ME/BE 788: Soft Tissue Biomechanics

Spring 2021
MW 12:20-2:05 pm

Course Description

This course will introduce students to the mechanics of soft biological tissue. In particular, the response of vasculature, heart, and tissue scaffolds to mechanical loads from the perspective of nonlinear solid mechanics will be studied. Constitutive models for hyperelastic materials will be adapted to biomaterials to handle mechanical characteristics such as nonlinearity, viscoelasticity, and anisotropy. Basic experimental methods, and anatomy and physiology of particular tissue types will also be introduced. Emphasis is placed on integrating the basic analytical, experimental, and computational methods for a more complete understanding of the underlying mechanobiology.
Prereq: Vectors and tensors, kinematics, stress/strain tensors, mechanics of rigid bodies; (BE420 & BE521) or ME521or equivalent with consent of instructor.

Instructor

Dr. Katherine Yanhang Zhang
Office: ENG 219
Telephone: (617) 358-4406
E-mail: Yanhang@bu.edu

Office Hours

By appointment.

Textbooks

Cardiovascular Solid Mechanics: cells, tissues, and organs, Jay D. Humphrey. Springer-Verlag, 2002. ISBN 0-387-95168-7.
Biomechanics: mechanical properties of living tissues, Y. C. Fung. Springer-Verlag, 1993. ISBN 0-387-97947-6.
Nonlinear Solid Mechanics: a continuum approach for engineering, Gerhard A. Holzapfel. John Wiley & Sons, 2001. ISBN 978-0471-82319-3.

Grading

Your grade in this course will be assessed by homework, project, exams, attendance and class participation.

Homework	15%
Virtual lab assignments	15%
Midterm exam	35%
Term project	25%
Class participation	10%
Total:	100%

Attendance and class participation

You are required to attend the class and are responsible for all materials and announcements in the class. Make-up class is only available in very special circumstances, such as illness. You are also required to participate in class discussions, analyzing and discussing reading assignments. Reading assignments, usually journal articles will be assigned weekly starting a few weeks after the class begins. For each reading assignment, a lead reader will also be assigned who will lead the discussion.

Homework
Homework will be assigned bi-weekly. Discussions on the homework are allowed. However, copying other people's homework will result in no credit.

Lab assignments*
There will be two virtual lab assignments. The objective of the lab assignments is to get some in-depth understanding on mechanical characterization of soft biological tissue, and to apply the knowledge on constitutive modeling to model and predict the mechanical behavior of biological tissue.

Term project*
Every student is required to complete a term project. The objective of the project is that each student understands the theoretical and experimental methods to study the biological mechanisms, and applies these understandings to analyze research problems.

*More details about the lab and term project will be forthcoming.

Important Dates:
Midterm exam: March 29th.
Term project presentation: April 21st, 26th, and 28th.

List of topics to be covered in the course:
Introduction and mathematical preliminaries
Continuum mechanics
Finite elasticity
Experimental methods
Structure-function of native and engineered soft tissues
Vascular mechanics of normal vasculature and vascular disorders
Constitutive modeling and parameter estimation
Viscoelasticity
Growth and remodeling (if time allowed)