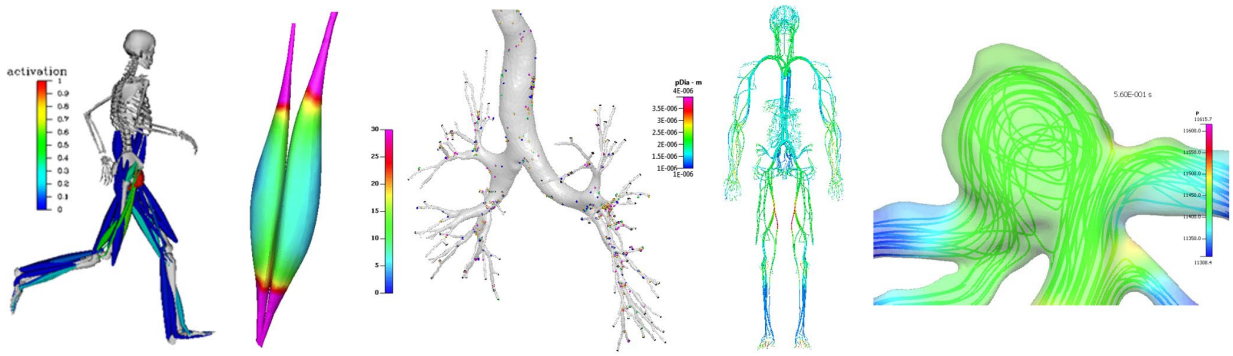
Course Syllabus

BME 676: Computational Biomechanics

Spring 2021



Course Information:

Instructor: Dr. Xianlian Alex Zhou
Office: 622 Fenster Hall
Email: alexzhou@njit.edu
Phone: 973-596-6940
Office Hours: Wednesday, 4:30-5:15PM or by appointment.

Lectures: 6:00PM-8:50PM, Wednesday, Synchronous Online, January 20 - May 5.

References:
1. An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, J.D. Humphrey and SL O'Rourke. Springer, NY, 2015 (2nd Ed.).
2. Biomechanics, Mechanical Properties of Living Tissues, 2nd Ed., Y.C. Fung
3. Introductory Biomechanics, from Cells to Organisms, C.R. Ethier and C.A. Simmons
4. Cardiovascular Solid Mechanics, Cells, Tissues, and Organs, J.D. Humphrey
5. Introduction to the Mechanics of a Continuous Medium, Malvern, Prentice-Hall
6. The Finite Element Method, I, II, III, 6th Ed., Zienkiewicz, etc., Elsevier
7. Computational Methods for Fluid Dynamics, Ferziger and Peric, 3rd Ed. Springer

Course Description:

This course provides an understanding of biomechanics in various physiological systems, including the musculoskeletal system (muscle, bone, ligament, tendon, cartilage), the cardiovascular system (arteries, aneurysms, blood circulation), and the respiratory system (lung, breathing, inhalation drug delivery), and computational methods used in simulating biomechanical phenomena such as the Finite Element Method (FEM), Computational Fluid Dynamics (CFD), and Multibody Dynamics (MBD). Course topics include equations of motion and equilibrium for solids and fluids, biomechanical constitutive models of tissue hyperelasticity, viscoelasticity, and damage, biofluids, various computational methods and their applications in biomechanical simulations. Advanced topics such as bio-fluid-structure interaction and machine learning in biomechanics will also be introduced.

Sample student projects from Spring 2020 can be found at
https://www.youtube.com/watch?v=9zz5CT2e_Zo

Prerequisites:
Students should be at least familiar with stress, strain, and material models from either BME 302 (Mechanical Fundamentals of Biomedical Engineering), BME 321 (Advanced Mechanics for Biomedical Engineers) or equivalent. This course is recommended for students in the biomechanics or biomaterials concentration and is suitable for BS, MS, and PhD students. It will be helpful (but not required) if the students have taken any of these classes below:
-- BME 670: Introduction to Biomechanical Engineering.
-- BME 478: Introduction to CAD for Biomechanics
-- BME 677: CAD for Biomechanics and Biomaterials
-- ME 614: Continuum Mechanics
-- ME 622: Finite Element Methods in Mechanical Engineering

Grade Weights:

Attendance & Participation	15%
Homework/Project	30%
Midterm Exam	20%
Final Project	35%

Final letter grades are assigned from numeric grades as follows:

	B+ = [87,89]	C+ = [77,79]		
A = [90,100]	B = [80,86]	C = [70,76]	D = [60,69]	F = [0,59]

Attendance Policy:
Attendance is mandatory, and participation is required. All absences must be pre-approved – Inform the instructor in advance. In case of extenuating circumstances, justification for any absences must be validated by the Office of the Dean of Students with documentation (e.g. doctor's note).

Exams:
There will be one midterm exam.

Makeup Policy:
Late homework approved by the Office of the Dean of the students will be accepted for any makeups. If any of the above items are missed, and no validated excuse is provided, a zero will be given for that item. If a validated excuse is provided, the student may be allowed to makeup the item if it has not yet been graded and returned.

No makeup examinations will be administered unless the reason for the absence is approved by the Office of the Dean of Students, along with any necessary documentation. If the absence is approved by the Office of the Dean of Students, the student will have the option, depending on availability, of either having a makeup quiz or exam, or having the weight of the missed exam transferred to the weight of the Final Exam. Failure to provide an approved reason for the absence will result in a zero on the exam.

Statement on Academic integrity:
Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. Copying other students' solutions, copying from a solution manual, or copying answers during an exam are all examples of cheating. As a member of the NJIT community, it is your responsibility

to protect your educational investment by knowing and following the academic code of integrity policy that is found at:
http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. ***Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.*** If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at *dos@njit.edu*

Special Needs and Accommodations:
Students needing special services or accommodations should contact the Disability Support Services at NJIT (http://www.njit.edu/studentsuccess/disability-support-services-0/)

- The appropriate office must document the need for accommodation.
- Please notify the instructor and present this documentation within the first two weeks of class.

Subject to Change Statement:
Policies are subject to change with advance notice, as deemed appropriate by the instructor.

Tentative Course Schedule:
The course calendar may be modified at the discretion of the instructor or in the event of extenuating circumstances. Students will be notified in class of any changes.

Week	Topics	HW/Project due
1	*Computational biomechanics overview, Kinematics and Continuum Mechanics*	
2	*Finite Element Method*	
3	*Biomechanics of musculoskeletal system 1:* bone, ligament, tendon, cartilage	
4	*Biomechanics of musculoskeletal system 2: muscle*	
5	*Biomechanics of musculoskeletal system 3: system level modeling*	*HW 1*
6	*Biomechanics of* cardiovascular system 1: arteries, vein, aneurysms	
7	*Biomechanics of* cardiovascular system 2: residual stress, adaptation	
8	*Midterm Exam*	*HW 2*
9	Spring Recess	
10	*Fluid mechanics and CFD*	

11	*Biomechanics of* cardiovascular system 3- blood circulation, CFD, FSI	
12	*Biomechanics of respiratory system (lung anatomy and physiology)*	
13	*Biomechanics of respiratory system (breathing and chemical reaction)*	*HW 3*
14	*Biomechanics of respiratory system (drug delivery)*	
15	*Advanced topics*	
16	*Final Project Report/Presentation*	*Final Project*