AME 509: Applied Elasticity

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Office Hours: TBD
Office: Covid-19

Web: https://courses.uscden.net/d2l/home/18411
Class Hours: T/Th 1:30-3:20pm
Class Room: TBD

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

Prerequisites: AME 403 (or equivalent).

Grading Policy

- **40%** Final Exam (open note, 24 hours).
- **30%** Mid-Term Exam (open note, 24 hours).
- **30%** Homework (7 assignments due roughly every other week).

Course Schedule

Week 01, 08/26 - 08/30: Introduction; mathematical foundations.

- the "gist" of elasticity.

Week 02, 09/02 - 09/06: Mathematical foundations.

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

Week 03, 09/09 - 09/13: 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, 09/16 - 09/20: Kinematics of deformations; balance laws.

- see above and below.

Week 05, 09/23 - 09/27: 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, 09/30 - 10/04: Constitutive equations.

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

Week 07, 10/07 - 10/11: Constitutive equations; generalized coordinates.

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

Week 08, 10/14 - 10/18: **Midterm Exam on Tuesday.** No class on Th; Fall Recess.

- Exam will cover math, kinematics, balance laws, and constitutive eqn's.

Week 09, 10/21 - 10/25: Generalized coordinates; elastostatics and nonlinear elastic problems.

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

Week 10, 10/28 - 11/01: Elastostatics and linear elastic problems.

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

Week 11, 11/04 - 11/08: Variational Methods

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

Week 12, 11/11 - 11/15: Variational methods; introduction to FEM

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

Week 13, 11/18 - 11/22: Introduction to FEM;

- approximation methods in elasticity; examples.

Week 14, 11/25 - 11/29: Introduction to structural theories (no class on Thursday; Thanksgiving).

- Euler-Bernoulli beam theory.

Week 15, 12/02 - 12/06: Introduction to structural theories

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

Week 16, 12/09 - 12/13: Special topics (time permitting).

- wrinkling in plates, microstructure in materials, and folding origami.

Week 17, 12/16 - 12/20: Final Exam

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