Methods of Applied Mathematics II (Math451H): Neuronal Dynamics

Syllabus

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Office hours: TBD or By Appointment

Course website:

http://web.njit.edu/~horacio/Syllabus_Math451H-S14.html

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NJIT Honor Code: All students should be aware that the Department of Mathematical Sciences takes the NJIT Honor Code very seriously and enforces it strictly. This means there must not be any forms of plagiarism; i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the Honor Code students are obligated to report any such activities to the instructor.

http://www.njit.edu/academics/honorcode.php

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Course Description

Theoretical, computational, and experimental research: Neuronal dynamics

This project will focus on the dynamic of single neurons and small networks of neurons. Electric activity in neuronal systems results from the cooperative activity of the participating electric currents, both intrinsic and synaptic. An important task of the modeling effort is to reproduce experimental results as a mean to understanding the link between the dynamic information contained in experimental data and the underlying biophysics. Mathematical models play a key role in this process. This goal of this project is to learn and use the necessary tools to address these issues.

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Course Description

Theoretical, computational, and experimental research: Neuronal dynamics

- Theoretical component
- Computational component
- , Experimental component

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Course Description

Theoretical component

- Biophysical (conductance-based) models of neurons and neuronal networks: Hodgkin-Huxley formalism for single neurons and synaptic connections
- Dynamical systems tools for the understanding of the mechanisms underlying spike generation
- Data analysis tools for the understanding of experimental data
- Firing rate models

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Course Description

Computational component

• Development of numerical algorithms to simulate biophysical (conductance-based) models of Hodgkin-Huxley type for single neurons and networks of interconnected neurons

• Development of numerical algorithms to simulate firing rate type models

•Development of numerical algorithms for the analysis of data including spike trains and firing rates, spike train statistics, spectral analysis, smoothing, spike-triggered average.

•Development of numerical algorithms to fit model parameters to data.

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Course Description

Experimental component

• Carrying out electrophysiological experiments involving spiking and bursting neurons and small neuronal networks

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Reports Policy:

A number of reports will be submitted during the semesters

Reports will not be accepted after the due date

Only hard copies of the reports will be accepted (NO electronic submissions).

The source code used in your calculations MUST accompany the submitted reports.

Students must be able to orally explain their results and codes upon request.

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Textbook and recommended books:

Mathematics for Neuroscientists, by F. Gabbiani, S. J. Cox, 2010, Elsevier (ISBN: 978-0-12-374882-9)

Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems, by Peter Dayan and Larry F. Abbott. The MIT Press, 2001 (ISBN 0-262-04199-5)

Mathematical Modeling in Systems Biology, B. P. Ingalls, 2013, MIT Press (ISBN: 978-0-262-01888-3)

Mathematical Foundations of Neuroscience, by G. B. Ermentrout & D. H. Terman - Springer, 2010, 1st edition (ISBN 978-0-387-87707-5)

Selected research articles (to be provided by the instructor)

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Grading Policy:

Projects and presentations through the semester:	70 %
Final report and presentation (Math Bio seminar):	30 %

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Class Policy - Attendance and Participation:

Students must attend all classes.

Absence from class will inhibit your ability to fully participate in class discussions and problem solving sessions and, therefore, affect your grade.

If a student is absent for more than three classes without valid justification, he/she will be given an F for the course. If the student opts to withdraw from the class before the withdrawal deadline, the grade will be W.

In case of serious illness or unavoidable causes, students must present appropriate documentation to the office of the Dean of Students within two lectures of returning.

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Class Policy - Attendance and Participation:

Any student who feels there are extenuating circumstances should consult the Associate Chair.

Tardiness to class is very disruptive to the instructor and students and will not be tolerated.

All cellular phones and other electronic devices must be switched off during class and exams times

Chatting using electronic devices during class time will not be tolerated