

# ME/BIOE 4340/6340 Cardiovascular Biomechanics

**Instructor:** Prof. Ethan Kung <[ekung@clemson.edu](mailto:ekung@clemson.edu)>

**Graduate Assistant:** Colin Pender <[cgpender@clemson.edu](mailto:cgpender@clemson.edu)>, Raj Dave <[rdave@g.clemson.edu](mailto:rdave@g.clemson.edu)>

**Office Hours:** Wed/Thur 1-2pm

**GA Office Hour:** Mon/Tues 11:15am-12pm

**Synchronous Component:** MWF 11:15am-12:05pm

**Midterm:** Wed, Oct 14<sup>th</sup> 2020, 7:00-8:15pm

**Final Exam:** Tues, Dec 8<sup>th</sup> 2020, 8:00-10:30am

**Equipment:** Webcam and reliable internet connection (required)

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

**Supplemental Texts:**

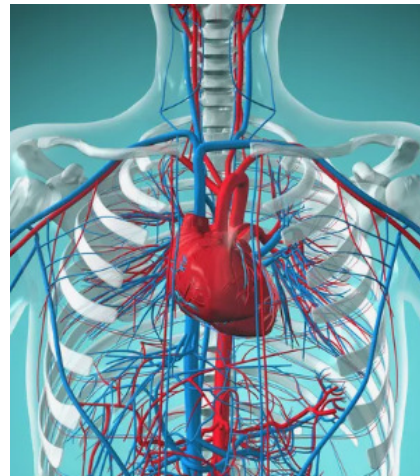
- “Cardiovascular Physiology Concepts”, Richard Klabunde, 2012
- “Computational Bioengineering”, Guigen Zhang et al., 2015

**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

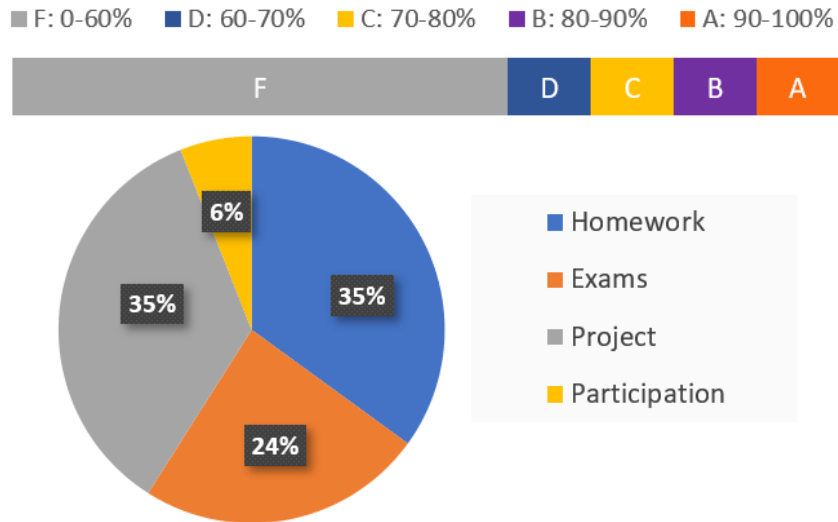
**Topical Outline** (45 Contact Hours Equivalence)

- 1) Cardiovascular Anatomy Review (2)
- 2) Cardiac Physiology and Modeling (6)
- 3) Vascular Structure and Biomechanics (5)
- 4) Lumped-parameter Cardiovascular Models (6)
- 5) Multi-scale Computational Modeling (3)
- 6) Blood Properties, Functions, and Behaviours (3)
- 7) Cardiac Electrophysiology (4)
- 8) Biomechanics in Cardiovascular Diseases (4)
- 9) Auto-Regulation (3)
- 10) Benchtop Experimental Techniques (3)
- 11) Presentations & Tests (6)



**Clemson Thinks<sup>2</sup> Integration** This class participates in the Clemson Thinks<sup>2</sup> 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 Thinks<sup>2</sup> program at <https://www.clemson.edu/academics/programs/thinks2/>

**Grading**



**Homework** Each week students are to review and write down a minimum of **20** things learned from lectures during the week. You will submit the contents of your compilation to Canvas twice, once before the midterm and once before the final exam; these self-made compilations will serve as your only notes during the open-notes exams. Other additional homework will be assigned by the instructor on specific weeks.

**Participation** The “Discussion” section on Canvas is a place for students to interact with each other and with the instructor for questions and answers. As you review the course materials each week, please post questions as well as provide your thoughts on other people’s questions. Do your best to offer the most sensible/logical thoughts to other students’ questions and do not worry whether your contributions are 100% accurate—this is a learning process and the instructor is there to correct misunderstandings that might surface. Each student is expected to contribute a minimum of three meaningful posts every week. You will earn participation points on the quality of your Canvas discussions as well as from completing other non-graded class activities.

**Debate Project (ME/BIOE 4340)** Each debate 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 Project: 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.

### Delivery Style

This course will be delivered in a hybrid format. Lectures are delivered via asynchronous

videos. Specific class activities will require in-person attendance during the scheduled class time, and other activities will require virtual attendance during the schedule class time. These synchronous components of the course will be announced over the semester.

### **Examinations**

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.

**Specific COVID-19 related information for in-person classes** While on campus, face coverings are required in all buildings and classrooms. Face coverings are also required in outdoor spaces where physical distance cannot be guaranteed. Please be familiar with the additional information on the [Healthy Clemson](#) website, such as the use of wipes for in person classes. If an instructor does not have a face covering or refuses to wear an approved face covering without valid accommodation, students should notify the department chair. If a student does not have a face covering or refuses to wear an approved face covering without valid accommodation, the instructor will ask the student to leave the academic space and may report the student's actions to the [Office of Community & Ethical Standards](#) as a violation of the Student Code of Conduct. If the student's actions disrupt the class to the extent that an immediate response is needed, the instructor may call the Clemson University Police Department at 656-2222.

**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](mailto: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. I am also involved with the "Secular Student Alliance of Clemson" (<https://bit.ly/2TIq1FH>) which is a campus group for atheists, agnostics, etc. I enjoy conversing with a wide range of people with different views and perspectives.