

ME/BIOE 4340/6340 Cardiovascular Biomechanics

Instructor: Prof. Ethan Kung, Mechanical Engineering & Bioengineering

Office Hour: Thursdays 10am-11am (231 Fluor Daniel)

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GA Office Hour: Mondays 10am-11am (224 Fluor Daniel)

Lectures: Tues/Thur 8:00am-9:15am (Riggs 305)

Midterm: Thursday Feb 28th in class

Final Exam: Friday, May 3rd 7:00pm-9:30pm in classroom

*(You **MUST** be able to make the midterm and final exam times in order to enroll in this class. There will be no alternate options except to accommodate emergencies.)*

Textbook (on Canvas): “Cardiovascular Biomechanical Models”, Ethan Kung, 2017

Supplemental Texts:

- “Cardiovascular Physiology Concepts”, Richard Klabunde, 2012
- “Computational Bioengineering”, Guigen Zhang et al., 2015

Course Objectives: After completing the course, students will be able to--

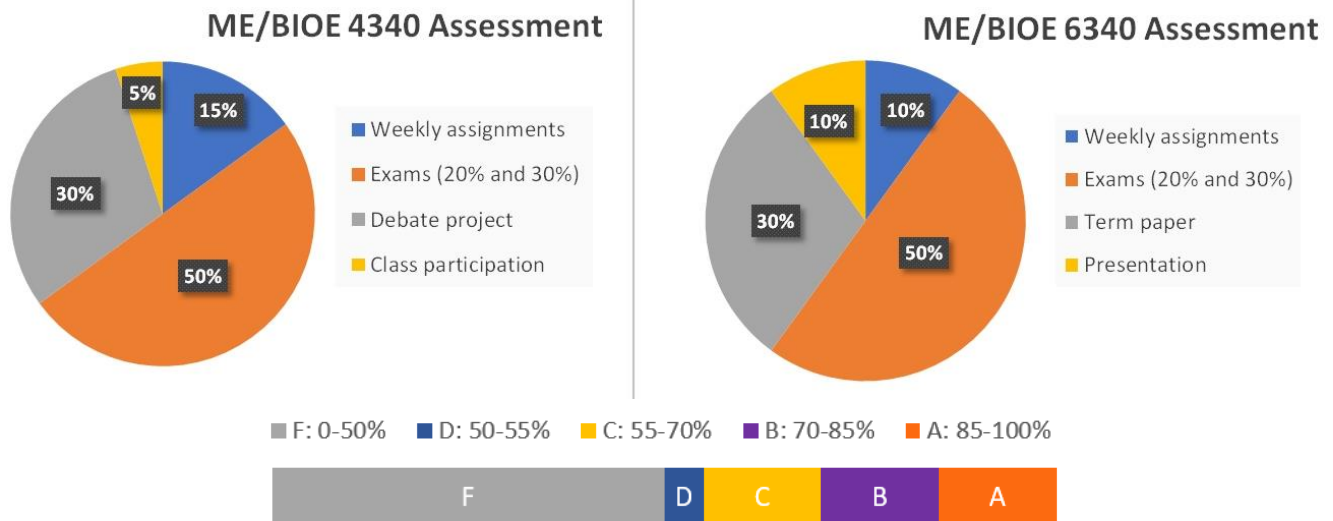
- 1) demonstrate an overall understanding of biological and physiological interactions in the cardiovascular system, and predict system behaviours in response to hypothetical scenarios
- 2) identify relevant cardiovascular anatomy in medical imaging data (ie. magnetic resonance imaging, computed tomography, etc)
- 3) modify, design, and evaluate computational circuit models which mimic cardiovascular physiology
- 4) apply appropriate considerations of cardiovascular biology/physiology in medical device design
- 5) comprehend and synthesize primary literature in biomedical engineering and medicine

Topical Outline (45 Contact Hours Total)

- 1) Cardiovascular Anatomy Review (2)
- 2) Cardiac Physiology and Biomechanics Modeling (4)
- 3) Vascular Structure and Biomechanics (4)
- 4) Lumped-parameter Cardiovascular Models (6)
- 5) 1D Theory of Blood Flow (2)
- 6) Multi-scale Computational Modeling (3)
- 7) Blood Properties, Functions, and Behaviours (1)
- 8) Cardiac Electrophysiology (3)
- 9) Biomechanics in Cardiovascular Diseases (4)
- 10) Auto-Regulation and Exercise Conditions (3)
- 11) In-vitro Experimental Techniques (3)
- 12) Medical Imaging (3)
- 13) Presentations & Tests (7)



Grading



Clemson Thinks² Integration This class participates in the Clemson Thinks² program, the university's Quality Enhancement Plan which seeks to enhance the critical thinking skills of Clemson students through transformative learning experiences. As such, the format of the class projects are designed to actively engage you and to promote thoughtful reflection and processing of relevant class contents. Critical Thinking is highly in-demand by employers, crucial in being a successful student, and useful in all aspects of our personal and professional lives. You can find more information about the Thinks² program at <https://www.clemson.edu/academics/programs/thinks2/>

Weekly Assignments Prior to each class, students must review and write down a minimum of **10** things learned from the previous lecture (2 lectures per week = 20 entries per week). You will be expected to share the contents of your compilation when called upon during class, as well as upload them to Canvas when asked to. Remember that these self-made compilations will also help you study for tests. Additional homework may be assigned by the instructor on specific weeks.

Debate Project (ME/BIOE 4340) Students are to form teams of 2~3. Each team will challenge and pair up with another team, mutually deciding on a debate topic of choice as well as the position that each team will defend. The topic can be anything related to the cardiovascular system, for example, competing theories of how the cardiovascular system works, efficacy of different treatment options (i.e. procedure, medical device) for a cardiovascular disease, health care policy, or anything else that peaks your interest-- the sky is the limit! Each team will create a 5-minute video that is due around mid-semester arguing for their debate position. Then at the end of the semester, the pair of teams will critic/deconstruct each others' videos during a live debate in front of the class. You will be graded on the richness of your arguments, concrete references to reliable sources of information, persuasiveness, critical thinking, creativity, effective logical organization, and delivery. See the project instructions document for details.

Term Research Paper & Presentation (ME/BIOE 6340) Each student will write a review paper on the current cutting-edge progress regarding a topic of your choice relating to the cardiovascular system. This project will involve graduate-level research, meaning that in order to be successful you must conduct an in-depth literature survey and develop good understanding of the current state-of-the-art. Each student will also deliver a PechaKucha presentation during the last week of classes to present their research. Refer to project and presentation instructions for details.

Attendance and Examinations You are expected to attend lectures and participate in discussions. Two or more absences without permission could result in your name being dropped from the rolls without further notice. Job interviews and personal engagements, except emergencies, are to be scheduled around class times. In the case if the instructor is late to a class, you are free to leave after 25 minutes of waiting from class start time.

Only in the event of an official excused absence a make-up exam can be allowed. Advance permission to miss a scheduled exam is necessary except for absolute emergency situations (such as hospitalization). A make-up exam may be oral or written in format at instructor's discretion. A missed exam will be scored as zero unless a make-up is approved and executed.

Clemson Academic Integrity Statement All undergraduate and graduate students, faculty and administrators at Clemson University are expected to abide by ethical standards of conduct. The Academic Integrity Policy is stated in the Undergraduate Announcements and the College Honor Code is available on the College website. In particular, plagiarism is a serious academic offense. Copying or submitting any work done by others for your personal credit –for example, copying homework or test work, using excerpts from others work without citation, using a solutions manual for your work submitted for credit, placing your name on a group document on which you did not participate, or placing your name on a document or work that was developed by another person(s), or using unauthorized reference materials on tests - is plagiarism. Violators typically receive an 'F' in the course and could face University expulsion.

Accessibility Clemson University values the diversity of our student body as a strength and a critical component of our dynamic community. Students with disabilities or temporary injuries/conditions may require accommodations due to barriers in the structure of facilities, course design, technology used for curricular purposes, or other campus resources. Students who experience a barrier to full access to this class should let the professor know, and make an appointment to meet with a staff member in Student Accessibility Services as soon as possible. You can make an appointment by calling 864-656-6848, by emailing studentaccess@lists.clemson.edu, or by visiting Suite 239 in the Academic Success Center building. Appointments are strongly encouraged – drop-ins will be seen if at all possible, but there could be a significant wait due to scheduled appointments. Students who receive Academic Access Letters are strongly encouraged to request, obtain and present these to their professors as early in the semester as possible so that accommodations can be made in a timely manner. It is the student's responsibility to follow this process each semester. You can access further information here: <http://www.clemson.edu/campus-life/campus-services/sds/>.

Title IX: Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veteran's status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972. This policy is located at <http://www.clemson.edu/campus-life/campus-services/access/title-ix/>. Mr. Jerry Knighton is the Clemson University Title IX Coordinator and Director of Access and Equity, located at 111 Holtzendorff Hall, 864-656-3181 (voice) or 864-565-0899 (TDD).

About Your Instructor: Prof. Ethan Kung



I run the Cardiovascular Modeling and Experimentation Research Laboratory (<http://www.cmerl.com/>) which conducts investigations in cardiovascular biomechanics. My research group focuses on translational research which integrates experimental and computational tools to help advance cardiovascular medical devices, diagnostics, and clinical procedures.

My teaching philosophy is to first approach subjects from an intuitive perspective with emphasis on context, and then fit in the details piece by piece to gradually clarify parts of the overall framework. I believe that the best way for you to learn is to have an immediate place in the brain where the course material can "click" into. I will do my best to encourage this to happen and I hope you would approach your learning with this mentality as well.

I have an educational background in Electrical Engineering from Queen's University, Canada (BSc), and Bioengineering from Stanford University (MS and PhD). I performed postdoctoral research in the Mechanical and Aerospace Engineering at the University of California San Diego. I joined the Mechanical Engineering faculty at Clemson in the Fall of 2014 and am currently jointly appointed in the Bioengineering department.

My other roles at Clemson include being part of the Clemson Faculty Commons as well as helping to advise the Clemson student group "Ratio Christi" (<http://ratiochristi.org/clemson>), which is an apologetics group that investigates the truth behind Christianity using logic and reasoning.