BME 3100: Physiological Modeling

Credits and Contact Hours: 3 Credits (One 150-minutes lecture per week)

Lectures: Thursdays: 5:00pm – 7:30pm ROWE – room 213

Instructor: Sabato Santaniello, Ph.D.

Office Hours:
Mondays: 10:30am – 12:30pm (walk-in) BRONWELL – room 308
Otherwise, by appointment as needed.

Textbook:
Mathematical Physiology, James Keener & James Sneyd (2009). Second edition, vol. 1-2. ISBN: 978-0-387-09419-9

Other Recommended Textbooks:
Introduction to Biomedical Engineering, John D. Enderle & Joseph D. Bronzino (2012). ISBN: 978-012-374-979-6
Dynamical Systems in Neuroscience. Eugene M. Izhikevich (2011). ISBN: 978-026-251-420-0

***Other Supplemental Materials*:**
Course handouts and scientific articles relevant to course topics covered.

Course Website:
Copies of the course syllabus, assignments, and supplemental materials will be posted online at the HuskyCT class site. Students are responsible for announcements and assignments posted on the HuskyCT class site. Please check it regularly.

***Specific Course Information*:**
a. Description:
The course aims to show how physiological problems can be formulated mathematically, and how such models can be used for analysis, prediction, and therapy design. A wide selection of mathematical models in physiology will be presented from the cellular level up to the systems level, including respiration/perfusion, muscle contraction, inner ear, and retina. Differential equations, Laplace transform, and computer-aided tools will be introduced and used during the course for modeling, simulation, and analysis purposes.

b. Prerequisite: MATH 1132Q; BIOL 1107

c. Required, Elective, or Selected Elective*:* Elective.

***Grading*:**
- Homework: 33%
- Midterm: 27%

- Project: 40%

Topics Covered:

- Biochemical Reactions
- Cellular Homeostasis
- Membrane Ion Channels
- Electrical Flow in Neurons
- Heart and Blood Circulation
- Respiration
- Muscle Contraction
- Retina and Vision
- Laplace Transform
- Differential Equations
- Elements of Statistical Modeling
- Numerical simulations in MATLAB

Course Objectives and Outcomes:

The objective of this course is to learn the basic concepts and tools for modeling physiological systems using engineering analogies. In particular, it will be learned how physiological problems can be formulated and studied mathematically, and how such models can pose challenging mathematical questions, whose solution will help gaining insights into the modeled physiological processes.

Policies:

a. Policy regarding Grading, Assignments, Class Participation, and Attendance:

Thirty percent (30%) of the final grade will be based upon the scheduled homework. **Late homework will not be accepted** unless extreme conditions occur (e.g., medical emergency with physician's signature). Thirty percent (30%) of the final grade will be based upon the scheduled **midterm exam**. The content for exam will focus on class lectures and homework. Inputs used in any calculation must be provided on the exam copy to receive credit. Partial credit will be given for correct procedures even if an error is made early in the problem, and each step of the procedure will be graded. Hence, providing only the correct answer will be worth very little credit. **Students who start late an exam will not be allowed any extra time**. Also, **makeup exams will be administered only in extreme cases** (e.g., medical emergency with physician's signature). Students may interact with their fellow students when preparing homework solutions but, at the end, every student must write up his/her solutions on his/her own. Duplicating a solution that someone else has written or providing solutions to be copied is not acceptable. Forty percent (40%) of the final grade will be based upon presentation (written and oral) of an assigned modeling project. Projects will involve a modeling component and a simulation component, with simulations to be conducted in MATLAB. Projects will be evaluated based on these criteria:

1) Clarity in formulation and statement of the project goals;
2) Outcomes of the design process and relevance to the expect goals;
3) Clarity in formulation, statement, and motivation of quantitative assumptions;
4) Appropriate use of presented modeling, analysis, and computational tools;

5) Satisfaction of assigned design constraints (**Honor students only**);
6) Quality of the theoretical analysis of the model that has been developed during the project (**Honor students only**).

Participation in class includes answering questions (orally or written), participating in class discussions and demonstrations, and providing feedback. Students are responsible for reading assigned material **before** it is covered in class. Even if the content is not clear, the exposure will familiarize the students with the terminology and allow to focus on understanding the concepts discussed during class. Students are responsible for all announcements and other information covered in class. Students who are late or unable to attend class will have the responsibility to obtain missed information from other students.

b. Policy Against Discrimination, Harassment, and Related Interpersonal Violence:

The University is committed to maintaining an environment free of discrimination or discriminatory harassment directed toward any person or group within its community – students, employees, or visitors. Academic and professional excellence can flourish only when each member of our community is assured an atmosphere of mutual respect. All members of the University community are responsible for the maintenance of an academic and work environment in which people are free to learn and work without fear of discrimination or discriminatory harassment. In addition, inappropriate amorous relationships can undermine the University's mission when those in positions of authority abuse or appear to abuse their authority. To that end, and in accordance with federal and state law, the University prohibits discrimination and discriminatory harassment, as well as inappropriate amorous relationships, and such behavior will be met with appropriate disciplinary action, up to and including dismissal from the University. Additionally, to protect the campus community, all non-confidential University employees (including faculty) are required to report sexual assaults, intimate partner violence, and/or stalking involving a student that they witness or are told about to the Office of Institutional Equity. The University takes all reports with the utmost seriousness. Please be aware that while the information you provide will remain private, it will not be confidential and will be shared with University officials who can help. More information is available at equity.uconn.edu and titleix.uconn.edu.

c. Sexual Assault Reporting Policy:

To protect the campus community, all non-confidential University employees (including faculty) are required to report assaults they witness or are told about to the Office of Diversity & Equity under the Sexual Assault Response Policy. The University takes all reports with the utmost seriousness. Please be aware that while the information you provide will remain private, it will not be confidential and will be shared with University officials who can help. More information is available at http://sexualviolence.uconn.edu/

d. For a complete list of University Policies: http://provost.uconn.edu/syllabi-references/

Academic Honesty and Student Code:

Academic dishonesty of any type will not be tolerated in this class. Students should refer to the Student Code, section on Academic Integrity at http://www.dos.uconn.edu/student_code.html, for specific guidelines.

Students with Disabilities:

Students who need course adaptations or accommodations because of a disability are invited to notify the instructor as soon as possible. Students with disabilities who believe that they may need accommodations in this class are encouraged to contact the Disability Services Office (http://www.csd.uconn.edu) as soon as possible in order to ensure that such accommodations are implemented in a timely fashion.

Non-Discrimination Policy Statement:

The University of Connecticut does not discriminate on the basis of race, color, religion, national origin, ancestry, disability, genetic information, sex, sexual orientation, gender identity or expression, age, veteran status, marital status or other legally protected characteristics in all programs and activities and supports all state and federal laws that promote equal opportunity and prohibit discrimination, including the provision of reasonable accommodations for persons with disabilities. The University engages in an interactive process with each person making a request for accommodations and reviews the requests on an individualized, case-by-case basis. To request an accommodation or for questions related to the University's non-discrimination policies, please contact: Elizabeth Conklin, J.D. ADA Coordinator, Title IX Coordinator, Associate Vice President, Office of Diversity and Equity, 241 Glenbrook Road, Unit 4175, Storrs, CT 06269 Phone: (860) 486-2943 Email: ode@uconn.edu / Website: www.ode.uconn.edu

Schedule:

A tentative schedule is reported below. Students must check their email for any change.

Week	Date	Subject	Assignment Due On
1	09/01	Numerical Methods to Solve ODEs	
2	09/08	Computational Laboratory	HW1: 09/15
3	09/15	Enzyme Reactions	HW2: 09/22
4	09/22	Modified Enzyme Reactions / Hemoglobin	HW3: 09/29
5	09/29	Passive Transport in Cells	HW4: 10/06
6	10/06	Nernst Potential and Ion Channels	HW5: 10/20
7	10/13	**Mid-term Exam**	
8	10/20	Neural Excitability and Synapses	HW6: 10/27
9	10/27	Microcirculation and Filtration	HW7: 11/03
10	11/03	Systemic Circulatory System	HW8: 11/10
11	11/10	Alveolar Gas Exchange	HW9: 11/17
12	11/17	Fluid Absorption in the Gastrointestinal Tract	HW10: 12/01
13	11/24	Thanksgiving Break	
14	12/01	Force-Velocity Model of Muscles	HW11: 12/08
15	12/08	Photoreceptors and Receptive Fields	
Finals	**12/12-17**	**Project Discussion**	

Legend:

HW = Homework assignment; Project = Project assignment