

AME 509: Applied Elasticity

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Office Hours: TBD

Office: OHE 430M

Web: **USC DEN**

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

Class Room: RTH 109

Course Description

Principles of elasticity and their application in engineering.

Learning Objective

Mathematical foundations in continuum mechanics; three fundamental relations of elasticity: kinematics of deformation, balance laws, and constitutive equations; variational principles; analytical methods for elasticity problems; introduction to FEM; beams and plates; special topics.

Required Materials

Course notes will be made available online.

Prerequisites

No prerequisites.

Grading Policy

- 30% Final Exam (open note, like a homework).
- 70% Homework (≈ 7 assignments due roughly every other week).

Course Schedule

Week 01, 08/22 - 08/26: Introduction; mathematical foundations.

- the "gist" of elasticity.

Week 02, 08/29 - 09/02: Mathematical foundations.

- vector algebra; scalar and vector fields; vector transformations; dyadics; indicial notation; cartesian tensors.
- **Homework 1 on mathematical foundations.**

Week 03, 09/05 - 09/09: Kinematics of deformation.

- material and spacial coordinates; description of motion; deformations gradients; strain tensors; strain displacements relations; compatibility of infinitesimal strain.
- **Homework 2 on kinematics.**

Week 04, 09/12 - 09/16: Kinematics of deformations; balance laws.

- see above and below.

Week 05, 09/19 - 09/23: Balance laws.

- balances laws; state of stress; equations of motion with stress tensors; balances laws for small deformations; mechanical energy and work.
- **Homework 3 on balance laws.**

Week 06, 09/26 - 09/30: Constitutive equations.

- scope and basic assumptions; approaches to establish constitutive equations; isotropic materials; incompressible materials; linear constitutive equations.

Week 07, 10/03 - 10/07: Constitutive equations; generalized coordinates.

- general coordinates; cylindrical and spherical coordinates; equilibrium equations in these coordinates.
- **Homework 4 on constitutive equations.**

Week 08, 10/10 - 10/14: **General coordinates continued on Tuesday.** No class on Th; Fall Recess.

- cylindrical and spherical coordinates; equilibrium equations in these coordinates.

Week 09, 10/17 - 10/21: Elastostatics and nonlinear elastic problems.

- equations and boundary conditions of static elasticity; simple nonlinear elasticity problems and solutions;

Week 10, 10/24 - 10/28: Elastostatics and linear elastic problems.

- linear elastic problems; planar problems; Navier's equation; Airy stress potential.
- **Homework 5 on elasticity problems.**

Week 11, 10/31 - 11/04: Variational Methods

- calculus of variations; virtual work principle; principle of minimum potential energy.

Week 12, 11/07 - 11/11: Variational methods; introduction to FEM

- see above and below;
- **Homework 6 on variational and approximation methods.**

Week 13, 11/14 - 11/18: Introduction to FEM;

- approximation methods in elasticity; examples.

Week 14, 11/21 - 11/25: Introduction to structural theories (no class on Thursday; Thanksgiving).

- Euler-Bernoulli beam theory.

Week 15, 11/28 - 12/02: Introduction to structural theories

- classical plate theory.
- **Homework 7 on structural theories.**

Week 16, 12/05 - 12/09: Study dates/Final Exam

- Everything covered in the course will be "fair game".

Week 17, 12/12 - 12/16: **Final Exam**

- Everything covered in the course will be "fair game".

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>