AME 509: Applied Elasticity

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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 ($\approx$ 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 continuedon 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 elasticty; 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".