

Department of Mathematical and Statistical Sciences
College of Science
Clemson University

MATH 4500-001, Mathematical Modeling

Spring 2022
TR 11:00–12:15am
Martin Hall M-301

“This is the plan, up until it is no longer the plan.”
–Anonymous university administrator (not at CU)

Instructor: Matthew Macauley, Martin Hall O-325, macaule@clemson.edu, 656-1838 (no voicemail)

Course website: We will rarely use Canvas. All of the course material will be made freely available on the course website:

http://www.math.clemson.edu/~macaule/classes/s22_math4120/

Course Description: This class will be an introduction to mathematical modeling with a particular focus on mathematical biology. We will sample from a variety of problems and modeling techniques throughout the class. Unlike most undergraduate math classes, the scope of this class will be more “breadth” rather than “depth”.

The course will be roughly divided into thirds: The first third will cover continuous models such as differential equations and difference equations, covering topics such as logistic, predator-prey, and infectious disease modeling. The second third will cover discrete models such as cellular automata, agent-based models, and Boolean models of gene networks. The last third will cover stochastic models, such as phylogenetics, RNA folding, and hidden Markov models in genomics.

Prerequisite: *Officially:* Math 3020 (statistics for science and engineering), Math 3600 (intermediate mathematical computing), and Math 4400 (linear programming). *Unofficially:* Neither 3020, 3600, nor 4400 are necessary, but Math 2080 (differential equations) and Math 3110 (linear algebra) are recommended.

Modality: This is an in-person class, but there is considerable uncertainty due to COVID, especially the omicron variant. We all must be prepared to shift to an online modality with little notice, and I will email a Zoom link that will be used if this happens. Though I plan to follow whatever the current university modality policy is, there is a strong chance that on at least one day, I will be sick (nearly impossible to avoid with a toddler at home), traveling due to a conference, or we will have a weather event like a hurricane, tornado, or snowstorm. If this happens, we will have class online (could be either synchronous or asynchronous), rather than it being canceled or taught by a substitute, and I will provide details ahead of time.

Communication Strategy: I prefer to communicate via emails rather than Canvas messages.

All of my email addresses (e.g., macaule@clemson.edu) go to the same gmail inbox, which I check multiple times a day. Though I have the gmail iPhone app, I don’t get email push notifications. Also, I usually don’t check email on Saturdays.

I will typically be in my office at least MWF, from roughly 8:00am–4:30pm. If you need to reach me immediately during the week, feel free to call my office phone, at (864) 656-1838. If I'm not there, please send an email rather than leaving a voicemail.

If you send me an email and do not get a reply by the time you go to bed, please re-send it, as that is my mistake. Just click "Reply" and "Send"; no need to explain.

Happy Hour: It has been my experience that evening Zoom office hours are much more frequently attended than (pre-COVID) on-campus office hours ever were. As such, three days a week at 7pm (days TBD), you are invited to join me and your classmates on Zoom for an Adult Beverage¹, company, and office hours. I'll stick around to answer questions as long as there are some. However, *I will only show up if at least one person RSVPs, either in class or by sending me an email before 6:30pm, saying they will attend.* If no one is there by 7:05pm, I will log off.

I am also available to meet by appointment, if desired, either over Zoom or in person. To make an appointment, email me and include block(s) of time in which you are available. Please let me know in advance if you want any Zoom meeting to be private, like if you want to discuss your grade. In that case, I will use a different Zoom meeting or a breakout room.

Textbooks: You do not have to buy a book for this class. I will draw from a number of resources. Both "required textbooks" are freely available online, with a ScienceDirect subscription (which Clemson has): (i) *Mathematical Concepts and Methods in Modern Biology : Using Modern Discrete Models*, edited by Raina Robeva and Terrell Hodge, and (ii) *Algebraic and Discrete Mathematical Methods for Modern Biology*, edited by Raina Robeva.

A complete set of my lectures note and/or slides will be posted on the course webpage.

Useful websites:

Course webpage: http://www.math.clemson.edu/~macaule/classes/s22_math4500/ (all relevant links posted here)

Canvas: <https://www.clemson.edu/canvas/> (will be used very sparingly, if at all)

Homework: There will be approximately weekly homework assignments that will be due in class. Late homeworks will not be accepted, but I will drop everybody's lowest homework score. This policy is intended to be an alternative to giving extensions due to unexpected circumstances such as an illness.

Working together is encouraged, but everyone must do their own work, and *collaborators must be cited*. Outside sources, such as webpages, must also be cited as well, if they were instrumental to a solution. You should keep all the graded homeworks in case of missing grades due to missing name or typo errors.

Any assignment that is typeset using L^AT_EX will get an automatic 24-hour extension (okay to hand-draw pictures, though).

Exams: There will be 2 in-class midterm exams. All exams will be closed notes and closed book.

¹For me, this means drinks like **LaCroix** or **Kombucha**, which are *very unpopular* among kids.

Project: Since Math 4500 is one of our capstone classes, it has a required final project as a component, including both a written report and oral presentation. We will spend the last week of class and the final exam block on presentations. Students must be prepared to present as early as Tues., April 26, though some will not get to present until Wed. May 4.

The *Mathematical Contest in Modeling* is an annual grueling 96-hour competition open to undergraduate teams of 2–3 individuals. Each year, thousands of teams enter this competition. I participated as a student myself, back in 2003. Any Math 4500 student who participates in and completes this contest will be exempted from the written component of their final project. They will also be exempted from that week’s homework. In two previous years, a Math 4500 team was awarded a distinction of *Honorable Mention* in this contest.

Attendance: Please make an effort to attend all classes if you are healthy, and to be on time. I will try to show up at least 5 minutes early to all classes. In the unlikely scenario that I am absent 5 minutes after class has started, check your email. If you have not heard from me 10 minutes after class has begun, you may assume that class has been canceled.

If you cannot make class, due to illness, quarantine, or some other reason, please let me know as a courtesy.

Technology in class: One particular study on multitasking showed that students on laptops score 11% lower than those not on laptops. Moreover, students who were not on laptops but had a laptop in their “line of sight” scored *17% lower!* Therefore, the use of laptops and cellphones in class will not be allowed. Tablets may be used *only* for taking notes.

Exams: There will be two 50-minute midterm exams during the semester. If these are given in person (the default plan), then students must provide their own blank paper.

If any exams are taken online, then I will proctor them over Zoom. You must provide consent to having the meeting recorded.

Exam rules (if online):

- Before beginning the exam, you must do a “room scan” with your camera, and also verify that all of the paper you brought is indeed blank.
- You must share your video for the entire duration of the exam.
- The camera must be far enough away so I can see your hands and paper at all times. That is, I must be able to verify that you are not using a phone or computer.
- When you are finished, send me a private Zoom Chat to let me know, and then scan and email your exam to me while still on camera. It must be scanned in one multi-page pdf document, and *not* multiple individual one-page documents.

Before *and* after submitting, double-check to make sure that the scanned file is (i) fully legible, (ii) complete (iii) the correct file, and (iv) correctly oriented (not upside down or rotated).

It is strongly recommended that you practice with your smartphone scanning app *before* the exam.

Grading: Your final grade will be computed as follows:

Homework	25%
Quizzes	10%
Midterm 1	20%
Midterm 2	20%
Final project	25%

I do not impose arbitrary numeric cutoff lines for final grades, e.g., A=90+, B=80–89, etc. Rather, I grade by natural “clusters.” I tend to give difficult assignments and exams, and so the letter grades end up corresponding to lower numeric averages than they do in most classes.

Student Learning Outcomes: Upon successful completion of the course, students will be able to

Explain the process and goals of mathematical modeling.

Construct simple models of real life scenarios and perform computer simulations using MATLAB and/or Sage.

Understand the simplifying assumptions accompanying a particular model.

Test a model against a given data set and draw conclusions on the quality of the model.

Model the *lactose operon* regulatory network using both continuous (differential equations) and discrete methods (Boolean networks), and understand the strengths and weaknesses of each.

Calculate phylogenetic distances.

Key Dates

Jan 13 (Thu)	First day of classes
Jan 19 (Tue)	Last day to register or add a class
Mar 18 (Fri)	Last day to drop a class or withdraw from the University w/o final grades
Mar 21–25 (W–F)	Spring break
Apr 29 (Fri)	Last day of class
May 4 (Wed)	Final Exam period, 3–5:30pm

“No exceptions”: In any class syllabus, no matter how they are worded, policies and phrases like “no exceptions”, “no make-ups”, etc. are *never* actually what they sound, and this is especially true this semester. Things happen, from natural distasters (hurricanes, tornados), to human disasters (9/11, school shootings), to personal and family tragedies, to health emergencies (COVID, auto accidents, hospitalizations). This does not mean that any exception or extension will be granted, but I will do my best to be reasonable, fair, and accommodating.

Make-Up Policy: I will drop your lowest midterm, which means that if you miss a midterm, then your final exam grade will replace it. The homework deadlines will not be extended for individual students, and assigned homework must be turned in by the deadline. **PLAN AHEAD:** If you submit assignments minutes before the deadline, you take the risk of bad luck, e.g., a power outage, computer freeze or crash, personal emergency, zombie attack, etc., that could make you miss the deadline.

By default, any exam that was scheduled at the time of a class cancellation due to power outage / inclement weather will be given at the next class meeting. Any extension or postponement of assignments or exams must be granted by me via email or Canvas within 24 hours of the weather-related cancellation.

Mental health: Your mental health is important to me, and I am always available to talk. Please don't hesitate to reach out. We're in this together, and all of us are struggling in some regards, myself included.

Social media: If you want to connect with me on Social Media, then use LinkedIn or Twitter. I don't really use the first one, though I have an account. I use the second one to promote my mathematical materials and current (abstract algebra) book project. I will not accept friend requests on Facebook, there is just too much potential for risk and liability.

Academic Integrity: "As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning'. Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

Special Accommodations: Students with disabilities who need accommodations should make an appointment with Dr. Arlene Stewart, Director of Disability Services, to discuss specific needs within the first week of classes. Students should present a Faculty Accommodation Letter from Student Disability Services when they meet with instructors. Student Disability Services is located in Suite 239 Academic Success Building (656-6848; sds-1@clemson.edu). Please be aware that accommodations are not retroactive and new Faculty Accommodation Letters must be presented each semester.

Title IX Policy: Clemson University is committed to a policy of equal opportunity for all persons and does not discriminate on the basis of race, color, religion, sex, sexual orientation, gender, pregnancy, national origin, age, disability, veterans status, genetic information or protected activity (e.g., opposition to prohibited discrimination or participation in any complaint process, etc.) in employment, educational programs and activities, admissions and financial aid. This includes a prohibition against sexual harassment and sexual violence as mandated by Title IX of the Education Amendments of 1972.

The University is committed to combatting sexual discrimination including sexual harassment and sexual violence. As a result, you should know that University faculty and staff members who work directly with students are required to report any instances of sexual harassment and sexual violence, to the University's Title IX Coordinator. What this means is that as your professor, I am required to report any incidents of sexual harassment, sexual violence or misconduct, stalking, domestic and/or relationship violence that are directly reported to me, or of which I am somehow made aware.

There are two important exceptions to this requirement about which you should be aware:

Confidential Resources and facilitators of sexual awareness programs such as "Take Back the Night and Aspire to be Well" when acting in those capacities, are not required to report incidents of sexual discrimination.

Another important exception to the reporting requirement exists for academic work. Disclosures about sexual harassment, sexual violence, stalking, domestic and/or relationship violence that are shared as part of an academic project, a research project, classroom discussion, or course assignment, are not required to be disclosed to the University's Title IX Coordinator.

This policy is at <http://www.clemson.edu/campus-life/campus-services/access/title-ix/>. Alesia Smith is the Executive Director for Equity Compliance and the Title IX Coordinator. Her office is at 223 Holtzendorff Hall, phone number is 864.656.3181, and email address is alesias@clemson.edu.

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