Department of Bioengineering
BIEN 310
Introduction to Biomolecular Engineering
Fall 2016

Lecture Schedule:
Day: Tuesdays & Thursdays (September 6 – December 1)
Time: 8:35am – 9:55am
Location: WONG 1050

Instructor:
Prof. Yu (Brandon) Xia (brandon.xia@mcgill.ca)
Office Hours: Wednesdays noon – 1pm, or by appointment
Office Location: Macdonald Engineering Building, Room 389

Teaching Assistant:
None

Course Information:
Audience: undergraduate engineering, science, and/or biomedical students
Prerequisites: None
Website: McGill myCourses (accessible via www.mcgill.ca/lms) will be used to distribute course materials, including lecture slides and assignments.

Course Description:
Forward and reverse engineering of biomolecular systems. Principles of biomolecular thermodynamics and kinetics. Structure and function of the main classes of biomolecules including proteins, nucleic acids, and lipids. Biomolecular systems as mechanical, chemical, and electrical systems. Rational design and evolutionary methods for engineering functional proteins, nucleic acids, and gene circuits. Rational design topics include molecular modeling, positive and negative design paradigms, simulation and optimization of equilibrium and kinetic properties, design of catalysts, sensors, motors, and circuits. Evolutionary design topics include evolutionary mechanisms, fitness landscapes, directed evolution of proteins, metabolic pathways, and gene circuits. Systems biology and synthetic biology.

Motivation and Rationale:
This is a required course in the proposed B.Eng. in Bioengineering. The course introduces students to fundamental concepts in biomolecular engineering, as well as its potential impact on society. The emphasis will be on reverse engineering approaches to understand naturally occurring complex biomolecular systems, as well as forward engineering approaches to design biomolecular systems with novel functionalities.

Course Material:
No textbook will be required.
Supplemental course materials, including lecture notes, will be distributed during the semester via WebCT.

Course Assignments and Grading:

Assignments	Points	Percentage
Homework Assignments	40	40
Midterm Exam	100	30
Final Exam	100	30

Objectives:

- Introduce the fundamental concepts of biomolecular engineering as well as the historical context of the field and perspective areas of future growth.
- Familiarize students with the fundamental principles of biomolecular engineering.
- Describe the current progress in biomolecular engineering research and its current and future impact on society, including health, energy, and environment.

Language of Written Work:
In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.

Academic Integrity:
McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/students/srr/honest/ for more information).

Disabilities:
If you have a disability, please contact the instructor to arrange a time to discuss your situation. It would be helpful if you contact the Office for Students with Disabilities at (514) 398-6009 before you do this.

Course Schedule

Week	Date	Homeworks	Section	Topic
1	Sep. 6 Sep. 8 (guest lecture)		1. Introduction	Introduction to biomolecular engineering; reverse engineering; forward engineering.
2 3	Sep. 13 Sep. 15 Sep. 20 Sep. 22	HW1	2. Biomolecular Thermodynamics & Kinetics	First and second laws of thermodynamics; entropy; free energy; chemical & physical equilibrium; equilibrium constant; chemical kinetics; ligand binding; enzyme catalysis.
4 5	Sep. 27 Sep. 29 Oct. 4 Oct. 6	HW2	3. Biomolecular Structure, Function & Modeling	Structure and function in biology; molecular driving forces for biopolymer folding and dynamics; molecular architecture; molecular

6 7	Oct. 11 Oct. 13 Oct. 28			modeling; molecular simulation.
7	Oct. 20	**Midterm**		
8 9	Oct. 25 Oct. 27 Nov. 1 Nov. 3	HW3	4. Biomolecular Design	Rational design; positive design; negative design; optimization methods; evolutionary design.
10 11	Nov. 8 Nov. 10 Nov. 15 Nov. 17	HW4	5. Systems Biology	Biomolecular networks; metabolic networks; interaction networks; regulatory networks; reconstruction and simulation of networks.
12 13	Nov. 22 Nov. 24 Nov. 29 Dec. 1		6. Synthetic Biology	Biology and simulation of lambda switch; synthetic biology of toggle switch; application of synthetic biology in health, environment, and energy; ethical considerations of synthetic biology.
14	TBA	**Final Exam**		