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Fall 2024

MATH 635-101: Analytical Computational Neuro

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MATH 430/635: Analytical and Computational Neuroscience

Fall 2024 Course Syllabus

For further information, please visit the Course Website

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 or MATH 213, MATH 337, and CS 113 or MATH 240, CS 115 or MATH 340, or departmental approval.

Course-Section and Instructors:

Course-Section	Instructor
Math 430-101	Professor H. Rotstein
Math 635-101	Professor H. Rotstein

Office Hours for All Math Instructors: Fall 2024 Office Hours and Emails

Required Textbook:

Title	*An Introductory Course in Computational Neuroscience*
Author	P. Miller
Edition	1st Edition (2018)
Publisher	MIT Press

ISBN #	978-0262038256
Recommended Books:	"Mathematical Foundations of Neuroscience" by G. B. Ermentrout & D. H. Terman – Springer (2010), 1st edition - ISBN: 978-0-387-87707-5. "Foundations of Cellular Neurophysiology" by D. Johnston & S. Wu – The MIT Press (1995) - ISBN: 0-262-100053-3. "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 P. Dayan & L. Abbott – The MIT Press (2001) , 1st edition– ISBN: 0-262-04199-5. "Biophysics of Computation: Information Processing in Single Neurons" by C. Koch – Oxford University Press (1999) – ISBN: 0-19-510491-9
Website:	Course Website

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, November 11, 2024**. It will be strictly enforced.

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%
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		

Course Policies: See Course Website

Exams: There will be one midterm exam/project and one final project/presentation during the final exam period:

Midterm Exam	TBA
Final Exam Period	December 15 - December 21, 2024

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: 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

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.

Accommodation of Disabilities: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you need an accommodation due to a disability, please contact the Office of Accessibility Resources and Services at oars@njit.edu, or visit Kupfrian Hall 201 to discuss your specific needs. A Letter of Accommodation Eligibility from the office authorizing student accommodations is required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS) website at:

https://www.njit.edu/accessibility/

Important Dates (See: Fall 2024 Academic Calendar, Registrar)

Date	Day	Event
September 2, 2024	Monday	Labor Day
September 3, 2024	Tuesday	First Day of Classes
September 9, 2024	Monday	Last Day to Add/Drop Classes
November 11, 2024	Monday	Last Day to Withdraw
November 26, 2024	Tuesday	Thursday Classes Meet

November 27, 2024	Wednesday	Friday Classes Meet
November 28 to December 1, 2024	Thursday and Sunday	Thanksgiving Recess - Closed
December 11, 2024	Wednesday	Last Day of Classes
December 12, 2024	Thursday	Reading Day 1
December 13, 2024	Friday	Reading Day 2
December 15 to December 21, 2024	Sunday to Saturday	Final Exam Period

Course Outline

Week	Topic	Assignment
1	Introduction to Mathematical and Computational Neuroscience Passive membrane properties – The passive membrane equation	See Course Website
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	Reduced models and reduction of dimensions	"
7	Introduction to dynamical system methods for neural models	"
8	One-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 & short-term plasticity	
12	Overview of network dynamics: small networks	"
13	Overview of network dynamics: large networks	"
14	Student Presentations	"
15	Student Presentations	

Updated by Professor H. Rotstein - 8/2024
Department of Mathematical Sciences Course Syllabus, Fall 2024