Tentative Syllabus Math/Cheg 460-050, Math 660
Introduction to Systems Biology, Fall 2012

Dr. Prasad Dhurjati, Chemical and Biomolecular Engineering
University of Delaware, Newark, DE
dhurjati@udel.edu

Dr. Richard Braun, Mathematical Sciences
University of Delaware, Newark, DE
braun@math.udel.edu

Dr. Abhyudai Singh**,** Electrical and Computer Engineering
University of Delaware, Newark, DE
absingh@udel.edu

Meeting time
Tuesday and Thursday 5-6:15pm in Room 046 Colburn (eCalc1 Lab)

Catalog Description
Computational/mathematical techniques for modeling and analysis of biological systems. Topics include properties of gene-regulatory and signaling networks; network reconstruction from data; stochastic modeling to study cellular variation and physiological modeling. Emphasis will be on using computation techniques as an in-silico tool for guiding experimental design.

Prerequisites
Basic background in linear algebra, ordinary differential equations and probability theory. Background in cell/molecular biology will be helpful but not required for the class. Additional mathematical/biological reading material may be given to individual students to bring their background at par with the class.

Texts
Recommended text:
A first course in systems biology by Eberhard Voit (Garland Science, paperback ISBN 9780815344674; e-book, for 30% less, at http://store.vitalsource.com/show/978-1-1362-1510-0.)

Supporting Texts:
1. *System Modeling in Cellular Biology: From Concepts to Nuts and Bolts* by Zoltan Szallasi.
2. *An Introduction to Systems Biology: Design Principles of Biological Circuits* by Uri Alon.
3. *Computational Modeling of Gene Regulatory Networks -- A Primer* by Hamid Bolouri.
4. *Dynamic Models in Biology* by S. Ellner and J. Guckenheimer.

Grading
Mini Projects/Homeworks (60%), one final project (30%) and class participation and attendance (10%)

The project will be a group effort (2-3 students per group), and evaluation will be based on a project report and presentation at the end of the class. List of potential projects will be provided during the course.

Tentative topics and timeline

- Course introduction. Why build math models? (Dhurjati, one week).
- Boolean network modeling, analysis and applications (Singh, two weeks).
- Equlibrium metabolic flux analysis (guest lecture, 1/2 week).
- Introduction to differential equation models, Analytical and numerical analysis tools for differential equation models (Braun, two weeks).
- Reaction network modeling and identification (Dhurjati, one week).
- Physiological modeling (Dhurjati, 1 week).
- Disease network modeling (Guest lecture, one week).
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- Gene network properties and design principles (Singh, one week).
- Introduction to stochastic models. Markov models of ion channels (Braun, one week).
- Stochastic modeling & analysis of gene-protein networks (Singh, one week).
- Introduction to commercial software for systems biology (guest lecture, 1/2 week).
- Project presentations (students, one week).

Potential Mini-Projects (Individual)

1. Boolean Network
2. Analysis of ODEs (repressilators)
3. Reaction Network Identification
4. Physiological Modeling
5. Stochastic Simulation of Gene Networks

Potential Final Projects

These projects for groups of two or three will be listed later.