NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 430: Analytical and Computational Neuroscience
Fall 2018 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: A mathematical and computational introduction to the biophysical mechanisms that underlie physiological functions of single neurons and synapses. Topics include voltage-dependent channel gating mechanisms, the Hodgkin-Huxley model for membrane excitability, repetitive and burst firing, nerve impulse propagation in axons and dendrites, single- and multi-compartmental modeling, synaptic transmission, calcium handling dynamics and calcium dependent currents and processes.

Number of Credits: 3

Prerequisites: MATH 211 with a grade of C or better or MATH 213 with a grade of C or better, and MATH 222 with a grade of C or better, andCS 100 with a grade of C or better or CS 113 with a grade of C or better or CS 115 with a grade of C or better or MATH 340 with a grade of C or better.

Course-Section and Instructors

Course-Section	Instructor
Math 430-001	Professor H. Rotstein

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

Required Textbook:

Title	*Mathematical Foundations of Neuroscience*
Author	G. B. Ermentrout & D. H. Terman
Edition	1st
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: 0-262090438.
- *Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems* by Peter Dayan and Larry F. Abbott. The MIT Press, 2001. ISBN 0-262041995.
- *Biophysics of Computation - Information processing in single neurons* by Christof Koch. Oxford University Press, 1999. ISBN 0-195104919.

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 & Class Participation	40%
Midterm Exam / Project	30%
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.

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

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

Makeup Exam Policy: There will be **NO MAKE-UP QUIZZES OR EXAMS** during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Math Department Office/Instructor that the exam will be missed.

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

ADDITIONAL RESOURCES

Math Tutoring Center: Located in the Central King Building, Lower Level, Rm. G11 (See: Fall 2018 Hours)

Further Assistance: For further questions, students should contact their instructor. All instructors have regular

office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

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

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	“