Term Information

Effective Term	Spring 2014

General Information

Course Bulletin Listing/Subject Area	Mathematics
Fiscal Unit/Academic Org	Mathematics - D0671
College/Academic Group	Arts and Sciences
Level/Career	Undergraduate
Course Number/Catalog	4350
Course Title	Quantitative Neuroscience
Transcript Abbreviation	Quant Neurosci
Course Description	Introduction to mathematical modeling and computational analysis of neuronal systems, Hodgkin-Huxley model, dynamical systems methods, neuronal networks, models for neurological disease.
Semester Credit Hours/Units	Fixed: 3

Offering Information

Length Of Course	14 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	Prereq: 1152 (152), 1157 or permission of instructor.
Exclusions	

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code	27.0101
Subsidy Level	Baccalaureate Course
Intended Rank	Junior, Senior

Quarters to Semesters

Quarters to Semesters	New course
Give a rationale statement explaining the purpose of the new course	This course provides an introduction to how mathematical and computational tools have been used to develop and analyze models that arise in neuroscience. This course was successfully piloted as a group studies course in Spring 2013.
Sought concurrence from the following Fiscal Units or College	Neuroscience Major

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

Content Topic List

- Overview of neurons, synapses and neuronal firing patterns.
- Hodgkin-Huxley Model: Resting potential, Nernst equation, Goldman-Hodgkin-Katz equation, Cable equation and action potentials.
- Introduction to differential equations, phase-planes and oscillations.
- Stability analysis, bifurcation theory and numerical methods.
- Propagating action potentials and rhythmic behavior.
- Variety of channels, bursting oscillations, dendrites and multi-compartment models.
- Simple networks, classification of network behavior; synchrony, role of different types of channels and coupling.
- Sleep/wake cycle and Thalamocortical oscillations.
- Parkinson’s disease: Basal ganglia, origin of pathological firing patterns and deep brain stimulation.
- Olfaction, vision and stroke.

Attachments

- 4350_quant_neuro_syllabus.pdf: Syllabus

  (Syllabus. Owner: Husen,William J)
- 4350_Quatitative_neuroscience_concurrence.pdf: Concurrence

  (Concurrence. Owner: Husen,William J)

Comments

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Husen,William J	05/09/2013 09:41 AM	Submitted for Approval
Approved	Husen,William J	05/09/2013 09:42 AM	Unit Approval
Approved	Hadad,Christopher Martin	05/09/2013 02:11 PM	College Approval
Pending Approval	Nolen,Dawn Jenkins,Mary Ellen Bigler Vankeerbergen,Bernadette Chantal Hogle,Danielle Nicole Hanlin,Deborah Kay	05/09/2013 02:11 PM	ASCCAO Approval

Quantitative Neuroscience

Math 4350

Mathematical models and computational methods have been very useful in understanding biological mechanisms underlying neuronal behavior. The Hodgkin-Huxley model, for example, has formed the basis for our understanding of how action potentials are generated and how they propagate along a nerve axon. More recently, mathematical models have been used to help understand cellular processes responsible for both normal and pathological firing patterns that arise in a wide range of neuronal systems. Examples include models for sleep rhythms, sensory processing, Parkinsonian tremor and working memory.

This course provides a detailed introduction to how mathematical and computational methods have been used to both develop and analyze models that arise in neuroscience. We begin by deriving the Hodgkin-Huxley model and then describe dynamical system methods for analyzing models. After discussing the dynamics of single neurons, we consider neuronal networks and describe how different types of population firing patterns depend on biological details, such as the intrinsic properties of individual neurons and synaptic coupling. We conclude by considering specific systems, including models for sleep rhythms, olfaction, working memory and neurological disease.

Math 4350: Quantitative Neuroscience

Catalog description: Introduction to mathematical modeling and computational analysis of neuronal systems, Hodgkin-Huxley model, dynamical systems methods, neuronal networks and models for neurological disease.

This 3-credit course will meet MWF in 55 minute classes.

Purpose of course: This course provides an introduction to how mathematical and computational tools have been used to develop and analyze models that arise in neuroscience.

Textbook: *Foundations of Mathematical Neuroscience*, by G. Bard Ermentrout and David H. Terman. Publisher: Springer, 2010.

Prerequisite: Math 1152 (152), 1157 or permission of instructor.

Grading: Students in this course can earn up to 450 points: One Midterm Exam (100 points), a Semester Project (150 points) and a Final Exam (200 points). Standard percentage cut-off scores will be used to determine letter grades.

Exams: The Midterm and Final Exams will be written examinations, with each student working alone with a graphing calculator, but without any notes or references. The Midterm will be in class (for 55 minutes), and the Final will be at the time scheduled by the Registrar (for 105 minutes).

Semester Project: Students will work in teams, typically with four members, choosing the topic of their project in consultation with the instructor. Each team will write up the results of their project in a document that includes background of the biological problem, what issues are addressed using mathematical modeling, what mathematical and computational tools are used to analyze the model, and how results from the model say something relevant about the biological problem. Each team will give an in-class, oral presentation of their project.

Students will be told about the projects at the beginning of the semester, but the teams will be formed officially during the tenth week. Oral presentations will be given during the final week and written documents will be turned in on the last day of class.

Grades for the projects will be based on the oral presentation and the written document. Emphasis will be given to biological relevance, model development and analysis, and clarity of presentation. Approximately 2/3 of the grade will be based on the group effort and 1/3 on individual effort.

Schedule of topics for the 14 weeks of the semester:

1) Overview: Neurons, synapses and neuronal firing patterns.
2) Hodgkin-Huxley Model: Resting potential, Nernst equation, Goldman-Hodgkin-Katz equation, Cable equation and action potentials.
3) Dynamics I: Introduction to differential equations, phase-planes and oscillations.
4) Dynamics II: Stability analysis, bifurcation theory and numerical methods.
5) Single cell dynamics I: Propagating action potentials and rhythmic behavior.
6) Single cell dynamics II: Variety of channels, bursting oscillations, dendrites and multi-compartment models.
7) Synapses: Simple networks.
8) Networks: Classification of network behavior; synchrony, role of different types of channels and coupling.
9) Models for sleep: Sleep/wake cycle and Thalamocortical oscillations.
10) Parkinson's disease: Basal ganglia, origin of pathological firing patterns and deep brain stimulation.
11) Olfaction.
12) Vision.
13) Stroke.
14) Presentation of projects.

Disability Statement:

Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone (614) 292-3307 and VRS (614) 429- 1334; webpage http://www.ods.ohio-state.edu.

Academic Misconduct Statement:

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term academic misconduct includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee. For additional information, see the Code of Student Conduct: http://studentaffairs.osu.edu/resource csc.asp

Quantitative Neuroscience Course

Bruno, John
Sent: Monday, August 13, 2012 2:22 PM
To: Terman, David
Cc: Campbell, Carroll

Dear David,

We have read the syllabus of your proposed Quantitative Neuroscience course with great interest and enthusiasm. As you know, the new undergraduate Neuroscience BS Program has a track of specialization entitled, 'Cognitive and Computational Neuroscience'. I believe that your proposed course will be a mainstay for our majors specializing in that track, as well as other neuroscience students seeking a more thorough quantitative background in the discipline.

Thank you for developing this course – we certainly approve it and welcome its delivery.

Sincerely,

John P. Bruno
Director – Neuroscience Major

From the office of:
Professor John P. Bruno
Director - Neuroscience Major
Faculty Athletics Representative
Department of Psychology
57 Psychology Building
The Ohio State University
Columbus, OH 43210
voice: 614-292-1770
FAX: 614-688-4733

"Bruno, John" <bruno@psy.ohio-state.edu> May 9, 2013 9:24 AM
To: "Husen, William" <husen@math.ohio-state.edu>
Cc: "Campbell, Carroll" <campbell.601@osu.edu>
RE: Math Quantitative Neuroscience concurrence

Dear Bill,

Our enthusiasm for this course remains quite high. We welcome its regular offering as our Neuroscience Majors will have a strong interest in the course.

I give you permission to reuse my original letter of support

Best
John

From the desk of:
Professor John P. Bruno
Depts. of Psychology & Neuroscience
Director - Neuroscience Undergraduate Degree
Room 57 Psych Bldg
(v) 614-292-1770
(f) 614-688-4733
www.psy.ohio-state.edu/bruno

From: Husen, William
Sent: Thursday, May 09, 2013 8:42 AM
To: Bruno, John
Subject: Math Quantitative Neuroscience concurrence

Dear Dr. Bruno,

The Math Department has formally approved the Quantitative Neuroscience course (which was run as a group studies pilot in SP13) to become a regular course. I would like to request a concurrence from the neuroscience major for our submission in the curriculum process. I have attached to syllabus for this course along with your concurrence for the group studies. Perhaps you could simply give me your permission to reuse your letter as its content seems to be relevant to the regular course submission.

Many thanks,
Bill Husen

William J. Husen, Ph.D.
Director of Undergraduate Instruction
Department of Mathematics
The Ohio State University