BMED/AE/CHE/ME 4758 Biosolid Mechanics (Elective)

Catalog Description: BMED 4758 Biofluid Mechanics (3-0-3)
Prerequisite(s): BMED 3400
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: Cardiovascular Solid Mechanics, Humphrey, Springer (2004)
Biomechanics: Mechanical Properties of Living Tissues, 2nd edition, Fung, Springer (1993)

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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:
Students who complete this course will be able to:
Outcome 1: Perform tensor algebra operations and employ index notation to manipulate expressions containing scalar, vector and second-order tensors. (Student Outcomes e and k)
Outcome 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. (Student Outcomes e and k)
Outcome 3: Delineate the general mechanical characteristics of different biological materials and identify an appropriate theoretical framework to perform stress analysis on these materials. (Student Outcomes e and k)
Outcome 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. (Student Outcomes e and k)
Outcome 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. (Student Outcomes e and k)

Correlation between course outcomes and student outcomes:

BMED 4758											
	Biomedical Engineering Student Outcomes										
Course outcomes	a	b	c	d	e	f	g	h	i	j	k
1					X						X
2					X						X
3					X						X
4					X						X
5					X						X

The Wallace H. Coulter Department of Biomedical 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, societal, 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 lifelong learning;
j. a knowledge of contemporary issues;
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice;