AE 6114 - Syllabus

Fundamentals of Solid Mechanics - 3 Credit Hours

General Information

Description

Unified overview of fundamental aspects of solid mechanics, from nonlinear continuum mechanics to linear elasticity, including an introduction to energy methods and other special topics.

Prerequisites:

COE 3001

Course Goals and Learning Outcomes

Upon successful completion of this course, students will be able to:

1) Understand the basic mathematical principles of operating with vectors and tensors and their application to solid mechanics.
2) Determine the appropriate formulation for a particular problem in solid mechanics. This includes choice of linear vs. nonlinear kinematics, choice of constitutive model, and understanding of suitable solution techniques.
3) Formulate the governing equations corresponding to the boundary value problem in solid mechanics.
4) Apply basic techniques for solving boundary value problems for linear elastic solid bodies. Application of Airy Stress functions to plane stress and plane strain problems.
5) Understand the basic principles of applying energy methods to problems in solid mechanics.

Course Requirements & Grading

Note: Graded components of a course may vary with each offering. The example below is typical but subject to change.

Description of Graded Components

- Homework Assignments: 20%
- Quiz 1: 20%
- Quiz 2: 20%
- Final Exam: 40%

Grading Scale

- Final grades are assigned based on a curve. The curve is generally "B" centered. I announce letter grade ranges after every exam.

Topics Covered

Note: The exact topics covered in a course may vary with each offering. The example below is typical but subject to change.

1) Mathematical Concepts
    a. Tensors. Definition and algebraic operations. Properties of tensors.
    b. Summation convention, Kronecker delta, and permutation symbol.

   c. Change of basis
   d. Eigenvalues and vectors of second order tensors.
2) Finite Kinematics
   a. Body and its configuration. Deformation mapping.
   b. Kinematics of local deformations. Metric changes.
   c. Changes in length, area, and volume.
   d. Polar decomposition. Strain measures.
   e. Infinitesimal deformations.
3) Balance Laws
   a. Conservation of mass
   b. Balance of linear and angular momentum
   c. Cauchy's stress principle. Cauchy's stress tensor.
   d. Balance of energy. Entropy imbalance. Free-energy imbalance
   e. Balance laws for small deformations
4) Linear Elasticity
   a. Definition of isotropic linear elasticity
   b. Symmetries of the elasticity tensor
   c. Material properties and generalized Hooke's law
   d. Boundary value problem in elastostatics
   e. Principle of superposition
   f. Two-dimensional problems in elasticity
   g. Airy stress potential for plane problems
5) Energy principles
   a. Strain energy
   b. Principle of Minimum Potential Energy
   c. Rayleigh-Ritz Method
   d. Introduction to the finite element method

Course Materials

Note: Course materials may vary with each offering. The example below is typical but subject to change.

Textbook

- Continuum Mechanics of Solids – Lallit Anand and Sanjay Govindjee
- Continuum Mechanics and Thermodynamics – Ellad B. Tadmor, Ronald E. Miller, and Ryan S. Elliot

Course notes

- Course notes will be delivered during the lecture on the whiteboard. They will not be distributed electronically.