BME 5335 Biological Materials, Mechanics, and Processes

Spring 2014

Time T/TH 5:00 - 6:20 p.m. **Room** ERB 131 **Computer Lab** ELB256

Instructor Dr. C. Chuong

TA Ishan Khan, TA hours: T/TH 11:00 am - 1:00 pm lunch area in front of ERB 231

Goals To apply basic principles in mechanics using experimental, analytical, and computational methods

a) to describe the mechanical property for various biofluids, biosolids,
b) to characterize the mechanical properties of cells, tissues and overall organs,
c) to describe the blood flow at both systemic and pulmonary circulation quantitatively
d) to learn the basics in finite element modeling and its applications in modeling bioengineering problems.

Prerequisites Undergraduate statics/dynamics, strength of materials (or introduction to mechanics) and fluid mechanics

Course contents

Part 1 Review of continuum mechanics (mechanics of solids, strengths of materials, and fluid dynamics)
Stress, Strain, Strain-rate
Constitutive equations - Hookean solid, hyperelastic solid, Newtonian fluid, visco-plastic behavior
Conservation of mass, momentum, and energy

Part 2 Mechanical Property of cells, tissues, and their application to assess organ functional properties
Flow properties of blood
Red cells and their deformability
Cellular mechanics – signal transduction in cytoskeleton, mechanism of traction force generation, focal adhesion, interaction with ECM
Biofluids – blood, synovial fluid, mucus, saliva, etc.
Biosolids – soft tissues- skin, arterial wall, vein, ligament, tendon etc. and hard tissues - bone, dental, trachea, etc.
Testing methods - 1D, biaxial, dynamic wave propagation, viscometer
AFM, optical trap, nano indentation, etc.
PDMS microfluidic devices
Bone & cartilage
Skeletal muscle, cardiac muscle, smooth muscle

Part 3 Circulation: Systemic and Pulmonary Blood flow in arteries
Laminar flow in a rigid tube, in an elastic tube
Turbulence in pulsatile blood flow
Creeping flow
Pulse wave propagation
Microcirculation in
Systemic capillary
Pulmonary capillary – sheet flow
Diffusion transport across capillary wall
Applications in drug delivery

Part 4 Basics of finite element modeling (computer lab component)
ANSYS program – building up geometry, 2D, 3D
Applications in biosolid problems (prosthetic devices, braces, hip replacement, TKR, heart valves, tissue-engineered vessels, scoliosis correction, etc.)

Project

Team project with group presentation and individual project report.

Textbook

Ethier CR and Simmons CA, Introductory Biomechanics from Cells to Organisms, Cambridge University Press, 2007.

References (all titles are on reserve at UTA S&T Lib)

1. Fung, YC, Biomechanics: Mech Prop of Living Tissues, Springer-Verlag, 1993, 2nd edition
2. Fung YC, Biomechanics: Circulation, Springer-Verlag, 1996, 2nd ed.
3. Humphrey JD, Cardiovascular solid mechanics: cells, tissues, and organs, Springer, 2002.
4. Humphrey JD and Delange SL, An introduction to Biomechanics, Springer –Verlag, 2004.
5. Fung YC, A First Course in Continuum Mechanics, Prentice Hall.

Grading

Homework	14%
Participation	5%
Midterm 1	22%
Midterm 2	22%
Final	22%
Project report and presentation	15%

Late Homework

Homework set is due at 5:00 pm of the announced due date at the classroom (or otherwise specified). There will be penalty for late submission calculated as 10% for every one hour.

Americans with Disabilities Act:

The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the Americans with Disabilities Act (ADA). All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

If you require an accommodation based on disability, I would like to meet with you in the privacy of my office, during the first week of the semester, to make sure you are appropriately accommodated.

Academic Integrity and Academic Dishonesty:

It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University. According to the UT System Regents' Rule 50101, §2.2, "Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts."