COURSE INFORMATION
EC552, BE552 – Computational Synthetic Biology for Engineers
Spring 2022
Instructor: Prof. Douglas Densmore (dougd@bu.edu)

Location and Time
Lectures: Tuesdays and Thursdays, 1:30-3:15pm, EPC 204

Staff
Instructors

Douglas Densmore (dougd@bu.edu, 617-358-6238, CILSE 403)
Office hours: Wednesdays 2pm-3pm also by appointment. *
https://bostonu.zoom.us/j/4602829913

*Please see Blackboard for potential updates.

Website
https://www.compsynbioclass.org/

Course content

This course presents the field of computational synthetic biology through the lens of four distinct activities: Specification, Design, Assembly, and Test. Engineering students of all backgrounds are introduced to synthetic biology and then exposed to core challenges and approaches in each of these four areas. Homework assignments are provided which allow the students to use existing computational software to explore each of these themes. In addition, advanced concepts are presented around data management, design algorithms, standardization, and simulation challenges in the field. The course culminates in a group project in which the students apply computational design methods to an experimentally created system (working with graduate students in the Biological Design Center and the DAMP Lab). This project will result in code being made available to the Nona Research Foundation (www.nonasoftware.org) and potentially the submission of a peer-reviewed research paper.

Required Background
This is a course intended for senior undergraduates and graduate students in electrical, computer, or biomedical engineering. A background in biology is not required. **However, the students do require solid programming and problem-solving abilities in an object-oriented language (C++ or Java is preferred).** Additional background in Perl/Python, HTML/Javascript/CSS, and databases (MySQL, MongoDB) is desirable but not required. The students must be interested in computation and have the willingness to learn how to program in the necessary programming environments.

Resources

Textbooks
- Natalie Kuldell, Rachel Bernstein, Karen Ingram, Kathryn M Hart, *BioBuilder* (1st Edition), O'Reilly Media 2015. **(Required)**
- Chris J. Myers, *Engineering Genetic Circuits* (1st Edition), Chapman & Hall/CRC Mathematical and Computational Biology, 2009. **(Highly Recommended)**
- H. Koeppl, D. Densmore, M. di Bernardo, and G. Setti, *Design and Analysis of Biomolecular Circuits*, Springer Books, 2011. **(Recommended)**

References

- Ptashne, M. (2004). *A genetic switch: phage lambda revisited*. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
- Alberts, B., Wilson, J. & Hunt, T. (2008). *Molecular biology of the cell*. New York: Garland Science.
- Wagner, R. (2000). *Transcription regulation in prokaryotes*. Oxford New York: Oxford University Press.
- Baldwin, G. (2016). *Synthetic biology: a primer*. Singapore Hackensack, NJ: Imperial College Press, World Scientific Publishing Co. Pte. Ltd.
- Alon, U. *An Introduction to Systems Biology: Design Principles of Biological Circuits*, Second Edition, Chapman & Hall.

- Andrew Johnson, JAVA: The Ultimate Beginner's Guide!, CreateSpace Independent Publishing Platform (November 10, 2015)
- Bjarne Stroustrup, *The C++ Programming Language (3rd Edition)*, Addison-Wesley, 1997
- Baier, C. & Katoen. (2008). *Principles of model checking*. Cambridge, Mass: MIT Press.

Course Elements

Blackboard:
You are responsible for checking the Blackboard page for ***EC552 – Spring 2022*** (not BE552) regularly. Blackboard will contain lecture material, handouts, homework, reading assignments, project information, and your grades as they become available. **Please check Blackboard for instructions on how to submit your homework and reading assignments.**

HW Assignments (3 total)
All homework assignments **must be done in groups of two**, although you may discuss *general* suggestions and questions with others in the class. Homework assignments will focus on using tools related to the specification, design, assembly, or testing of synthetic biological systems *in-silico*. Each homework assignment will have an associated “mentor” (course staff or other senior graduate student) that will help with questions and will be ultimately responsible for that homework. The schedule of HW assignments is provided in the overall course schedule.

Project:
There will a group project assignment. Details will be provided roughly on March 2nd (according to schedule). The project will be in teams of 3-4 students and will be partnered with experimental students from the Biological Design Center (BDC) at BU. The goal of the project will be to build a synthetic biological sensor application. Students in this course will use the tools available to them AND create new software to augment or enhance those tools. The results of this *in-silico* work will then be used with the experimental students to physically create the designs. Iterations will involve both the computational and experimental aspects being refined. The project will culminate with the curation of all wetware, hardware, and software artifacts in the appropriate on-line repositories, a project presentation to the class, and project postmortem process at the end of the semester.

Reading Assignments:
There will be six reading assignments throughout the semester. In general, there will be one reading assignment due **roughly every other Tuesday** on a single research paper related to computational synthetic biology. These readings may be discussed in class. In addition to reading the paper, you must submit your responses to a “reading summary assignment” (to be posted on Blackboard) for each paper. The list of papers and their due dates is provided with the course schedule.

Late Penalties:

- HW: There will be a **10% penalty** per day for late homework, up to a **maximum of two days late**.
- Reading Assignments: **No late reading assignments.**
- Project: **No late projects.**

Penalties may be removed **only** for legitimate excuses with written, dated documentation.

Grades:
All grades will be curved. This is NOT a precise process and is a function of class average, improvement, class participation, and providing a balanced distribution of letter grades. The final grade and which grade we assign to class average will depend on our assessment of the class as a whole.

Raw scores will be computed based on the following approximate weights:

- Reading Assignments (20%)
- Homework (30%)
- Project (50%)

Collaboration:
All students are responsible for reading the university academic conduct policy. Dishonesty in representing one's academic work is a serious ethical violation and will be reported according to university policy.

Cheating and plagiarism will be taken **very seriously**. You may use any textbooks or web sources (not run by a class member) when completing your homework or project subject to the following strict conditions:

1. You must clearly acknowledge and cite all your sources (e.g. stack overflow).
2. You must write all answers in your own words. All code must be your own.
3. You must be able to fully explain your answers upon demand.

You may collaborate with people, **unless explicitly stated otherwise in writing by the instructor**:

A good rule of thumb is that discussions on whiteboards and with pencil and paper are okay while discussions with computers, code, electronics, etc. are potentially dangerous. **When in doubt, ask!**

* Failure to meet any of the above conditions could constitute plagiarism and will be considered cheating in this class. **If you are unsure about an activity, please ask the instructor first.**