ME/BE 788: Soft Tissue Biomechanics

Spring 2015
Tue, Thu 10am-12pm, PSY B40

Course Description

This course will introduce students to the mechanics of soft biological tissue. In particular, the response of the heart, vasculature, 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 orthotropy. 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
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Office Hours

TBD. In addition to the regularly scheduled hours, the instructor is also available by appointment.

Textbooks

Cardiovascular Solid Mechanics: cells, tissues, and organs, Jay D. Humphrey. Springer-Verlag, 2002. ISBN 0-387-95168-7.

Reference

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	10%
Lab	25%
Midterm exam	35%
Term Project	20%
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 encouraged. However, copying other people's homework will result in no credit.

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

*More details about the term project will be forthcoming.

Important Dates:
Lab 1: March 3rd, 5th, report due March 19th
Lab 2: March 17th, report due March 31st.
Midterm exam: April 14th.
Term project presentation: April 28th, 30th.

List of topics to be covered in the course:
Introduction and mathematical preliminaries
Continuum mechanics/finite elasticity
Experimental methods
Structure/function/properties for native and engineered soft tissues
Vascular mechanics of normal vasculature and vascular disorders
Constitutive modeling and parameter estimation
Cardiac mechanics
Viscoelasticity
Mechanotransduction
Electrochemical effects on tissue properties
Poroelasticity
Growth biomechanics