BIOE 602 Cellular and Tissue Biomechanics Spring 2006

Time: Tu Th 2:00-3:15pm
Location: CHE 2118
 # Credits: 3

Instructor: Professor Adam H. Hsieh, Ph.D.
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Office Hours
Mon 10am-12pm
Wed 10am-12pm

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Office Hours
Thurs 4-6pm

Textbooks (suggested):
Humphrey JD. Cardiovascular Solid Mechanics: Cells, Tissues, and Organs. Springer-Verlag, Inc., New York City, NY, 2002.

Mow VC, Huiskes R. Basic Orthopaedic Biomechanics and Mechanobiology, 3nd ed. Lippencott Williams & Wilkins, Philadelphia, PA, 2005.

References (on reserve in EPSL):
Humphrey JD, DeLange SL. An Introduction to Biomechanics: Solids and Fluids, Analysis and Design. Springer-Verlag New York, Inc., New York City, NY, 2004.

Fung YC. Biomechanics: Mechanical Properties of Living Tissues, 2nd ed. Springer-Verlag New York, Inc., New York City, NY, 1993.

Fung YC. Biodynamics: Circulation, 2nd ed. Springer-Verlag New York, Inc., New York City, NY, 1997.

Fung YC. Biomechanics: Motion, Flow, Stress, and Growth Springer-Verlag New York, Inc., New York City, NY, 1990.

Alberts B, et al. Molecular Biology of the Cell, 3rd ed. Garland Science Publishing, New York City, NY, 1994.

Catalog Description:
Introduction to the fundamentals of biomechanics including force analysis, mechanics of deformable bodies, stress and strain, multiaxial deformations, stress analysis, and viscoelasticity. Biomechanics of soft and hard tissues.

Expanded Description:
Biomechanics has been one of the cornerstones of bioengineering research for decades. While recent technological advances have generated more and more specialization within biomechanics, the basic principles remain important, both for direct biomechanics applications and for an appreciation of biomechanical factors in other research studies. This course is designed to provide background and knowledge of approaches and tools that have traditionally been used in several aspects of biomechanics. The goal is to provide an understanding of biomechanics fundamentals that will then enable the student to explore specific areas of interest in more depth.

Course Objectives:
The specific goals of this course are to provide students with:

- an overview of engineering approaches used to study biomechanics with emphasis on biomedical applications.
- familiarity of biomechanics problems in various organs in the human body and at various hierarchical levels.
- understanding of the molecular and cellular contributions to the biomechanics of tissues.
- appreciation for the contribution of biomechanics to physiologic processes.
- background to read journal articles that describe specific research findings and the ability to relate these findings to the overall field of biomechanics.

Grading Policy:
Homeworks, papers, and exams will contribute to your final grade as follows:

Homework: 40%	(4 @ 10% each)
Papers: 20%	(2 @ 10% each)
Presentation: 10%	(1 @ 10% each)
Exams: 30%	(2 @ 15% each)

Homework and papers:
Assignments are due at the end of class time on the announced due date. Grades will be reduced by 10% for each day late. Assignments are meant to help you master the concepts presented in class and apply them in different contexts, as well as provide you and me with opportunities to evaluate whether or not the learning objectives are being met. Please complete assignments using the following guidelines:

- The two papers that will be assigned for the course should be typed.
- For partial credit reasons, it is in your best interest to write out as much step-by-step work as it takes to make thought processes clear, including but not limited to listing knowns, assumptions, sketches.
- Please be professional and organized (i.e. clip or staple your papers together in the correct order, try to write neatly or, if necessary, type your work). If we cannot make heads or tails of your assignment, we're not going grade it.

Reminders on Key Campus Policies:
Academic Integrity
The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.studenthonorcouncil.umd.edu/whatis.html

Accommodations for Students With Disabilities
The University is required to provide appropriate accommodations for students with disabilities. Students with disabilities should inform me of their needs at the beginning of the semester so that I can contact the appropriate individuals who will work to determine and implement appropriate accommodations.

Policy on Religious Holidays
The University System of Maryland policy on religious observances provides that "students should not be penalized because of observances of their religious beliefs; students shall be given an opportunity, whenever feasible, to make within a reasonable time any academic assignment that is missed due to individual participation in religious observances." However, "it is the student's responsibility to inform the instructor of any intended absences for religious observances in advance. Notice should be provided as soon as possible but no later than the end of the schedule adjustment period."

Class Schedule

Week	Date	Topic	Course material	HW assigned	HW due
1	Th, Jan 26	Introduction to course, significance and relevance of biomechanics	Overview, Chapter 1		
2	Tu, Jan 31 Th, Feb 2	Vector/tensor preliminaries	Humphrey Ch. 2		
3	Tu, Feb 7 Th, Feb 9	Fundamental concepts from physics/mechanics Biomechanical analysis of joints	Handouts/notes Mow Ch. 2-3	HW #1	
4	Tu, Feb 14	Paper discussion (biomechanics of joints)			
	Tu, Feb 14 Th, Feb 16	Structure/composition: basis of tissue mechanics	Handouts/notes	Paper #1	HW #1
5	Tu, Feb 21	Laboratory demonstration (tissue struct/comp)			
	Tu, Feb 21 Th, Feb 23	Structure/composition: basis of tissue mechanics Biomolecular mechanics (Dr. Gregory Payne)	Handouts/notes Handouts/notes		
6	Tu, Feb 28	Paper discussion (biomolecular mechanics)			
	Tu, Feb 28 Th, Mar 2	Biomolecular mechanics (Dr. Gregory Payne) Biosolids: Stress, strain, & constitutive relations	Handouts/notes Humphrey Ch. 3, 5	HW #2	Paper #1
7	Tu, Mar 7	Paper discussion (biosolids techniques)			
	Tu, Mar 7 Th, Mar 9	Biosolids: Stress, strain, & constitutive relations Linear elasticity	Humphrey Ch. 3, 5 Mow Ch. 4		
8	Tu, Mar 14	Laboratory demonstration (bone mechanics)			
	Tu, Mar 14 Th, Mar 16	Finite elasticity **Mid term exam**	Humphrey Ch. 4		HW #2
9	Mar 21, 23	**Spring Break – No classes**	**n/a**		
10	Tu, Mar 28 Th, Mar 30	Finite elasticity Viscoelasticity	Humphrey Ch. 4 Mow Ch. 5/notes	HW #3	
11	Tu, Apr 4	Laboratory demonstration (soft tissue mechanics)			
	Tu, Apr 4 Th, Apr 6	Coupled solid-fluid (biphasic) tissue behavior Biofluids: Stress, strain, & constitutive relations	Mow Ch. 5/notes Handouts/notes		HW #3
12	Tu, Apr 11	Paper discussion (soft tissue mechanics)			
	Tu, Apr 11 Th, Apr 13	Biofluids: Stress, strain, & constitutive relations Fundamental balance relations, exact sol'ns	Handouts/notes Handouts/notes	HW #4	
13	Tu, Apr 18	Paper discussion (biofluids techniques)			
	Tu, Apr 18 Th, Apr 20	Blood flow in vessels, pulsatile flow	Handouts/notes		HW #4
14	Tu, Apr 25	Laboratory demonstration (blood flow)			
	Tu, Apr 25 Th, Apr 27	Introduction to mechanobiology Mechanobiology in the musculoskeletal system	Handouts/notes	Paper #2	
15	Tu, May 2	Paper discussion (biological/biochemical assays)			
	Tu, May 2 Th, May 4	Mechanobiology in the circulatory system Cell mechanics	Handouts/notes		
16	Tu, May 9	Paper discussion (cell mechanics)			
	Tu, May 9 Th, May 11	Muscle physiology and mechanics Presentations	Handouts/notes Handouts/notes		Paper #2
Final	Wednesday May 17	**Final exam (10:30am-12:30pm)**			