

# AME 506: Continuum Mechanics

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Office Hours: T/Th 4:00-5:00PM

Office: OHE 430M

Web: D2L

Class Hours: T/Th 2:00-3:50pm

Class Room: RTH 109

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## Course Description

This course provides a unified development of the mathematical description for modeling a continuum. It will be useful for any beginning or advanced graduate student planning to study solid and fluid mechanics. It offers a unified introduction to topics like elasticity, inelastic material modeling, and simple and complex fluid behavior.

## Learning Objective

The learning objectives associated with this course are:

1. A thorough understanding of vector and tensor algebra and calculus.
2. The ability to represent and understand the kinematics of a continuum including concepts like deformation, strain, strain gradient, vorticity, etc.
3. A thorough understanding of the balance laws of continuum physics and the ability to express them in mathematical terms.
4. The knowledge of typical forms of constitutive behavior (elasticity, plasticity, creep, Newtonian and non-Newtonian fluids, etc.) and the ability to design new constitutive laws.
5. An understanding of the principle of material frame indifference, and the second law of thermodynamics and their role in continuum physics.

## Required Materials

Course notes will be made available online.

## Suggested Material

Course notes will be developed based on the following book:

Gurtin, Morton E., Eliot Fried, and Lallit Anand. The mechanics and thermodynamics of continua. Cambridge University Press, 2010.

Note, the book is not required – everything needed will be made available through the course notes.

Some students have also found Allan Bower's free online book "Applied Mechanics of Solids" helpful for vector and tensor analysis and index notation.

## Prerequisites

No prerequisites.

## Grading Policy

- 100% Homework (6-8 assignments due every or every other week).

## Course Schedule

**Week 01, 08/23 - 08/27:** Tensor algebra.

**Week 02, 08/30 - 09/03:** Tensor calculus and integral theorems.

**Week 03, 09/06 - 09/10:** Motion of a body: deformation gradient and strain.

**Week 04, 09/13 - 09/17:** Material and spatial description; evolution of vectors and tensors.

**Week 05, 09/20 - 09/24:** Kinematics: rates of strain and vorticity.

**Week 06, 09/27 - 10/01:** Balance laws: conservation of mass

**Week 07, 10/04 - 10/08:** Balance laws: balance of linear momentum. (Fall Recess, Oct. 14-15)

**Week 08, 10/11 - 10/15:** Balance laws: conservation of energy.

**Week 09, 10/18 - 10/22:** 2nd law of thermodynamics; frame indifference.

**Week 10, 10/25 - 10/29:** Theory for constitutive laws

**Week 11, 11/01 - 11/05:** Fluid behavior: equations of fluid mechanics.

**Week 12, 11/08 - 11/12:** Solid behavior: elasticity and hyperelasticity

**Week 13, 11/15 - 11/19:** Inelastic solid behavior

**Week 14, 11/22 - 11/26:** Continuum mechanics of multiple species

## Statement on Academic Conduct and Support Systems

### Academic Conduct:

Plagiarism – presenting someone else’s ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Part B, Section 11, “Behavior Violating University Standards” <https://policy.usc.edu/scampuspart-b/>. Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct, <http://policy.usc.edu/scientific-misconduct>.

### Support Systems:

*Student Counseling Services (SCS) - (213) 740-7711 – 24/7 on call*

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

<https://engemannshc.usc.edu/counseling/>

*National Suicide Prevention Lifeline - 1-800-273-8255*

Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. <http://www.suicidepreventionlifeline.org>

*Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-4900 - 24/7 on call*

Free and confidential therapy services, workshops, and training for situations related to gender-based harm. <https://engemannshc.usc.edu/rsvp/>

*Sexual Assault Resource Center*

For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: <http://sarc.usc.edu/>

*Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086*

Works with faculty, staff, visitors, applicants, and students around issues of protected class. <https://equity.usc.edu/>

*Bias Assessment Response and Support*

Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. <https://studentaffairs.usc.edu/bias-assessment-response-support/>

*The Office of Disability Services and Programs*

Provides certification for students with disabilities and helps arrange relevant accommodations.  
<http://dsp.usc.edu>

*Student Support and Advocacy – (213) 821-4710*

Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. <https://studentaffairs.usc.edu/ssa/>

*Diversity at USC*

Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. <https://diversity.usc.edu/>

*USC Emergency Information*

Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible, <http://emergency.usc.edu>

*USC Department of Public Safety – 213-740-4321 (UPC) and 323-442-1000 (HSC) for 24-hour emergency assistance or to report a crime.*

Provides overall safety to USC community. <http://dps.usc.edu>