Spring 2018: Math 577-001 Mathematical Neuroscience

Instructor: Calvin Zhang (calvinz@math.arizona.edu)

Tuesdays & Thursdays 11-12:15 (Classroom to be determined)

Prerequisite: Working knowledge of differential equations and probability as used in applications.

This course will focus on the mathematical aspects of neuroscience at the cellular level; the mechanistic and mathematical descriptions of neuronal dynamics and input/output properties. Topics will include: ionic channels (current-voltage relations, gating kinetics, different types), Hodgkin-Huxley equations and reductions (the action potential, repetitive firing, bursting, propagation), dendrites (branching cable theory, passive and active membrane, spines), glial cells (calcium dynamics in astrocytes), and synapses (transmitter release, depression/facilitation, plasticity). Both analytical (perturbation and bifurcation methods, partial differential equations, stochastic processes) and numerical techniques will be described and used, serving as an applied introduction to these methodologies. Course requirements include homework assignments and a computing project, but no exam. Students may collaborate on the homework and on the computing project, and are encouraged to present the results of their computing projects to the class.

Text: A collection of reprints and lecture notes will be available online.

Reference books:

Izhikevich EM. Dynamical Systems in Neuroscience: The Geometry of Excitability and Bursting. MIT Press, 2007.

Koch C. Biophysics of Computation. Oxford University Press, 1998.

Hoppensteadt FC & Peskin CS. Modeling and Simulation in Medicine and the Life Sciences. Springer, 2002.

Segel LA & Edelstein-Keshet L. A Primer on Mathematical Models in Biology. SIAM Press, 2013.

Strogatz S. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014.