

BMED 3520 Biomedical Systems and Modeling**Summer Galway 2026****Credit Hours:** 3**Prerequisites:** BMED 3100, BMED 2210, CS1371/1171, MATH 2403/24X3/2552/2562/2X52**Lectures and Problem Solving Sessions:** Mo, Tu, We, Th: TBA**Exams:** Two exams and a final; administered during class time**Instructors:** Eberhard Voit (eberhard.voit@bme.gatech.edu) May 18 – June 21
Ahmet F. Coskun (ahmet.coskun@bme.gatech.edu) June 22 – July 25**Teaching Assistant:** TBA**Grader:** TBA**Catalog Description:**

The course introduces BME undergraduates 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 construction 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 (Required):

Voit, E.O., Kemp, M.L. A First Course in Systems Biology; 3rd edition. Taylor & Francis, New York, NY, 2025.

Or

Voit, E.O. A First Course in Systems Biology; 2nd edition. Taylor & Francis, New York, NY, 2018.

Instructional Format:

Four sessions are scheduled each week. The course material is explored through a combination of lectures and hands-on computer-based Problem-Solving Session (PSS). In many cases, the sessions will be a mixture of lecture material and PSS. The lectures present a high-level introduction of the topics to be studied during the

week. The problem-solving sessions consist of hands-on projects, addressed through team-based problem solving.

Every student must bring a laptop to every class in order to follow the lectures and to work on practice problems. 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 of the course.

Evaluation:

Class participation is mandatory

Homework assignments (~6) 30% (total)

In-semester exams (2) 40% (total)

Final exam (cumulative) 30%

Course curving: The default for final grades is Georgia Tech's recommendation: A ≥ 90 , B ≥ 80 , etc. Sometimes in the past, other minimum accomplishments for grades were used. The instructors reserve 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 announcements, lecture notes, assignments and other files will be uploaded.

Piazza website:

Piazza will be available for class discussions. The system is highly effective in getting help fast and efficiently from classmates, the TAs, and the instructor. 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's Piazza system at <https://piazza.com/gatech/summer2026/bmed3520r>.**

Math reviews:

There will be special reviews held by the TA or instructor during the first two weeks of class during the regular class time. These reviews will focus on concepts from calculus and linear algebra that every student needs 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.

Computer and Software Use:

Every student is required to have a laptop computer available for classes, homework and exams. While any pertinent software may be used, such as Python or R, the examples and projects in most PSSs will be presented in Matlab format.

In-Semester exams:

Two in-semester exams and one final exam will assess each student's mastery of the materials discussed in class. The exams will be **closed book**, written exams without the use of other resources. While Matlab is used as a tool to develop programs in this class, you will be tested on the underlying mathematical, physical, and biological concepts rather than on Matlab programming. Communication during exams is prohibited.

Final exam:

The final exam will be **closed book**, written exams without the use of other resources. While Matlab is used as a tool to develop programs in this class, you will be tested on the underlying mathematical, physical, and biological concepts rather than on Matlab programming. The exam will be comprehensive covering all

material from the entire semester, however, there will be a particular focus on material since exam 2 that has not yet been covered on an exam. Communication during the exam is prohibited.

Homework and Regrade Policy:

Homework may be done and submitted in groups of up to three individuals. Study groups may be changed for each homework assignment so that no student does has to work 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 file name must contain the HW number and 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 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.

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.
- Making untrue claims or statements to the instructors regarding the use of electronic resources (Canvas submission, Matlab, your personal laptop crashing, etc.).

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

Use of Artificial Intelligence:

AI-based assistance, such as ChatGPT or Copilot, will be treated in the same way as collaboration with other people: Every student is welcome to communicate ideas and work with other people, both inside and outside the class, as well as with AI-based assistants. However, all submitted work must be the student’s own. It is not allowed to include in an assignment or exam anything that was not written directly by the submitter without proper citation (including quotation marks and in-line citation for direct quotes).

Including anything not written by the submitter of an assignment without proper citation will be treated as a case of academic misconduct. A simple way to ensure not crossing the line with AI-assistance is never to copy and paste answers (which are often incorrect) into a submitted solution and never to have the AI tool and homework open simultaneously.

You may not submit any work generated by an AI program as your own. If you were aided by AI, you and include material generated by an AI program, you must include an appendix that provides the complete prompt and output from the exchange.

Topical Outline

The following schedule for the class is the tentative. It may be edited throughout the semester to reflect necessary changes.

Date	Class	Instructor	Topic	HW: Reading/Projects
5/18	Lecture 1	Voit	Introduction; why modeling?	Chapters 1 and 2 HW 1 released
5/19	Review Problem Solving	TA Voit	Calculus	
5/20	Lecture 2	Voit	Types of models, modeling process	Chapter 3
5/21	Problem Solving			
5/25	Review	TA Voit	Linear Algebra Solving ODEs in Matlab	
5/26	Lecture 3	Voit	Static network models	Chapter 4 (pp.93-108)
5/27	Problem Solving			HW 1 due
5/28	Problem Solving			HW2 released
5/29	Lecture 4	Voit	Discrete models (linear, nonlinear)	Chapter 5 (pp. 113-133)
6/1	Irish Holiday			
6/2	Problem Solving			
6/3	Review (as needed); Problem Solving			
6/4	EXAM 1		Content: Chapters 1-4	
6/8	Lecture 5	Voit	Continuous models	Chapter 5 (pp. 133-157)
6/9	Problem Solving			HW 3 released
6/10	Problem Solving			
6/11	Lecture 6	Voit	Standard methods of analysis	HW 2 due
6/15	Problem Solving			HW 4 released
6/16	Problem Solving			Chapter 6
6/17	Lecture 7	Voit	Parameter estimation	
6/18	Problem Solving			Chapter 7 HW 3 due
	End of Session One			
6/22	Lecture 8	Coskun	Gene and protein networks	
6/23	Problem Solving			
6/24	Problem Solving			
6/25	Lecture 9	Coskun	Metabolic systems	HW 5 released
6/29	Problem Solving	Coskun		Chapter 8
6/30	Problem Solving			
7/1	Review			
7/2	EXAM 2		Content: Chapters 1-7	HW 4 due
7/6	Lecture 10	Coskun	Bistability, hysteresis, MAPK cascade	Chapter 9
7/7	Problem Solving			HW 6 released
7/8	Problem Solving			
7/9	Lecture 11	Coskun	Population systems	Chapter 10

				HW 5 due
7/13	Problem Solving			Problem Solving
7/14	Problem Solving			Chapters 13 & 14
7/15	Lecture 12	Coskun	Personalized medicine & drug development; Synthetic biology	HW 6 due
7/16	Problem Solving			Chapters 12 & 15
7/20	Lecture 13	Coskun	Multi-scale modeling: the future	
7/21	Review			
7/22	Problem Solving/Review			
7/23	Final Exam		Cumulative	