NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 635: Analytical Computational Neuroscience
Fall 2018 Graduate Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that 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 University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

COURSE INFORMATION

Course Description: This course will provide an intermediate-level mathematical and computational modeling background for small neuronal systems. Models of biophysical mechanisms of single and small networks of neurons are discussed. Topics include voltage-dependent channel gating mechanisms, the Hodgkin-Huxley model for membrane excitability, repetitive and burst firing, single- and multi-compartmental modeling, synaptic transmission, mathematical treatment of 2-cell inhibitory or excitatory networks. In this course, the students will be required to build computer models of neurons and networks and analyze these models using geometric singular-perturbation analysis and dynamical systems techniques.

Number of Credits: 3

Prerequisites: MATH 211 or 213, MATH 337, and CS 113 or MATH 240, or departmental approval.

Course-Section and Instructors

Course-Section	Instructor
Math 635-001	Professor H. Rotstein

Office Hours for All Math Instructors: Fall 2018 Office Hours and Emails

Required Textbooks:

Title	*Mathematical Foundations of Neuroscience*
Author	G. B. Ermentrout & D. H. Terman
Edition	1st Ed.
Publisher	Springer
ISBN #	978-0387877075
Website	http://web.njit.edu/~horacio/Math635/IntroCompNeuroF18.html

University-wide Withdrawal Date:The last day to withdraw with a **W** is **Monday, November 12, 2018**. It will be strictly enforced.

RECOMMENDED BOOKS

- *Foundations of Cellular Neurophysiology* by D. Johnston & S. Wu – The MIT Press (1995) - ISBN: 0-2621000533.
- *Dynamical Systems in Neuroscience: The Geometry of Excitability and Bursting* by E. M. Izhikevich – The MIT Press (2007), 1st edition – ISBN: 0-262-09043-8.
- *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.
- *Biophysics of Computation - Information processing in single neurons* by Christof Koch. Oxford University Press, 1999. ISBN 0-19-510491-9.

POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

Homework, Quizzes, and Class Participation	40%
Midterm Exam/ Project	30%
Final Project/ Presentation	30%

Your final letter grade will be based on the following tentative curve.

A	90 - 100	**C**	70 – 74
B+	85 – 89	**D**	60 – 69
B	80 – 84	**F**	0 - 59
C+	75 – 79		

Attendance Policy: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy. This policy will be strictly enforced.

Course Policies: See course website.

Exams: There will be one midterm exam held in class during the semester.

Midterm Exam	TBA
Final Exam Period	December 15 - 21, 2018

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

Makeup Exam Policy: To properly report your absence from a midterm or final exam, please review and follow the required steps under the DMS Examination Policy found here:

- http://math.njit.edu/students/policies_exam.php

Cellular Phones: All cellular phones and other electronic devices must be switched off during all class times.

ADDITIONAL RESOURCES

Accommodation of Disabilities: Disability Support Services (DSS) offers long term and temporary

accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please contact Chantonette Lyles, Associate Director of Disability Support Services at 973-596-5417 or via email at lyles@njit.edu. The office is located in Fenster Hall, Room 260. A Letter of Accommodation Eligibility from the Disability Support Services office authorizing your accommodations will be required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Disability Support Services (DSS) website at:

- http://www5.njit.edu/studentsuccess/disability-support-services/

Important Dates (See: Fall 2018 Academic Calendar, Registrar)

Date	Day	Event
September 4, 2018	T	First Day of Classes
September 10, 2018	M	Last Day to Add/Drop Classes
November 12, 2018	M	Last Day to Withdraw
November 20, 2018	T	Thursday Classes Meet
November 21, 2018	W	Friday Classes Meet
November 22 - 25, 2018	R - Su	Thanksgiving Recess
December 12, 2018	W	Last Day of Classes
December 13 & 14, 2018	R & F	Reading Days
December 15 - 21, 2018	Sa - F	Final Exam Period

Course Outline

Week	Topic	Assignment
1	Introduction to Mathematical and Computational Neuroscience	See course website
	Passive membrane properties – The passive membrane equation	
2	Ordinary differential equations (ODEs): Review of analytical methods	"
	Ordinary differential equations (ODEs): Review of numerical methods and Matlab	
3	Dynamics of the passive membrane	"
	The passive membrane equation	
4	Integrate-and-fire models	"
	The Hodgkin-Huxley model	
5	Hodgkin-Huxley type models with additional ionic currents	"
	The cable equation	
6	Introduction to dynamical system methods for neural models	"
	Reduced one- and two-dimensional neural model	
7	One-dimensional neural models: Phase-space analysis	"
8	Two-dimensional neural models: Phase-space analysis I	"

9	Two-dimensional neural models: Phase-space analysis II	“
10	Sub-threshold oscillations: Two and Three dimensional models	“
	Bursting	
11	Synaptic dynamics	
	Overview on network dynamics	
12	Student Presentations	“
13	Student Presentations	“
14	Student Presentations	“