BMED 3520 Biomedical Systems and Modeling **Summer Galway 2020**

Credit: 3-2-3

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

Lectures and Problem Solving: Mo, Tu, We, Th, 9:00 am– 10:00 am

Exams: 9:00 am– 10:00 am

Instructors:

Eberhard Voit (May 18-June 28; Weeks 1-5)
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Denis Tsygankov (June 22-July 24; Weeks 6-10)
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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: the choice of a modeling framework from among alternative approaches; the design of interaction diagrams; the identification of variables and processes; the design of systems models; standard methods of parameter estimation; the analysis of steady states, stability, sensitivity and gains; numerical evaluations of transients; phase-plane analysis; and the 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.

Instructional Format:
Four hours each week are scheduled for the class. The overview lectures present 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. The review sessions 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.

Three 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 (~8)	15% (total)
In-semester exams (3)	20% (each)
Final exam (cumulative)	20%

Course curving: In the past, ranges for lower cutoffs as shown below were used. However the instructors reserve the right to go above or below these ranges:

Lower cutoff for A ranging from 85 – 90
Lower cutoff for B ranging from 75 – 80
Lower cutoff for C ranging from 65 – 70

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

Piazza website:
We will be using Piazza for class discussions. The system is highly effective in getting you help fast and efficiently from classmates, the TA, and instructors. Rather than emailing questions to the teaching staff, we encourage you to post your questions on Piazza. You are responsible for enrolling yourself 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.

In-Semester exams:
The exams are closed book, with the use of a scientific or graphing calculator and a letter-size, two-page "cheat-sheet."

Final exam:
The final exam will be held on July 24.

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 you do not have to stick with the same group for the entire semester. Homework must be uploaded in the Assignments section of Canvas in PDF format, **other file formats will not be accepted**. Please submit one PDF file rather than multiple files. 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 put in writing.

Honor Code:
Students are expected to abide by the GT Honor Code (www.honor.gatech.edu) at all times. The 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.
- Claiming other students' work as your own.
- Using notes of any kind during closed-book exams.
- Making untrue claims/statements (of any sort) to the instructors regarding use of electronic resources (Canvas submission, Matlab, your personal laptop crashing, etc.).
- Illegally copying, sharing, or downloading the textbook or solution manual.
- Misrepresenting attendance in class through signing in 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. We will edit this calendar throughout the semester to reflect any changes to the schedule.

Date	Class	Instructor	Topic	Reading/notes
5/18	Lecture	Voit	Introduction; why modeling?	Chapter 1 HW 1 released
5/19	Review	TAs	Calculus	
5/20	Review	TAs	Linear Algebra	
5/21	Lecture	Voit	Types of models, modeling process	Chapter 2
5/25	Lecture	Voit	Static network models	Chapter 3 HW2 released
5/26	Problem Solving			HW 1 due
5/27	Problem Solving			
5/28	Review			
6/1	Lecture	Voit	Discrete models (linear, nonlinear)	Chapter 4 (pp.83-93) HW 3 released
6/2	Problem Solving			HW 2 due
6/3	Review			
6/4	EXAM 1		Focus: Chapters 1-3	
6/8	Lecture	Voit	Continuous models	Chapter 4 (pp.93-110)
6/9	Problem Solving			
6/10	Lecture	Voit	Standard methods of analysis	Chapter 4 (pp. 110-128)
6/11	Problem Solving			
6/15	Lecture	Voit	Parameter estimation	Chapter 5 HW 4 released
6/16	Problem Solving			HW 3 due
6/17	Review			
6/18	EXAM 2		Focus: Chapter 4	
6/22	Lecture	Tsygankov	Gene and protein networks	Chapters 6 & 7 HW 5 released
6/23	Problem Solving			HW 4 due
6/24	Problem Solving			
6/25	Problem Solving			
6/29	Lecture	Tsygankov	Metabolic systems	Chapter 8 HW 6 released
6/30	Problem Solving			HW 5 due
7/1	Problem Solving			
7/2	Problem Solving			
7/6	Lecture	Tsygankov	Bistability, hysteresis, MAPK cascade	Chapter 9 HW 7 released
7/7	Problem Solving			HW 6 due
7/8	Problem Solving			
7/9	EXAM 3		Focus: Chapters 5-9	
7/13	Lecture	Tsygankov	Population systems	Chapter 10 HW 8 released

7/14	Problem Solving			HW 7 due
7/15	Problem Solving			
7/16	Problem Solving			
7/20	Lecture	Tsygankov	Personalized medicine & drug development; Synthetic biology.	Chapter 13, 14
7/21	Problem Solving			
7/22	Review			
7/24	Final Exam			