BMED 3520 Biomedical Systems and Modeling **Summer Galway 2021**

Credit Hours: 3

Prerequisites: BMED 3100, BMED 2210, CS1371/1171, MATH 2403/24X3/2552/2562/2X52

Lectures and Problem Solving: Mo, Tu, We, Th: 1 hour and 50 minutes each

Exams: Two exams and a final; administered during class time

Instructor:

Eberhard Voit (eberhard.voit@bme.gatech.edu)

Teaching Assistants:

TBA

Catalog Description:
The course introduces juniors in BME to the field of computational systems biology. It covers all typical aspects of biomathematical modeling, including: choice of a modeling framework from among alternative approaches; design of interaction diagrams; identification of variables and processes; design of systems models; standard methods of parameter estimation; analysis of steady states, stability, sensitivity and gains; numerical evaluations of transients; phase-plane analysis; and simulation of representative biomedical scenarios. All theoretical concepts are exemplified with applications.

Objectives:
This course introduces the student to the emerging field of systems biology. It consists of overview lectures, problem solving sessions, and discussions/reviews. The overarching objective is to equip students with solid basic knowledge of different types of mathematical and computational modeling approaches and their applications to solving biomedical problems.

Expected Outcomes:
By the end of the course the students should:
1. Understand the basic strengths and limitations of quantitative modeling
2. Have acquired a basic skill set for designing and implementing quantitative models of biomedical systems
3. Have mastered standard techniques of steady-state and dynamical analysis
4. Understand how to apply different modeling tools to the analysis of dynamical systems in biomedicine

Text:
Voit, E.O.: *A First Course in Systems Biology*. Garland Science, New York, NY, 2017, 2nd edition. Freely available from Georgia Tech library

Computer and Software Use: Every student is required to have a laptop computer available. Every student must either load the software PLAS (http://enzymology.fc.ul.pt/software/plas/) onto his/her computer or have access to PLAS through Georgia Tech's free software cloud.

Instructional Format:
Four sessions each week are scheduled for the class. Each will begin with a 30-minute lecture and followed by a brief break and a 75-munte hands-on computer-based Problem-Solving Session (PSS).

Each overview lecture presents a high-level discussion of the topics to be studied during the week. The problem-solving sessions begin with a brief question-and-answer period followed by hands-on projects and team-based problem solving. Review sessions will summarize and explain details of the topics that were learned during the past classes in a question-and-answer manner and include, if desired, a discussion of homework problems. Every student must bring a laptop to every class in order to follow the lectures and to work on practice problems. Software installation will be required throughout the semester for computational exercises. The primary weekly assignment is the reading and understanding of selected materials from the book. Secondary assignments consist of exercises uploaded to Canvas.

Two semester exams and one final exam assess each student's mastery of the materials discussed in class.

Evaluation:

Class participation (attendance and engagement)	5%
Attendance is required and will be registered through the use of in-class sign-in sheets.	
Homework assignments (~5-6)	25% (total)
In-semester exams (2)	40% (total)
Final exam (cumulative)	30%

Course curving: The default is Georgia Tech's recommendation: A $\geq$90, 89>B $\geq$80, etc. Sometimes in the past, other minimum accomplishments for grades were used. The instructor reserves the right to go above or below these earlier ranges.

Website for Communication and Sharing of Information: The primary means of communication regarding the class will be through Canvas, where lecture notes, assignments, and other files will be uploaded.

Piazza website:
Piazza will be made available for class discussions. The system is highly effective in getting help fast and efficiently from classmates, the TA, and instructors. Rather than emailing questions to the teaching staff, students are encouraged to post your questions on Piazza. Every student is responsible for enrolling her/himself to the course Piazza page.

Math review:
There will be special reviews held by the TAs during the first week of class during the regular class time. These reviews will focus on concepts from calculus and linear algebra that you need to master to pass BMED3520. Past experience shows that most students need this refresher and even benefit from it if they think they remember the material. These sessions will also offer and introduction to PLAS.

In-Semester exams:
It has not been decided whether the exams will be open or closed book.

Final exam:
The final exam will be held on August 5. It has not been decided whether this exam will be open or closed book.

Homework and Regrade Policy:
Homework may be done and submitted in groups of up to three individuals. On Canvas, study groups can be changed for each homework assignment so that a student does not have to stick with the same group for the entire semester. Homework must be uploaded in the Assignments section of Canvas as a single PDF file, **other file formats or multiple files will not be accepted**. The first and last name of each group member that contributed to the solutions must be listed. The file name must contain the surname of each group member. For example: HW4_Gupta_Miller_Zhang.pdf

Requests for regrades on exams and homework are permitted **up to one week** after graded materials are returned to the student. Requests for any regrades must go through the TA and, if asked by the TA, put in writing.

Honor Code:
Students are expected to abide by the GT Honor Code (www.honor.gatech.edu) at all times. The stated objective of the honor code is "to prevent any students from gaining an unfair advantage over other students through academic misconduct." Starting with the first offense, any potential violations of the honor code may be reported to the Dean of Students for review. To preserve the integrity of the classroom and the instructor-student relationship, the instructors cannot use personal discretion in instances of potential honor code violations – ***consider this the first and only warning***.

Examples of honor code violations include:

- Looking at another individual's solutions during an exam.
- Communicating with other students during an exam, directly or electronically.
- Claiming other students' work as the student's own.
- Using notes of any kind during closed-book exams.
- Making untrue claims or statements to the instructors regarding use of electronic resources (Canvas submission, Matlab, your personal laptop crashing, etc.).
- Misrepresenting attendance in class through signing in for / through friends.

For any questions involving these or any other Academic Honor Code issues, please consult your instructor or visit www.honor.gatech.edu*.*

Topical Outline

This is the **tentative schedule** for the class. As needed, the instructor may edit this calendar throughout the semester to reflect necessary changes to the schedule.

Date	Class	Instructor	Topic	Reading/notes
6/21	Lecture and PSS	Voit	Introduction; why modeling?	Chapter 1 HW 1 released
6/22	Review with PSS	TAs	Calculus, PLAS	
6/23	Review with PSS	TAs	Linear Algebra	
6/24	Lecture and PSS	Voit	Types of models, modeling process	Chapter 2
6/28	Lecture and PSS	Voit	Static network models	Chapter 3 HW2 released
6/29	Lecture and PSS	Voit	Discrete models (linear)	Chapter 4 (pp.83-93) HW 1 due
6/30	Lecture and PSS	Voit	Discrete models (nonlinear)	
7/1	Lecture and PSS	Voit	Continuous models	Chapter 4 (pp.93-110) HW 3 released
7/5	Lecture and PSS	Voit	Continuous models	
7/6	Lecture and PSS	Voit	Continuous models	HW 2 due
7/7	Review	TBD		
7/8	EXAM 1		Focus: Chs. 1-3+ Discrete models	
7/12	Lecture and PSS	Voit	Standard methods of analysis	Chapter 4 (pp. 110-128) HW 4 released
7/13	Lecture and PSS	Voit	Standard methods of analysis	HW 3 due
7/14	Lecture and PSS	Voit	Parameter estimation	Chapter 5
7/15	Lecture and PSS	Voit	Parameter estimation	
7/19	Lecture and PSS	Voit	Gene and protein networks	Chapters 6 & 7 HW 5 released
7/20	Lecture and PSS	Voit	Metabolic systems	Chapter 8 HW 4 due
7/21	Review	TBD		
7/22	EXAM 2		Focus: Chapters 4-5	
7/26	Lecture and PSS	Voit	Bistability, hysteresis	Chapter 9 HW 6 released (not graded)
7/27	Lecture and PSS	Voit	MAPK cascade	HW 5 due
7/28	Lecture and PSS	Voit	Population systems	Chapter 10
7/29	Lecture and PSS	Voit	Population systems	
8/2	Lecture	Voit	Personalized medicine & drug development	Chapter 13
8/3	Lecture and PSS	Voit	Synthetic biology	Chapter 14
8/4	Review	TBD		
8/5	Final Exam (3 hrs)		Cumulative	