BIOEN 5005/6005, Computational Neuroscience
spring semesters of odd years
MW, 10:45–12:15
SMBB 4100

Instructor: Chuck Dorval
Email: chuck.dorval@utah.edu
Office: SMBB 4535

Contact Preferences
Questions regarding course material should be asked as a discussion in Canvas.
Questions about personal matters should be emailed to the instructor.

Course Materials
Primary
Thomas P. Trappenberg, Fundamentals of Computational Neuroscience, 2nd Ed,
Instructor will add depth where necessary.

Supplementary:
Christof Koch, Biophysics of Computation : Information Processing in Single Neurons,
ISBN:978-0195181999. Thorough on single cell material; tends to bloviate.
Peter Dayan & L. F. Abbott, Theoretical Neuroscience: Computational and
Foundational text for quantitative systems neuroscience.
Thomas Fischer Weiss, Cellular Biophysics: Transport & Electrical Properties, Vol. 2,
fundamental neuronal biophysics, but predates computational approaches.
Vol. 1 is great introduction to cellular biophysics.

Course Description
This course explores advances in neuroscience enabled by progress in computational
power. The course reviews the quantitative underpinnings of classical neurophysiological
understanding, but the focus is on using modern computational techniques to broaden that
understanding. Topics include: simulating biophysical models of neuronal membranes;
constructing computational neuronal models and deconstructing them with techniques
from nonlinear dynamics; models of neural plasticity and adaptive behavior; and neural
encoding and decoding. Students are expected to perform a substantial amount of
programming in problem sets and a course project. Assignments will be most readily
completed through extensive use of MATLAB, though alternatives are acceptable.

Grading Policy

<table>
<thead>
<tr>
<th></th>
<th>BIOEN 6005</th>
<th>BIOEN 5005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exam</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>Project</td>
<td>25%</td>
<td>50%</td>
</tr>
<tr>
<td>Exams</td>
<td>25%</td>
<td></td>
</tr>
</tbody>
</table>

Curving may occur, or not

<table>
<thead>
<tr>
<th>Grade</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>≥ 280/3 %</td>
</tr>
<tr>
<td>A-</td>
<td>≥ 270/3 %</td>
</tr>
<tr>
<td>B*</td>
<td>≥ 260/3 %</td>
</tr>
<tr>
<td>etc.</td>
<td></td>
</tr>
</tbody>
</table>
Course Utility
1. This course is appropriate for advanced students considering a career in computational neuroscience, neural engineering or quantitative neurology.
2. This course is strongly recommended for graduate students aiming to pass the Neural Interfaces comprehensive written exam in the Department of Biomedical Engineering.

Teaching and Learning Methods
I teach. You learn. Homework includes daily readings and a problem set every 2-3 weeks. There will be one midterm and a final exam. Students in 6005 (but not 5005) will also be expected to complete an end-of-the-semester project sufficiently sophisticated to submit as an abstract and present at a national conference.

University Policies
1. *Americans with Disabilities Act.* The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you will need accommodations in this class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, (801) 581-5020. CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in an alternative format with prior notification to the Center for Disability Services.
2. *Addressing Sexual Misconduct.* Title IX makes it clear that violence and harassment based on sex and gender — including sexual orientation and gender expression — is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran’s status or genetic information. If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to the police, contact the Department of Public Safety, 801-585-2677 (COPS).
3. *Students’ Preferred Addressing.* Class rosters are provided to the instructor with the student’s legal name as well as their preferred first name, if it was previously entered into the student profile section of their CIS account. We aim to honor you by referring to you with the name and pronoun that feels best for you in class. Please advise us of any name or pronoun changes so that we can help create a learning environment in which you, your name, and your pronoun will be respected. If you need assistance getting your preferred name on your UIDcard, please visit the LGBT Resource Center Room 409 in the Olpin Union Building, or email bpeacock@sa.utah.edu to schedule a meeting. The LGBT Resource Center hours are M-F 8am-5pm, and 8am-6pm on Tuesdays.
4. *Academic Code of Conduct.* Academic misconduct — including but not limited to cheating, misrepresenting one’s work, inappropriately collaborating, plagiarizing, and fabricating or falsifying information — shall not be tolerated. You may read the Student Code, Policy 6-400 for details. We do employ a plagiarism detection service, the details of which you will not be informed. If you are unclear whether any particular action violates this policy within the context of BioSystems, ask an instructor for clarification. Perceived misconduct will be reported to the Department of Biomedical Engineering for investigation and record keeping. Any verified misconduct will result in a negative grade (i.e., less than zero) on the assignment in question, for all students involved.
5. **Grading Appeals.** Scores on all course deliverables must be made in writing, on paper, within a week of receiving the grade. Emails will be ignored. If you approach an instructor to argue a grade, you will have waived your right to appeal to the course instructors. If you believe that an academic action made by the instructor or a teaching assistant is arbitrary or capricious, you should discuss the action with Dr. Dorval and attempt to resolve the issue. If we are unable to reach a resolution, you may appeal the action in accordance with the following: deliver a written appeal to the chair of the Department of Biomedical Engineering within 40 business days. The chair must notify you of a decision within 15 days; if you disagree with his decision, you may appeal to the Academic Appeals Committee (see [http://www.coe.utah.edu/current-undergrad/appeal.php](http://www.coe.utah.edu/current-undergrad/appeal.php) for members of committee). See II Section D, Code of Student Rights and Responsibilities for details.

**Course Policies**

*Problem sets* are due at the beginning of class. Assignments turned in even 1 second after the beginning of class will yield greatly reduced or zero credit. Students are encouraged to discuss homework problems with their classmates. However, either directly copying a classmate’s work or allowing a classmate to copy one’s own work is not allowed. Instructors will not provide help on homework assignments due within 24 hours.

*Exams* will not be rescheduled unless they conflict with other courses. Exams missed due to illness will be considered unexcused unless the instructor is notified of the situation ahead of time and receives a signed excuse from a physician on his or her letterhead. The midterm will include a take home portion; the final exam will be comprehensive.

*Electronic devices* are allowed in class. Students are encouraged to take notes on tablets or laptops, and may record lectures with phones or other personal devices. However, no electronic devices are allowed during exams, excepting during any take-home portions.

**Course Schedule**

**Week Topic**

**Unit 1: Biophysics of Cellular Neuroscience**

1. Simple Models: Integrate & Fire, Current Inputs
2. Diffusion, Membrane Biophysics, Conductance Inputs
3. Hodgkin & Huxley Models; Strength-Duration Curves
4. Cable Equation & Spike Propagation

**Unit 2: Modeling Systems Neuroscience**

6. Markov Models, Firing Rate Approximation
7. Synaptic Plasticity & Adaptation
8. Ion Channel Varieties & Dynamical Systems
9. Brain Organization & Information

**Unit 3: Neuroscience-Inspired Computation**

11. Neural Networks; Perceptrons
12. Self Organizing Maps & Dynamic Neural Fields
13. Neural Network Attractors & Memory
14. Neural Models of Learning & Prediction

*Note: This syllabus is meant to serve as an outline and guide for our course. Please note that the instructor may modify it with reasonable notice to you. A more detailed syllabus will be made available at the start of the course, and any changes to that syllabus will be announced.*