

MA591Z Syllabus
Introduction to Continuum Mechanics of Elastic & Viscoelastic Solids
Spring 2009

Description: Continuum models have been widely employed in describing the mechanics of many solid and solid-like materials. In these models, appropriate kinematic quantities (vectors, tensors etc.) are introduced to quantify deformation in the material relative to an undeformed reference state. For a specific application, constitutive laws are then formulated to relate the kinematic quantities to forces inside the material. Finally, balance laws are employed to enforce conservation of mass, momentum and energy, resulting in a closed system of governing equations for a specified geometry and boundary conditions. This course will introduce the student to continuum mechanics models for elastic, viscoelastic and poroelastic materials. Applications will be included, with an emphasis on continuum modeling in biomechanics.

Instructor: Dr. Mansoor Haider, HA306, 515-3100, m_haider@ncsu.edu

Time/Place: 8:30-9:45 Tues/Thurs, HA274

Office Hours: Tuesdays 10-11, Wednesdays 1:30-2:30, or by appointment

Prerequisites: Vector calculus (MA242 or equivalent), Elementary differential equations (MA341 or equivalent), some experience with symbolic computing (e.g. MAPLE) will also be beneficial.

Textbook: *An Introduction to Continuum Mechanics: with applications*, by J.N. Reddy, Cambridge University Press, 2008

Grade: 6 Homework Assignments (50%)
1 Take-home Test (20%)
1 Take-home Final Exam (30%)

Topics:

- I. Mathematical Concepts: Vector fields, tensor analysis, orthogonal curvilinear coordinates.
- II. Kinematics and Strain: Measures of strain, strain tensors, compatibility.
- III. Stress & Conservation Laws: The stress tensor, stress-strain relations, linear elasticity, conservation of mass, momentum and energy
- IV. Applied Linear Elasticity: Mathematical solutions for plane stress, plane strain and axisymmetric boundary value problems, energy methods.
- V. Linear Viscoelasticity: Discrete models (Maxwell, Kelvin, Voigt), hereditary integrals, creep, stress relaxation, dynamic loading, hysteresis.
- VI. Introduction to Poroelasticity: Two-phase (fluid-solid) mixture models, balance laws for mass/momentum/energy, applications to biological tissues.
- VII. Introduction to Nonlinear Elasticity.