BMED/ME 4758 Biosolid Mechanics (Elective)

Catalog Description: BMED/ME 4758 Biosolid Mechanics (3-0-3)

Prerequisites: BMED 3400 Introduction to Biomechanics or COE 3001 Mechanics of Deformable Bodies

Crosslisted with AE, BMED, CHBE, and ME.

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.

Textbook: Jay D. Humphrey, *Cardiovascular Solid Mechanics*, Springer New York, 2004. (required)
Yuan-Cheng Fung, *Biomechanics. Mechanical Properties of Living Tissues*, 2nd Edition, Springer New York, 1993. (recommended)

Topics Covered:

1. Introduction
2. Mathematical preliminaries
   a) Properties and manipulation of scalars, vectors, and tensors
   b) Matrix methods
3. Continuum mechanics
   a) Kinematics: Deformation and concept of strain
   b) Stress, traction
   c) Balance relations
   d) Constitutive formulation
4. Finite elasticity for soft tissue biomechanics
   a) Uniaxial extension
   b) Planar biaxial extension
   c) Inflation, extension, and torsion of a thick walled, residually stressed tube
5. Soft tissue viscoelasticity
   a) Finite viscoelasticity
   b) Linear and quasi-linear viscoelasticity

Course Outcomes:

Outcome 1: The student will develop a working knowledge of continuum mechanics concepts.

1.1 The student will perform basic tensor algebra operations.

1.2 The student will employ index notation to manipulate expressions containing scalar, vector and second-order tensors.

1.3 The student will demonstrate the ability to understand the concepts and various definitions of stress and strain.

1.4 The student will demonstrate an ability to 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.

Outcome 2: The student will develop a working knowledge of the constitutive laws of different biological materials.

2.1 The student will demonstrate the ability to identify an appropriate theoretical framework to perform stress analysis on these materials.

2.2 The student will demonstrate the ability to 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.

2.3 The student will demonstrate an ability to determine material parameters for biological tissues modeled as non-linear, elastic, heterogeneous, anisotropic, incompressible materials.

Correlation between Course Outcomes and Student Outcomes:

BMED/ME 4758											
	Mechanical Engineering Student Outcomes										
Course Outcomes	a	b	c	d	e	f	g	h	i	j	k
Course Outcome 1.1	X										
Course Outcome 1.2	X										
Course Outcome 1.3	X										
Course Outcome 1.4	X				X						X
Course Outcome 2.1	X										
Course Outcome 2.2	X				X						
Course Outcome 2.3	X				X					X	X

GWW School of Mechanical Engineering Student Outcomes:

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

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