

# **BMED 3520-A: Biomedical Systems and Modeling**

## **Summer Term 2026**

**Credits: 3.0**

**Prerequisites:**

BMED 3100, BMED 2210, MATH 2403

**Course Instructors:**

**Dr. Denis**

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Office hours: Wednesdays, 2-3 pm

Location: Whitaker 1212

**Teaching Assistant**

**Mingxuan Si**

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Office Tuesdays, 11 am - noon

Location: Whitaker 4101

**Meeting Times:**

**Lectures:**

Wednesday, 12:30-1:45 pm at Molecular Sciences and Engineering (building 167), **Room 1201A**

**Problem Solving Studios:**

Tuesday and Thursday, 3:30-6:15 pm at Molecular Sciences and Engineering (building 167), **Room 1201A.**

**Important Dates:**

May 19 (Tue): First day of classes - PSS (Our first lecture is on May 20)

May 25 (Mon): Memorial Day, Holiday (We don't have classes on Mondays)

June 19 (Fri): Juneteenth, Holiday (We don't have classes on Fridays)

July 2 (Thu): Student recess day, Holiday

July 3 (Fri): Independence Day, Holiday (We don't have classes on Fridays)

July 5 (Sun): Withdrawal deadline.

July 28 (Tue): Last day of classes

August 6 (Thu): End of Term

August 10 (Mon): Grade submission deadline

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### **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 will consist of a weekly overview lecture and two Problem Solving Studio (PSS) sessions. 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

### **Textbook**

Voit, E.O.: *A First Course in Systems Biology*. Garland Science, New York, NY, 2017, 2<sup>nd</sup> or 3<sup>rd</sup> edition. (This book is important. We will cover material closely following this book.)

### **Instructional Format**

Six hours 45 minutes each week are scheduled for the class. The weekly 1 hour 15 minutes overview lecture on Wednesday presents a high-level discussion of the topics to be studied during the week. The sessions on Tuesday and Thursday are dedicated to hands-on projects and problem solving, as well as reviews and additional explanations of details regarding the topics addressed during the week. The primary weekly assignment is the reading and understanding of selected text from the book. Homework must be done individually. It is due at 11:55pm on Sundays of the week listed in the syllabus. Two midterm exams and one final (cumulative) exam assess each student's mastery of the materials discussed in class.

### **Piazza**

This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates and the TA. Rather than emailing questions to the teaching staff, we encourage you to post your questions on Piazza. If you have any problems or feedback for the developers, email [team@piazza.com](mailto:team@piazza.com).

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### Grading Policy

Grades will be determined based on demonstrated proficiency on **homework submissions**, **problem solving studios**, and **exams**. The points associated with each graded event are shown below. Consider the following numbers as a plan **subject to change** if necessary:

<b>Problem Solving Studio:</b>	15.0% (fifteen sessions, 1 point each)
<b>Homework Assignments:</b>	18.0% (six HW, 3 points each)
<b>Midterm Exam 1:</b>	22.0%
<b>Midterm Exam 2:</b>	22.0%
<b>Final Exam:</b>	23.0%

Your final grade will be assigned according to the accumulated score. The specific cutoffs will be determined at the end of the course, but we will try to stay as close as possible to the following targeted values:

<b>A</b> (“Excellent”):	≥ 90%
<b>B</b> (“Good”):	≥ 80%
<b>C</b> (“Satisfactory”):	≥ 70%
<b>D</b> (“Passing”):	≥ 50%
<b>F</b> (“Failure”):	< 50%

### Problem Solving Studio Assessment

PSS will be graded based on participation/contribution. No paper submissions will be required. Each session will be given a grade 0 or 1 (adding to maximal 15 points in total for 15 studios).

### Software:

While you are welcome to use any pertinent software you like, such as Python or R, we will use MATLAB during PSS sessions. Installation of software or online use of MATLAB will be necessary throughout the semester for specific computational exercises. There are 3 ways to access Matlab. 1) For laptop downloads, please refer to the Georgia Tech MATLAB Portal for installation. 2) You may use VLab, or 3) you can use your browser by logging onto your MathWorks account at <https://matlab.mathworks.com/> for the online version. The library offers emergency computer loans that can be used temporarily (<https://library.gatech.edu/gadgets>).

### Course Schedule

Week	Date	Class	Topic	Assignment
1	5/19	Review	Linear Algebra, Calculus	
	5/20	Lecture	Biological Systems and Modeling	Chapter 1 and 2
	5/21	Review	MATLAB	
2	5/26	PSS1	Components of models	Chapter 2
	5/27	Lecture	Static Network Models	Chapter 3
	5/28	PSS2	Static Network Models	Chapter 3, <b>HW1 released</b>

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3	6/02	PSS3	Static Network Models	Chapter 3
	6/03	Lecture	Discrete Models	Chapter 4 (pp. 83-93)
	6/04	PSS4	Discrete Models	Chapter 4 (pp. 83-93)
				<b>HW2 released</b>
				HW1 due
4	6/09	PSS5	Discrete Models	Chapter 4 (pp. 83-93)
	6/10	Lecture	Continuous Models	Chapter 4 (pp. 93-110)
	6/11	PSS6	Continuous Models	Chapter 4 (pp. 93-110)
				HW2 due
5	6/16	Exam 1	Chapter 1, 2, 3 and 4 (pp. 1-110)	
	6/17	Lecture	Analysis of Biological Systems	Chapter 4 (pp. 110-128)
	6/18	PSS7	Analysis of Biological Systems	Chapter 4 (pp. 110-128), <b>HW3 released</b>
6	6/23	PSS8	Analysis of Biological Systems	Chapter 4 (pp. 110-128)
	6/24	Lecture	Parameter Estimation	Chapter 5
	6/25	PSS9	Parameter Estimation	<b>HW4 released</b>
				HW3 due
7	6/30	PSS10	Parameter Estimation	Chapter 5
	7/01	Lecture	Metabolic systems	Chapter 8
	7/02	Holiday	No class	
				HW4 due
8	7/07	PSS11	Metabolic systems	Chapter 8
	7/08	Lecture	Signaling Networks	Chapter 9
	7/09	Exam 2	Chapter 4 (pp. 107-118) and 5	<b>HW5 released</b>
9	7/14	PSS12	Signaling Networks	Chapter 9
	7/15	Lecture	Population Dynamics	Chapter 10
	7/16	PSS13	Population Dynamics	<b>HW6 released</b>
				HW5 due
10	7/21	PSS14	Population Dynamics	Chapter 10
	7/22	Lecture	Personalized Med. and Drug Dev.	Chapter 13
	7/23	PSS15	Personalized Med. and Drug Dev.	Chapter 13,
				HW6 due
11	7/28	Review	Course Review	Chapter 1-5, 8-10, and 13
	7/29		Reading Period	
	7/30		Reading Period	
12	TBA	Final Exam	Chapters 1-5, 8-10, and 13	
	8/10		Grade submission due	

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### Honor Code:

Students are expected to abide by the GT Honor Code ([www.honor.gatech.edu](http://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 will 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.
- Making untrue claims/statements (of any sort) to the instructors regarding use of electronic resources (Canvas submission, PLAS/Matlab, your personal laptop crashing, etc.).
- Illegally copying, sharing, or downloading the textbook.
- Misrepresenting attendance in class through signing in when not present or facilitating another student signing in who is not present.

*For any questions involving these or any other Academic Honor Code issues, please consult your instructor or visit [www.honor.gatech.edu](http://www.honor.gatech.edu).*