Master Course Description for EE-423, EE-523 (ABET sheet)

Title: Introduction to Synthetic Biology

Credits: 3

UW Course Catalog Description

Coordinator: Georg Seelig, Professor, Electrical and Computer Engineering

Goals: For students to acquire the necessary tools for the analysis and design of synthetic biochemical systems.

Learning Objectives: At the end of this course, students will be able to:

1. *Understand* the challenges and applications of synthetic biology.
2. *Understand* the basic cellular processes including transcription, translation, regulation, metabolism, and information processing.
3. *Build* mathematical models of biochemical systems inside cells using Boolean logic, finite state machines, ordinary differential equations and/or stochastic processes.
4. *Understand* biochemical processes in terms of stability, robustness, parameter sensitivity, modularity, and evolvability.
5. *Estimate* model parameters from data.
6. Use Matlab or similar software to *model, design and simulate* systems.
7. *Use* molecular sensors, regulatory elements, reporters, enzymes, etc. in new designs and *predict* their behavior mathematically.
8. *Understand* the risks and ethical considerations of synthetic biology.

Textbook: (Optional) U. Alon, *Control Systems Engineering, An Introduction to Systems Biology.*

Prerequisites by Topic:

1. Differential equations
2. Linear algebra
3. Familiarity with the use of Matlab or other mathematical software
4. NOTE: No biochemistry background is required.

Topics:

1. The applications of synthetic biology
2. The risks, ethics and challenges of synthetic biology
3. Transcription, translation and regulation
4. Metabolism
5. Review of mathematical modeling
6. Mass action and enzyme kinetics

7. Stochastic chemical kinetics
8. Modeling software
9. In vitro synthetic biology
10. Composition, modularity and sensitivity
11. Robustness and sensitivity in biochemical systems
12. Parameter estimation and system identification
13. Review of recent literature in synthetic biology

Course Structure: The class meets for three lectures a week (MWF). There is weekly homework due; Grading is based on homework, one midterm exam, and a final exam. The grading percentages and nature of the exams are left to the discretion of the instructor.

Computer Resources: The course uses Matlab for homework problems. The students complete an average of 3 hours of computer work per week.

ABET Student Outcome Coverage: This course addresses the following outcomes:

H = high relevance, M = medium relevance, L = low relevance to course.

(1) *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics* **(H)** Lectures and homework deal with the application of differential equations, linear algebra and Laplace transforms to control systems. Students will also identify, formulate and solve engineering problems. Some of the homework assignments require students to evaluate different design approaches to reach an acceptable design.

(2) *An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors* **(H)** Students are required to apply the skills acquired in this course to design control systems to meet specific performance requirements.

(3) *An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts* **(M)** An understanding of professional and ethical responsibilities related to introducing new genetic material into the ecosystem. Knowledge of contemporary issues in genetic engineering, gene therapy, biofuels and energy, medicine and disease.

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