BMED/ME 4758 Biosolid Mechanics {Elective}

Credit: 3-0-3

Prerequisite(s): BMED 3400 or COE 3001

Catalog Description
The mechanics of living tissue, e.g., arteries, skin, heart muscle, ligament, tendon, cartilage, and bone. Constitutive equations and some simple mechanical models. Mechanics of cells. Applications.

Text
Cardiovascular Solid Mechanics, JD Humphrey, Springer New York, 2004. (required)

Biomechanics. Mechanical Properties of Living Tissues, 2nd Edition, YC Fung, Springer New York, 1993. (recommended)

Objectives

The overall objective of this course is to provide students with the mathematical preliminaries and theoretical framework to analyze the mechanics of biological materials. Much of the course will consider modeling biological tissues as non-linear, elastic, homogeneous, anisotropic, incompressible materials. Additional consideration will be given to viscoelasticity, heterogeneities, and linearized elasticity and quasi-linear viscoelasticity.

Outcomes

At the end of the course the students should be able to:

1. Perform basic tensor algebra operations and employ index notation to manipulate expressions containing scalar, vector and second-order tensors. (Program Outcomes 1 and 2)
2. Understand the concepts and various definitions of stress and strain and identify the 3D state of stress and strain under different loading scenarios, including uniaxial and biaxial extension and compression, simple and pure shear, and inflation and extension of a residually stressed tube. (Program Outcomes 1 and 2)
3. Delineate the general mechanical characteristics of different biological materials and identify an appropriate theoretical framework to perform stress analysis on these materials. (Program Outcomes 1 and 2)
4. Apply the basic postulates of classical physics (conservation of mass, linear and angular momentum, and energy and the entropy inequality) to determine the 3D distribution of stress and strain in biological tissues under various loading scenarios with a given constitutive equation. (Program Outcomes 1 and 2)

5. Apply the basic postulates of classical physics to formulate constitutive equations and determine material parameters for biological tissues modeled as non-linear, elastic, heterogeneous, anisotropic, incompressible materials. (Program Outcomes 1 and 2)

Topical Outline

1. Introduction
2. Mathematical Preliminaries
   Properties and Manipulation of Scalars, Vectors, and Tensors
   Matrix Methods
3. Continuum Mechanics
   Kinematics: Deformation and Concept of Strain
   Stress, Traction
   Balance Relations
   Constitutive Formulation
4. Finite Elasticity for Soft Tissue Biomechanics
   Uniaxial Extension
   Planar Biaxial Extension
   Inflation, Extension, and Torsion of a Thick Walled, Residually Stressed Tube
5. Soft Tissue Viscoelasticity
   Finite Viscoelasticity
   Linear and Quasi-Linear Viscoelasticity

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Last modified April 24, 2007