

G80.2221 – Fall 2001
Mathematical Tools for Neural Science

Course Description

Instructor: Eero Simoncelli

TA: Zang (Jenny) Li

Brief Description: A graduate course covering basic mathematical techniques for analysis and modeling of neural systems and data. The goal of the course is to cover the basic mathematical and computational tools required to solve data analysis and modeling problems, the transformations of raw data into a form in which these tools may be utilized, and the interpretation of such analyses. Lectures on each topic will include some mathematical background, derivation of basic results, and examples relevant to neural science. The course will include weekly problem sets based on the MATLAB software package.

Format: The course will consist of two 2-hour lectures per week. A portion of this time will be devoted to introducing materials in the computer laboratory (Meyer, room 157). The course will have a sequence of homework assignments (roughly every two weeks), to examine the lecture topics in terms of concrete and realistic problems. Grades will be based on homework.

Course materials: There is no textbook for this course. Supplementary reading materials will be handed out in class. In addition, all materials will be available as Acrobat (pdf) files from the course web site:

<http://www.cns.nyu.edu/~eero/math-tools01/>

Alternatively, they are available on any machine with access to the CNS file system, from directory

/users/eero/math-tools01/

Topics:

- I. Linear Methods in Data Analysis:** Basics of linear algebra, least-squares fitting, Principal Components Analysis, total-least-squares, linear discriminants.
- II. Differential Equations:** Basic ODE's, membrane models, Hodgkin-Huxley and other spiking models, coupled diffEQ's.
- III. Linear Systems Theory:** Convolution, Fourier Transforms, sampling.
- IV. Uncertainty & Statistics:** basic probability, estimation, bias/efficiency, significance tests, bootstrapping, decision theory / signal detection theory, stochastic models of neurons, stochastic experiments and data analysis (e.g. reverse correlation).