

# CSCE 496/896 – Genetically Engineered Systems

Spring 2017, MWF 10:30AM – 11:20AM  
Room 106, Avery Hall

**Instructor** Dr. Massimiliano Pierobon  
Assistant Professor  
107 Schorr Center  
Department of Computer Science and Engineering  
University of Nebraska-Lincoln  
Lincoln, NE 68508

Tel: (402) 472-5021  
Fax: (402) 472-7767  
E-mail: [pierobon@cse.unl.edu](mailto:pierobon@cse.unl.edu)

**Website of Class** <http://cse.unl.edu/~pierobon/teaching.html>

**Office Hours** MW 11:30AM – 12:30PM or by appointment.

**Description** The goal of this course is to introduce students to the emerging field of synthetic biology, and its interdisciplinary foundational concepts. This course will present the technologies at the basis of synthetic biology, together with the engineering concepts that underlie the design, modeling, and realization of genetically engineered systems. The course will survey examples of cutting edge applications, from the production of biofuels to the design and implementation of biosensors to detect harmful agents. A special emphasis will be given to the International Genetically Engineered Machine (iGEM) competition and its latest results in terms of research and training. Ethical, legal, and societal aspects of this new interdisciplinary field will be also discussed by glancing at possible future scenarios.

**Prerequisite** Graduate standing from Computer Science and Engineering, Electrical Engineering, and Mathematics, or upon instructor permission.

Most of the necessary concepts from physics, chemistry, and biology, will be provided during the lectures. Student creativity, passion, and open-minded attitude will be highly appreciated and rewarded.

**Required Textbook** NO TEXTBOOK REQUIRED.

## Main References:

Paul S Freemont, Richard I Kitney, et al.  
“Synthetic Biology — A Primer”  
Imperial College Press

Chris J. Myers  
“Engineering Genetic Circuits”  
Chapman and Hall/CRC Press

Uri Alon  
“An Introduction to Systems Biology: Design Principles of  
Biological Circuits”  
Chapman and Hall/CRC Press

Lecture slides (PDF) will be available on Blackboard.

A list of reference books and research papers will be given throughout the semester.

Some of the research papers and reports will be available in Blackboard.

HOMEWORKS and EXAMS will be based on what explained during the lectures and supplemental reading materials.

## Course Topics

### 0. Course Introduction

#### 1. Molecular Biology Fundamentals

- 1.1 Information Storage in Biology
- 1.2 Information Flow in Biology
- 1.3 Control of Information Flow in Biology
- 1.4 The Cell: the Living Unit of Biology
- 1.5 Chemical Reactions: the Engine of Biology
- 1.6 Macromolecules: What Makes Up Biological Systems

#### 2. Synthetic Biology Foundations

- 2.1 Enabling Technologies
- 2.2 Systematic Design
- 2.3 Standard DNA Assembly
- 2.4 Standard Measurements
- 2.5 Standard Part Characterization and Parts Registries
- 2.6 The BioCAD Concept
- 2.7 Information Exchange in Synthetic Biology

#### 3. Introduction to Genetic Circuits

- 3.1 Networks in Biology

- 3.2 Genetic Circuits Basics
- 3.3 An Example of Biological Circuit
- 3.4 Genetic Circuit Models
- 3.5 Phage  $\lambda$ : A Simple Genetic Circuit

#### 4. **Genetic Circuit Modeling**

- 4.1 Why is Mathematical Modeling Important?
- 4.2 Forward Engineering Approach
- 4.3 Differential Equation Analysis
- 4.4 Stochastic Analysis
- 4.5 Reaction-based Abstraction
- 4.6 Logical Abstraction
- 4.7 Learning Models
- 4.8 Model Repositories

#### 5. **Genetic Circuit Design**

- 5.1 Standard Genetic Parts (and the PartsRegistry Protocol)
- 5.2 How to Design Genetic Constructs (Circuits) from Parts
- 5.3 Types of Genetic Constructs: Devices
- 5.4 Types of Genetic Constructs: Systems

#### **Lectures by Prof. Jean Peccoud, Biocomplexity Institute, Virginia Tech**

- 1 Synthetic Biology Research in the Peccoud's Lab
- 2 Introduction to GenoCAD
- 3 Advanced Topics in GenoCAD

#### 6. **Synthetic Biology and Society**

- 6.1 Public Health and Environmental Risks
- 6.2 Biosecurity and Biohacking
- 6.3 The Ownership of Technology
- 6.4 "Playing God" and the Ethical Aspects
- 6.5 Public Value and New Global Inequality

#### **Bonus Chapters:**

#### 7. **Minimal Cells and Synthetic Life**

#### 8. **Cutting Edge Applications**

#### **Course Organization**

There will be TWO exams, FOUR homeworks, and ONE TEAM PROJECT assignment to be de.

<b>Grade Distribution</b>	Homeworks: 20% Exam 1: 20% Exam 2: 20% Project: 35% In-class Participation: 5%
<b>Homeworks</b>	Homework submissions will be through web handin Late homework is penalized 10% per day, and no homework will be accepted after the solution is posted online
<b>Exams</b>	There will be TWO in-class exams.
<b>Project</b>	There will be half-semester-long projects, focused on the research of material from the available literature, analysis and presentation to the class (at the end of the semester) of a specific topic chosen from those introduced in the class. The project will be assigned to students divided into teams according to the class size.
<b>Academic Integrity</b>	All homework assignments, quizzes, exams, etc. must be your own work. No direct collaboration with fellow students, past or current, is allowed unless otherwise stated. The Computer Science & Engineering department has an <b>Academic Integrity Policy</b> :  <a href="http://cse.unl.edu/ugrad/resources/academic_integrity.php">http://cse.unl.edu/ugrad/resources/academic_integrity.php</a>  All students enrolled in any computer science course are bound by this policy. You are expected to read, understand, and follow this policy. Violations will be dealt with on a case by case basis and may result in a failing assignment or a failing grade for the course itself.
<b>Students with Disabilities</b>	Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodations to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.

- Suggestion Box** The CSE Department has an **anonymous suggestion box** (<http://cse.unl.edu/department/suggestion.php>) that you may use to voice your concerns about any problems in the course or department if you do not wish to be identified.
- Stay Up-to-date** It is CSE Department policy that all students in CSE courses are expected to regularly check their email so they do not miss important announcements.
- CSE Resource Student Center** The CSE Student Resource Center (Avery Hall 13A) is intended to provide UNL Computer Science and Computer Engineering majors who are new to the program with a set of resources that will help them assimilate to college life and encourage them to continue their study of Computer Science and Computer Engineering (<http://cse.unl.edu/src>).

This syllabus will be updated and expanded as the semester progresses.