Spring 2018
MECH 934; Credits: 3

NONLINEAR ELASTICITY

Instructor: Prof. Eveline Baesu, Department of Engineering Mechanic,
e-mail : ebaesu@unl.edu, ph:2-2382, W304 Nebraska Hall

(tentative)Tu, Th, 3:30 - 4:45

Office Hours: Wed: 2:00 -3:00 or by appointment

The research topics covered are pertaining to nonlinear elasticity, thermodynamics, and theory of elastic stability. The emphasis of the course is towards general nonlinear elasticity theory, modeling of thin films, thin film/substrate interactions and fiber networks. Prior knowledge of continuum mechanics is desired, but a short introduction to this subject will be provided.

The modern subject of nonlinear elasticity resulted from a resurgence of interest in continuum mechanics in the latter half of the 20th century and even today serves as a model upon which theories for new materials are based. Over the past several years, applications of the theory have extended beyond the mechanics of rubber to embrace polymer behavior and the mechanics of biological tissues, including skin, arterial walls and the heart.

Nonlinear elasticity provides a vehicle for the analysis of the stability of materials and structures and the effects of initial stress on material stiffness and performance. Also, as recently demonstrated in the research literature, it also furnishes a framework for incorporating microstructural effects on material behavior. An important example of this is the description of the shape memory effect, which is increasing being employed in commercial applications (for e.g. in smart material systems in the aerospace industry)

Other specific topics to be covered include thermoelasticity and notions of stability theory based on nonlinear three-dimensional theory of elasticity, as well as thin film/substrate interaction.

Prerequisite: ENGM 910, Continuum Mechanics

Grading: Several problem sets and a project (e.g., thorough review of a paper, worked-out solution or original contribution, etc.)

TOPICS

1. Brief review of basic continuum mechanics.

2. Concept of an elastic and thermoelastic material: Experiments, constitutive postulate, strain-energy function.

3. Material symmetry theory: Isotropy and anisotropy.

4. Universal relations for use in testing theory against experiment. Controllable deformations: Ericksen's theorem.

5. Examples of exact solutions.

6. Stability criteria and their implications for constitutive equations and material instabilities associated with phase transformations in certain shape-memory alloys and polymers such as polyethylene.

7. Linear theory of small deformations superposed on a large deformation. Problems involving pre-stress.

8. Thin film modeling. Membrane theory.

9. Fiber network continuum modeling.

11. Biomechanics applications.