Solid Mechanics I (MCEN 5023)

Mechanics of Aerospace Structures (ASEN 5012)

Fall 2007

http://www.colorado.edu/engineering/CAS/courses.d/ASEN5012.d/ASEN5012_2007.html

Instructor	**TA**
K. C. Park	TBD
Office: ECME 185	Office:
Telephone: 2-6330	Telephone:
E-mail: kcpark@colorado.edu	E-mail:

Office Hours
Instructor: MW: 4:00PM-6:00PM.
TA: TBD.

Prerequisites

MCEN 2063 for ME; APPM 2360 and ASEN 2001, 2003, and 3112, or equivalent.

Reference Books

Elasticity in Engineering Mechanics, 2nd e dition, by Arthur R. Boresi, Ken P. Chong. Wiley Interscience Publication, New York, 2000.

Classical and Computational Solid Mechanics, Fung, Y.C., Tong, P., World Scientific Publishing, Singapore, 2001

Nonlinear Solid Mechanics, A Continuum Approach for Engineering, Holzapfel, G.A., John Wiley & So ns, New York, 2000.

Continuum Mechanics: Concise Theory and Problems, Chadwick, P. Dover Publications,1999.

Grading

Your grade in this course will be assessed by homework, exams, (projects), and class discussions. Grading will follow one of two options below, depending on the preference of the class.

Option A:

Homework 30%

Two mid-term exams: 30%

One two-hour final exam: 30%

Class participation: 10%

Course Content

1. Introduction & Review of Undergraduate Mechanics
2. Concepts and Fundamentals of Scalar, Vectors, and Tensors
 a. Concepts of scalar, vectors, and tensors
 b. Basic operations of scalar, vectors, ad tensors
3. Stress and Strain Tensors
 a. Stress Tensor
  i. Traction and stress tensor
  ii. Stress transformation and Mohr's circle
  iii. 3D Mohr's circle
  iv. Stress invariant and stress
 b. Equation of static equilibrium
 c. Strain Tensor
  i. Deformation and strain
  ii. Strain tensor and transformation of strain tensor
  iii. Stress invariant and stress deviations
 d. Compatibility of strain fields
4. Linear Elasticity-Boundary Value Problem
 a. General Hooke's Law
 b. Governing equations and uniqueness of boundary value problems
 c. Saint Venant's theory of torsion
 d. Plane stress and plane strain
 e. Airy stress function in Cartesian coordinates
5. Energy Theorems and Variational Method
 a. Principle of virtual displacement; strain energy; complementary energy; Potential Energy; Energy principles
 b. Variational Method
 c. Method of Lagrange Multipliers
6. Constitutive Equations
 a. Classification of materials
 b. Plastic material behavior
 c. Constitutive equations for plasticity
7. Advanced Topics
 a. Waves in Elastic Solids
 b. Nonomechanics

What is Solid Mechanics?

-- **Mechanics is the study of forces and their effects.**

-- **Solid Mechanics is a branch of mechanics involving solids.**

"Engineers have always relied on their knowledge of previous designs, experiments, ingenuity, and creativity to develop new designs.

Modern engineers add a powerful technique: mathematical equations Based on the physical characteristics of the devices they design.

With these mathematical models, engineers predict the behavior of their designs, modify them, and test them prior to their actual construction." -- Bedford and Fowler in *Engineering Mechanics: Statics*

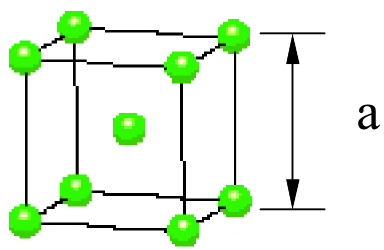
Length scales where solid mechanics is valid

Size of an atom:

Hydrogen: 0.12nm   Oxygen: 0.14nm

Carbon: 0.16nm   **~0.1nm**

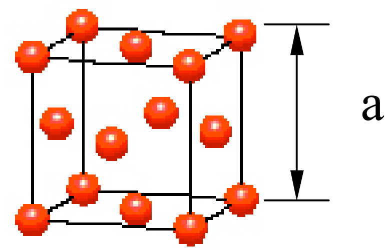
Size of lattice in crystal:



b.c.c

Iron α: a=0.286nm

Sodium: a=0.429nm



f.c.c

Aluminum: a=0.405nm

Copper: a=0.355nm

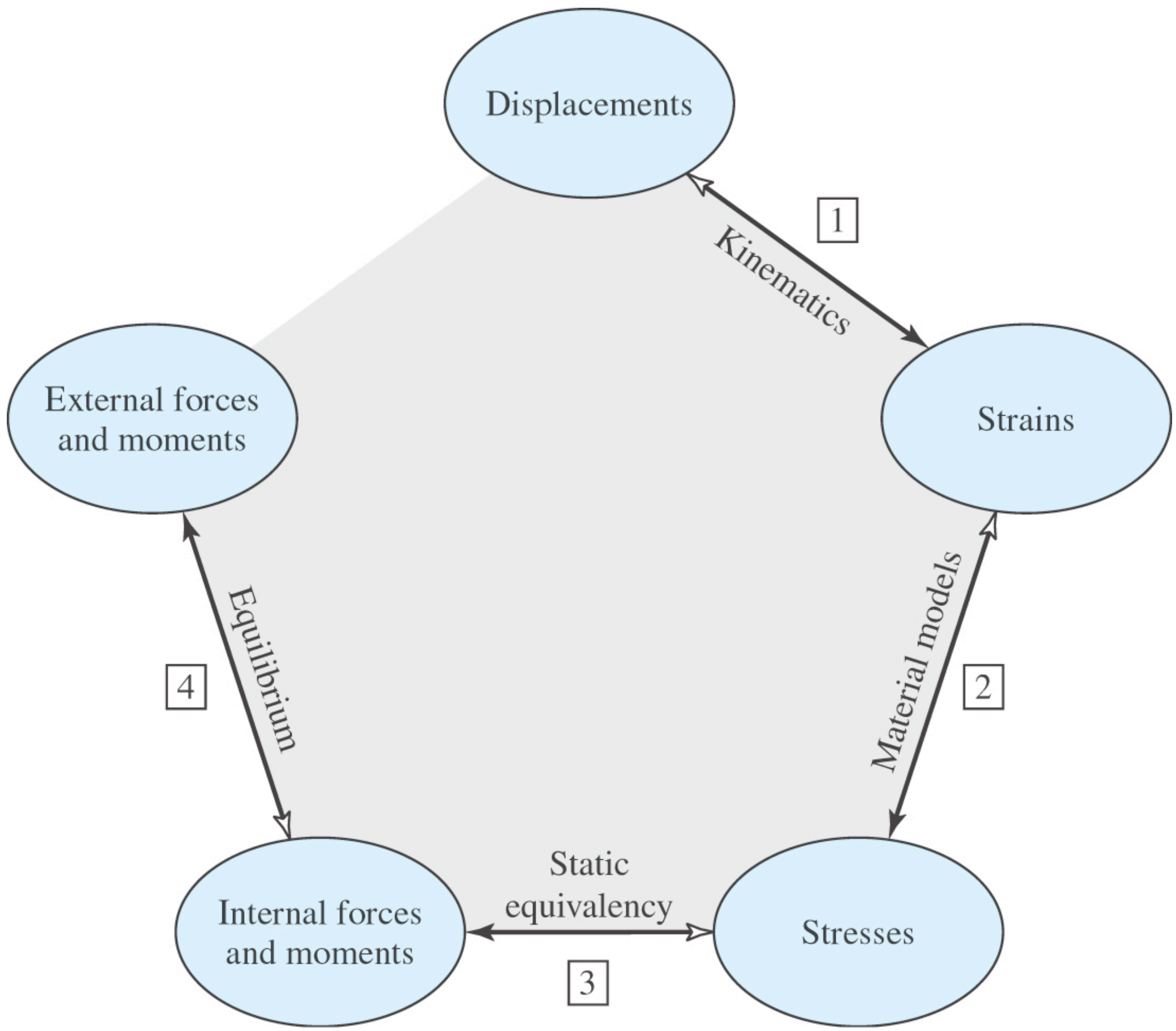
For Solid Mechanics:

>10μm, safe

>100nm, but <10μm, safe but size effect

>1nm, but <100nm, applicable in some case, but be cautious. Many arguments.

Logic in Mechanics of Materials



Undergraduate Mechanics Course:

Kinematics: small strains (linear stress-strain relations)
Constitutive behavior: Mostly linear elastic materials
Mathematical models: Differential equations based;
Applications: Extension, Torsion, and Bending
of Machine /Structural Elements;

Graduate Mechanics Course:

Kinematics: small and large strains (nonlinear stress-strain relations)
Constitutive behavior: Linear and nonlinear elastic-plastic materials
Mathematical models: Differential equations for simple models, and
Variational formulations for complex models;
Applications: General continuum, including structural elements.

A word about Lecture Notes:

Mostly handwritten and will be posted on the class website, normally after each lecture is delivered.

It is ***strongly recommended*** that students utilize the lecture notes to reaffirm his/her notes, not as the principal sources of materials learned. The instructor believes that this is a good learning process. For those who do not believe in learning through note-taking, please read the reference sources cited at the end of each lecture notes.

If the particular lecture notes are based on a specific text or references, they will be cited at the end of each lecture notes.

When there is no cited references, it is created by the instructor. In those instances, the students should read them with maximum caution and some suspicion!! For your instructor is fallible and has a habit of making mistakes all the time!!!