MA665: Introduction to Modeling and Data Analysis in Neuroscience

(Fall 2012)

Instructor:	Mark Kramer (mak@bu.edu)
Course Hours:	September 4, 2012 - October 18, 2012 [7 weeks] 12:30-2:00 PM / TTh, MCS B23
Office Hours:	2:00-3:30 PM / TTh, Math & Stats Room 224, or by appointment
Textbook:	*MATLAB for Neuroscientists*, Academic Press; 1 edition + Handouts . . .
Course Website:	http://math.bu.edu/people/mak/MA665/
Prerequisites:	Graduate standing and calculus or consent of instructor.

This course is intended for neuroscience graduate students with limited mathematics backgrounds (calculus is the only prerequisite) and interest in learning mathematical concepts in neuroscience. We will use experimental observations in neuroscience to motivate the study of mathematics, both to quantify the observed data and build biophysical models. The course will provide a focused overview of mathematical neuroscience, with emphasis on quantifying neurophysiological time series and developing mathematical models of the activity observed. Neuroscience topics will span the spatial scales of brain activity from spike trains of individual neurons, to local field potentials of small neural populations, to the electroencephalogram recorded at the scalp surface. The mathematical models will include both descriptive and biophysical models utilized in contemporary neuroscience research. An important component of the course will include an introduction to scientific computing in MATLAB. Students completing this course will develop computational skills essential in interdisciplinary neuroscience research and in more advanced neuroscience courses offered at BU.

Course goals

To introduce mathematical concepts encountered in neuroscience research and more advanced neuroscience graduate courses. To teach basic programming skills in MATLAB. To think about neuroscience in quantitative ways.

Course requirements

You are required to attend lecture and a computational laboratory section each week, and complete weekly readings (assigned in the textbook, provided as handouts, or posted on the course website). The computational lab will be held in LSEB Room B03. **Homework** will be assigned each week, sometimes in lecture but usually during lab. Most assignments will involve "Challenge Problems": executing and interpreting computer code in MATLAB. You will be asked to complete one or more Challenge Problems each week. Typically the Challenge Problems will be assigned in Lab (on Thursday) and due by the next lecture meeting (on Tuesday). You are encouraged to work in groups, but please submit your own written or typed solutions to each homework problem and a list of your collaborators. Please arrange with me late assignment submissions in advance of the due date. There will be no exams in this course.

Grades

To earn an "A", the general requirements are: attend all lectures and labs, correctly complete all assigned challenge problems. To earn an "A-", the general requirements are: attend all lectures and labs, attempt seriously all assigned challenge problems. To earn a "B+", the general requirements are: attend all lectures and labs, attempt seriously most assigned challenge problems. To earn a "B", the general requirements are: attend all lectures and labs, attempt seriously some assigned challenge problems. To earn a “B-/C”, the general requirements are: miss lecture and lab, fail to seriously attempt challenge problems.

Tentative Course Schedule

Week 1
Sept 4 - *Lecture*: Introduction, types of data and models, field trip.
Sept 6 - *Lab*: MATLAB Basics Tutorial.
Reading: MATLAB for Neuroscientists: Ch 2. *Handout #1*.

Week 2
Sept 11 - *Lecture*: Observations of spiking neurons and their quantification.
Sept 13 - *Lab*: Analysis of spiking data, histograms and ISIs.
Reading: MATLAB for Neuroscientists, Ch 13 & 26. *Handout #2*.
Teich and Khanna, J Acoust Soc Am (1985) vol. 77 (3) pp. 1110-28

Week 3
Sept 18 - *Lecture*: Statistical models of spiking data.
Sept 20 - *Lab*: The Poisson model.
Reading: MATLAB for Neuroscientists, Ch 13 & 26. *Handout #2*.
Teich and Khanna, J Acoust Soc Am (1985) vol. 77 (3) pp. 1110-28

Week 4
Sept 25 - *Lecture*: Simple biophysical models of spiking data.
Sept 27 - *Lab*: The integrate and fire model neuron and the leaky integrate and fire model neuron.
Reading: Abbott, Brain Res Bull (1999) vol. 50 (5-6) pp. 303-4

Week 5
Oct 2 - *Lecture*: More complicated biophysical models of spiking data.
Oct 4 - *Lab*: The Hodgkin-Huxley model neuron.
Reading: MATLAB for Neuroscientists, Ch 19, 20
Hodgkin and Huxley, J Physiol (Lond) (1952) vol. 117 (4) pp. 500-44

Week 6
Oct 9 - No class (substitute Monday)
Oct 11 - *Lecture*: An introduction to Fourier transforms and the power spectrum.
Reading: MATLAB for Neuroscientists, Ch 7, 8. *Handout # 3*.

Week 7
Oct 16 - No class (SfN Meeting)
Oct 18 - *Lab*: Computing the power spectrum.
Reading: MATLAB for Neuroscientists, Ch 7, 8. *Handout # 3*.

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Oct 11 - *Lab & Lecture*: An introduction to Fourier transforms and the power spectrum. 12:30-3:30 PM
Oct 18 - *Lab & Lecture*: An introduction to networks in neuroscience. 12:30-3:30 PM

Your conduct in this course, as with all BU courses, is governed by the BU Academic Conduct Code. A copy of the code is available,

http://www.bu.edu/academics/files/2011/08/AcademicConductCode.pdf

Violations of the code are punishable by sanctions including expulsion from the University.