Course Information

- Webpage: http://www.async.ece.utah.edu/~myers/ece6760/
- Meeting time: TTh 3:40-5:00pm
- Meeting place: MEB 3105
- Office hours: T1-2pm and Th 2:30-3:30pm
- Email: myers@ece.utah.edu
- Office: MEB 4112 / 581-6490

Prerequisites/Textbook

- Students should have some familiarity with:
  - Genetics, cell biology, molecular biology, or biochemistry, OR
  - Engineering methods for modeling, analysis, and design.
- I’m writing a text which will be available on the course website.

Grading Policy

- Participation - 10 percent
  - Attend class.
  - Participate in class discussions.
- Homework - 40 percent
  - Will learn how to use modeling and analysis tools.
  - Use simple system for tutorial.
  - Choose network to champion.
  - Model and analyze your network with the tool.
- Project - 50 percent
  - Model and analyze a biological network, or
  - Design and implement an analysis tool.

Systems Biology

- We now have a parts list (genomes) of many biological systems.
- Beginning to get data on the functions of genes from new high throughput experimental methods.
- Systems biology perspective essential in functional genomic era.
- Systems biology is the study of the mechanisms underlying complex molecular processes as integrated into systems or pathways made up of many interacting genes and proteins.

Systems Biology (cont)

- Systems biology involves:
  - Collection of large experimental data sets.
  - Constructing mathematical models from this data.
  - Designing software to accurately and efficiently analyze these models in silico (i.e., on a computer).
  - Comparing numerical simulations with the experimental data, and
  - Designing new synthetic biological systems.
- Systems biology is enabled by:
  - cDNA microarrays and oligonucleotide chips.
  - Mass spectrometric identification of gel-separated proteins.
  - 2-hybrid systems.
  - Genome-wide location analysis (ChIP-to-chip)
**Biological Networks**

- **Metabolic networks** are enzymatic processes that transform food into energy, and perform both biosynthesis and biodegradation.
- **Protein networks** are communication and signaling networks which are composed of basic reactions between two or more proteins.
- **Genetic regulatory networks** or **genetic circuits**, regulate gene expression at many molecular levels.
- The focus of this course are methods for modeling, analysis, and design of genetic circuits.

**Engineering Methods**

- Models and analysis techniques need to be developed.
- Engineers have experience in modeling and analyzing systems.
- Can take a circuit view of a genetic circuit (Science1995).
- Collaborations needed between engineers and biologists.
- Goal of this course is to facilitate these collaborations.

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**The Engineering Approach**

- **Set of Experiments**
  - **Perform Experiments**
  - **Learn Models**
  - **Construct Models**
  - **Design and Simulation**
  - **Modeling and Analysis**
  - **Plasmid Insertion**

**Genetic Circuit Modeling**

- **Set of Experiments**
  - **Perform Experiments**
  - **Learn Models**
  - **Construct Models**
  - **Simulation and Synthesis**
  - **HDL**

**Genetic Circuit Analysis**

- **Set of Experiments**
  - **Perform Experiments**
  - **Learn Models**
  - **Construct Models**
  - **Simulation and Analysis**
  - **Design**

**Genetic Circuit Design**

- **Set of Experiments**
  - **Perform Experiments**
  - **Learn Models**
  - **Construct Models**
  - **Simulation and Analysis**
  - **Design**
Tentative Syllabus

- Weeks 1 and 2: An Engineer's guide to biology and biochemistry
- Week 3: Phage λ: A simple genetic circuit
- Weeks 4 and 5: Learning genetic circuits
- Weeks 6 and 7: Differential equation analysis
- Weeks 8 and 9: Stochastic analysis
- Weeks 10 and 11: Circuit abstractions
- Weeks 12 and 13: Genetic circuit design
- Week 14: Advanced topics
- Week 15: Project presentations