, and chemomechanical deformation and fracture; (2) grasp the computational techniques and skills needed to perform nonlinear analysis of structures and materials.

Textbook and reference materials

There is no required textbook for this course. The main references will be electronic handouts and class notes. However, you may find it helpful to read relevant chapters in the following books to gain additional perspectives on the course content and to explore more advanced materials independently.

1. ABAQUS documentation. Documentation is available through installed ABAQUS, and you can use the online manual as well.
2. Ted Belytschko, Wing Kam Liu, Brian Moran, Khalil Elkhodary. Nonlinear Finite Elements for Continua and Structures, Wiley, 1st or 2nd edition.
3. Klaus J. Bathe. Finite Element Procedures, Prentice Hall, 1995.
4. Richard Lesar. Introduction to Computational Materials Science, Cambridge University Press, 2013.
5. Allan Bower. Applied Mechanics of Materials (http://solidmechanics.org/)
6. Rob Phillips. Crystals, Defects and Microstructures: Modeling Across Scales, Cambridge University Press, 2001.
7. Ellad B. Tadmor and Ronald E. Miller. Modeling Materials: Continuum, Atomistic and Multiscale Techniques, Cambridge University Press, 2011.

Prerequisites

Before taking this course, you should have completed at least one solid mechanics course equivalent to Continuum Mechanics or Linear Elasticity. It will be helpful if you have taken introductory courses on Finite Element Methods and Plasticity Theory.

Web Resources: Electronic handouts, homework assignments and solutions will be posted on https://canvas.gatech.edu/

Problem Set: Periodic problem sets will be assigned throughout the semester. Completed homework sets and projects should be submitted electronically through Canvas. Request for extensions of homework deadlines should be made to the instructor in advance.

Lab Session: This class consists of an unsupervised lab session, which primarily involves the use of ABAQUS to conduct finite element analyses and to complete homework assignments and the term project. The ABAQUS package can be accessed remotely through ME Vlab (http://mycloud.gatech.edu).

Academic and Research Honesty/Integrity Statement
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. Review the Student Code of Conduct and the Academic Honor Code, especially Appendix A: Graduate Addendum to the Academic Honor Code.

Students are expected to perform research in an ethical and responsible manner. All Doctoral and Master's Thesis students are required to take the Responsible Conduct of Research training, and it is expected that students abide by the principles taught in that training while performing research for this thesis course.

Allegations of scientific or scholarly misconduct are handled in accordance with the procedures outlined by the Policy for Responding to Allegations of Scientific or Other Scholarly Misconduct.

Accommodations for Students with Disabilities
If you are a student with learning needs that require special accommodation, contact the Office of Disability Services as soon as possible to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Expectations of Advisors and Advisees
At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. The Expectations of Advisors and Advisees articulates some basic expectations that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

Grading Policy

Homework	60%
Term project	40%

There will be no written final exam.

Outline

Overview of computational mechanics

Review of solid mechanics
Continuum mechanics, plasticity, fracture

Basics of finite element analysis
Finite element methods for linear elastic problems
Introduction to ABAQUS/CAE and user subroutines

Finite element methods for nonlinear problems
Small-strain plasticity
Small-strain viscoplasticity
Large-strain viscoplasticity
Crystal plasticity
Time dependent and dynamic problems
Chemo-mechanical coupling

Finite element methods for crack and fracture
Crack-tip field
Cohesive fracture model

Multiscale materials modeling
Density functional theory and numerical implementation
Molecular dynamics & Kinetic Monte Carlo methods
Quasi-continuum & Interatomic potential finite element methods
Phase field method