MATH 231
Introduction to Mathematical Modeling

Professor:
Dr. Joanna Bieri
joanna_bieri@redlands.edu

Class:
Fall 2023
T,Th 2:40 - 3:55 am - Duke 206

Office Hours:
Lab: Wednesday 6-8pm Duke 206
Make an appointment - see website

About This Course

This course is an introduction to mathematical modeling. In this course we will deal with discrete systems. This course is intended to introduce you to the art of mathematical modeling. The main goal of this course is for you to become good at modeling the real world using mathematics, and to have some fun along the way!

Our course website can be found at:
MathematicalModeling.JoannaBieri.com

Course Learning Objectives

By the end of this course you should have the ability to:

1. What it means to build a model.
2. How every model is based on assumptions.
3. How available information dictates the structure of the model.
4. How to test and refine a model.
5. How to use a model to obtain qualitative and quantitative results.
6. How to analyze the sensitivity of your model.
7. What the limitations of a model are.

In addition I hope this course helps you

1. Improve your ability to organize information and form solutions strategies.
2. Improve your ability to think logically and analytically.
3. Learn how to work effectively in teams to form mathematical models.
4. Improve your ability to communicate your scientific findings to others, specifically those who will be using your models.
5. Learn how to use computer packages in your mathematical modeling.

Required Texts

The course follows the basic structure of the book, however you can be successful in this course without purchasing the book. It is a great reference for anyone who wants to do future mathematical modeling and is helpful for the student seeking more depth in their learning.

- A Course in Mathematical Modeling, by Douglas Mooney and Randal Swift.
  (Also please come by my office to check out my mini-library of math modeling books.)
- Other texts and articles made available via our course website.

Classwork

Consistent attendance and participation are crucial to your success in the class. Please read the following carefully:

i. **Individual Homework, Class Participation, and Preparation**:

Aim to bring a positive and excited attitude to class each day and be prepared to engage in the course material. Individual homework will be assigned in class during the semester. Homework posted on class website, please check this after each class. You are expected to come to class prepared and to participate actively in class. It is important to be a good member of the math modeling community.

ii. **Group Projects**:

Group projects will be assigned in class. Groups will consist of 2-3 students, assigned randomly and likely changed for each project. Some class time will be available for starting the projects, but a majority of the work must be done outside of class. Group projects will consist of one modeling problem. The modeling problem must be solved and typed up carefully, including information about the problem, the modeling assumptions, the full solutions and conclusion. Each member of the group is expected to contribute equally to the solution, and each student is expected to complete the online self assessment of his/her contribution and learning on the project. If you miss class on a day that a project is assigned or group work is carried out, points will be subtracted from your grade on the project. See class website for posted project information.

iii. **Final Modeling Project**:

Each student will work individually on a final project. The topic is to be chosen by the student. It is strongly recommended that you consult with a faculty member in your primary area of interest when deciding on a project topic. The goal of the final project is to take a problem, that you are interested in, and model it mathematically. You are expected to research your problem, find sources for data and background, clearly state your assumptions and describe your model, draw conclusions from your model, discuss the appropriateness of your model, and present your results in a professional way. We will have a scientific poster session where you will present your final project in the last week of class and your written report is due Tuesday December 10th at 5pm. (The final project takes the place of the final exam.) See class website for rubric, examples of past work, and more information.

Evaluation Procedures

There are seven elements of the course which contribute to your overall grade, as follows:

Participation and Individual Homework		25 %
Group Project 1	9 %	
Group Project 2	9 %	
Group Project 3	9 %	
Group Project 4	9 %	
Group Project 5	9 %	
Final Individual Project		30 %

Grading Criteria

All work for the course will be graded according following criteria.

4.0 **Exceptional**: Diligently completes assignments on time, explains ideas fully and clearly, writes assignments in a neat and professional way. Clearly shows a mastery of the material by explaining reasons behind the calculations, assumptions, or model formulation. Clearly connects mathematics and real world models and exceeds the basic expectations for each modeling project. Makes few, if any, errors in basic calculations, can easily spot basic errors, and has a strong interest in expanding foundational skills.

3.0 **Very Good**: Diligently completes assignments on time, usually explains ideas fully and clearly, writes assignments in a neat and professional way. Shows an understanding of the material by explaining reasons behind each calculation, assumption or model formulation, although some explanations may be unclear or calculations hard to follow. Is working toward connecting mathematics and real world models and makes some effort toward going beyond basic expectations for each modeling project. Sometimes makes small errors in basic calculations, occasionally has a hard time seeing where errors are, exhibits an interest in improving foundational skills.

2.0 **Acceptable**: Usually completes assignments on time, only occasionally explains ideas fully, often skips steps or arguments, writes assignments fairly neatly but does not show all steps, and has work that is hard to follow. Can explain reasons behind calculations, assumptions, or model formulation when following the textbook or notes, but some explanations are unclear and calculations hard to follow. Meets all the basic expectations within the class but has trouble connecting mathematics and real world models. Makes many small errors in basic calculations, has a hard time seeing where errors are, and has an apathetic attitude toward improving foundational skills.

1.0 **Unacceptable**: Does not complete assignments on time, rarely explains ideas fully, writes assignments messily, and skips many steps making the calculations hard to follow. Cannot explain reasons behind calculations, assumptions, and model formulation, has few to no explanations and calculations that are extremely hard to follow. Hands in homework unfinished, not meeting all basic expectations within the class, does not connect mathematics and real world models. Makes many errors in basic calculations, refuses to seek out errors when they happen, and has a negative attitude toward improving foundational skills.

Grading Scales:

4.0	95-100%
3.7	90-94%
3.3	87-89%
3.0	83-86%
2.7	80-82%
2.3	77-79%
2.0	73-76%
1.7	70-72%
1.3	67-69%
1.0	63-66%
0.7	60-62%

***Please note**: According to the University Course Catalog (p. 13) 3.7 and 4.0 are reserved for "outstanding" work; 3.3 and 3.0 are both defined as "excellent," not mediocre.*

Course Policies

Communication

- The most reliable way to reach me is by email. Please note that my normal working hours are 9 a.m. to 5 p.m., Monday to Friday. I do not respond to emails after 5 p.m. or on weekends, except in an emergency.
- I try to check my chat on teams multiple times a day during my work hours. This is a good place to have a quick chat or even set up a quick video meeting.
- You can make appointments with me on Calendly, check out the course website for a link. Appointments can happen in Duke 209 or on Teams.
- It is important that you communicate throughout the semester. Let me know if there are ways I can improve your learning in the class. If you are going to miss class or need an extension on the homework, the earlier you tell me the better!

COVID-19 Health Protocols

- In an effort to keep the classroom community safe and healthy, please follow the guidelines outlined here:
  - Wearing a mask is voluntary.
  - Do not come to class if you feel ill or have been exposed to someone who is ill.
- In any case of the above, e-mail me directly to reconcile any class work and/or attendance issues. Please contact me if you have any concerns as to your health needs and goals for the semester.

University Policies

Academic Honesty

The University of Redlands enforces strict standards as regards academic honesty, and students may be dismissed for breaches of these standards. To learn these standards, please look at the relevant section of the University Course Catalog, "Academic Honesty ". See in particular Section III, Paragraph B, which states that it is an offense to offer "as one's own work the words, ideas, or arguments of another person without appropriate attribution by quotation, reference, or footnote."
In light of this, please note that:

- intentional plagiarism—i.e. piecemeal or wholesale appropriation of text from one or more printed or internet source—will result in a fail grade for the course.
- plagiarism by default—i.e. uncredited adoption of ideas from source texts due to carelessness in citation—will result in a fail grade for the project.

Artificial Intelligence: There is no tolerance for the use of generative artificial intelligence in place of individual work and thinking in this course. All work is to be considered a student's own. Any violation of that will result in a failing grade for the work.

If you are still in any doubt about what constitutes plagiarism, please ask me before you undertake any written work. If you do not ask, I shall not accept a plea of ignorance after the fact.

Office of Equity and Title IX

In order to provide a safe and equitable learning environment for all students, faculty, and staff, discrimination, harassment, retaliation, sexual misconduct, and sexual harassment (including sexual assault, dating or domestic violence, and stalking) are not tolerated at the University of Redlands. The University prohibits unlawful discrimination or harassment (as defined in the Policy Prohibiting Discrimination, Harassment, Sexual Misconduct, and Retaliation on the basis of age, color, race, ethnicity, national origin, ancestry, sex, marital status, pregnancy, status as a complaining party of domestic violence, sexual orientation, gender, gender identity or expression, physical or mental disability, genetic information, religion/creed, citizenship status (except to comply with legal requirements for employment), military/veteran status, or any other characteristic protected by law. If you or someone you know has experienced or experiences any of these behaviors, know that you are not alone. You can contact the Office of Equity and Title IX for reporting options, supportive measures, and resources to support you.

All faculty and staff at the University of Redlands are considered "Responsible Employees," which means that if you tell me about a situation involving any of the above, I must report the matter to the Office of Equity and Title IX. Although I make that report, you are in control of how you would like to proceed, including whether, or not, you wish to pursue a formal complaint. Our goal is to make sure you are aware of the range of reporting options available to you and have access to the support and resources you need. To report an incident, you can:

- Contact the Director of Equity & Title IX, Corinne Vorenkamp, at titleix@redlands.edu or 909-748-8916
- Report online.

You can also report to local law enforcement at (909) 798-7681, ext. 1. If you are ever in immediate danger, please call 911 or email/text 911@redlandspolice.org if you cannot call.

If you wish to speak to someone confidentially (meaning not connecting with the Office of Equity and Title IX Office), you can contact the following

resources:

- Campus: Counseling Service: 909-748-8108 or 24-Hour Crisis Line: 909-748-8960 or Chaplain's Office: 909-748-8368
- Community: Partners Against Violence, 24-hour sexual assault crisis line: 909-885-8884
- Option House. 24-hour dating/domestic violence crisis line: 909-381-3471
- Online chat: https://www.loveisrespect.org/

For more information, please visit: www.redlands.edu/titleixandequity.

Disabilities and Accommodations

If you are a student with a disability that qualifies for academic accommodations under the Americans with Disabilities Act and Section 504 of the Rehabilitation Act, contact Academic Success and Accessibility (ASA). ASA is located on the ground floor of the Armacost Library, down the hall from the Jones Computer Center (past the restrooms). You can reach the office at 909-748-8069 or asa@redlands.edu.

Please let me know by the end of the second session at the latest if you have a learning or physical disability which will require accommodation.

Counseling Center

The Counseling Center provides free and confidential short-term mental health services, including individual therapy, group therapy, single session therapy, consultations, and urgent appointments to all students with in-person or virtual options. Our Counseling Center is committed to inclusivity and to providing a supportive space for everyone. Please call 909-748-8108 to schedule an appointment. If a student is in crisis, please call 909-748-8960 for the 24/7 mental health crisis line. For more information, see:

https://www.redlands.edu/student-affairs/health-and-psychological-services/counseling-center/

Another option for individual therapy for all students is TimelyCare which provides virtual therapy immediately (Talk Now) or up to 12 scheduled virtual therapy sessions per year. Students can choose their therapist from a list of providers for the scheduled therapy option.

Conflict Resolution Center

Experiencing a conflict? Whether it's with a friend, roommate, another member of a student organization, or faculty or staff member, conflicts happen. Learning to navigate conflicts is important to success in virtually any field, and a vital step in being a part of a community and having healthy, meaningful relationships with others. See https://sites.redlands.edu/conflict-resolution-center/student-resources/ for more information.

The Care Team

The University CARE Team exists to help provide support and resources to students that are overwhelmed, experiencing significant distress, or possibly present some risk to themselves or others. As a faculty member, I may reach out to students about whom I am concerned to talk individually, and/or refer them to the CARE Team. If you have concerns about a fellow student, consider sharing your concern with the CARE Team via their online form. This is part of who we are as a caring, proactive community where we all look out for one another. Additionally, if you feel that you or someone else needs immediate mental health support, the University has a 24/7 mental health crisis line at 909-748-8960, and the Timely Care app, which offers on-demand emotional care. Both services connect to a live, licensed counselor.

Aditional Resources

If you are in need of additional resources, please refer to the available programs below.

Book Lending Program

The Book Lending Program is an initiative to ensure the academic success of First-Generation students (students who are the first to go to college in their families who meet a particular estimated family contribution [EFC] level). Funded through alumni donations, this program provides books and other classroom materials, when needed, for First-Generation students who could not otherwise afford to purchase them. Books are returned at the end of the course, to be used by other First-Generation students the next semester. The program works alongside the Library and faculty members to ensure the availability of books and classroom materials. For more information, click the link above or contact blp@redlands.edu.

Emergence Student Loans

Student Financial Services (SFS) administers a short-term, no-interest loan fund to assist students experiencing an emergency or cash-flow problem. Except in unusual circumstances, these loans do not exceed $200 and are billed to the student's account. Evidence of repayment ability is a prerequisite for all short-term loans made to students. Students are not eligible for more than one emergency student loan per term. Contact: SFS@redlands.edu or x8047

ASUR Student Emergency Fund

The Student Emergency Fund was established by the Associated Students of the University of Redlands (ASUR), funds are available to students who are unable to meet immediate, essential expenses due to temporary hardship related to an unforeseen or emergency situation. Our goal is to provide flexible assistance in a timely manner to help students continue successfully in school. The distribution of funds is agreed upon by committee comprised of

representation from Student Affairs, ASUR Cabinet, and Student Financial Services. Awards are not considered loans and do not require repayment. Some funds may be considered income and are therefore subject to federal taxes. The average award ranges between $25 and $400. Students may only be awarded assistance from the ASUR Student Emergency Fund once during their undergraduate career at the University of Redlands. Go to ASUR Emergency Fund App | Presence.

Student Affairs Discretionary Fund

These endowed funds in Student Affairs can be used to support student success and remove impediments that otherwise may cause the student to stop or leave school. To utilize this fund, divisional leadership should be made aware of the student in dire need of financial support. This support can be anything from personal expenses, such as utility bills, gas money, emergency trips home due to family tragedy, off-campus counseling, and other medical costs, and occasionally mental health assessment expenses. Students receive grants based on their financial need. Contact: student_affairs@redlands.edu.

Student Food Support Pantry

The Student Food Support Pantry is a resource available to all established full and part-time University of Redlands students facing food insecurities. The Pantry is located on the north side of North Hall. This space is an open, no-questions-asked space with dried and canned goods, and non-perishable items, as well as seasonal fresh produce from our sustainable farm and limited refrigerated goods. Food for this distribution is provided in partnership with Feeding America Riverside and San Bernardino. It is also funded through private donations, ASUR, and the Office of Community Service Learning. For more information, please contact SURF@redlands.edu.

Course Schedule

The Course Schedule is provided below. The schedule is subject to change as we encounter new challenges and progress through the semester. You will be notified of any changes in class and the most recent schedule is posted on the class website.

Course Schedule

	Day	Date	Topic	Due	Notes
Week 1	T	Sep 03	Project 1		Project 1 Assigned
	W	Sep 04	LAB - P1		
	TH	Sep 05	Discrete Dynamical Systems		
Week 2	T	Sep 10	Discrete Dynamical Systems		
	W	Sep 11	LAB - P1		
	TH	Sep 12	Population Models	Project 1 DUE	Project 2 Assigned
Week 3	T	Sep 17	Closed Form Solution		
	W	Sep 18	Lab - P2		
	TH	Sep 19	Fixed Points and Stability		Work on Final Project Proposals
Week 4	T	Sep 24	Logistic Equation	Project Proposals DUE	
	W	Sep 25	Lab - P2		
	TH	Sep 26	Systems with two equations	Project 2 DUE	Project 3 Assigned
Week 5	T	Oct 01	Lotka Voltera		
	W	Oct 02	Lab - P3		
	TH	Oct 03	Start Stochastics		
Week 6	T	Oct 08	FALL BREAK		
	W	Oct 09	Lab - P3		
	TH	Oct 10	Stochastic Squirrels	Project 3 DUE	Work on Final Project Assumptions
Week 7	T	Oct 15	Monte Carlo Simulations		Project 4 Assigned
	W	Oct 16	Lab - P4		
	TH	Oct 17	Introduce Stochastic Modeling	Final Project Update & Assumptions DUE	

Week 8	T	Oct 22	Spreadsheet Analysis		
	W	Oct 23	Lab - P4		
	TH	Oct 24	Validity Testing		
Week 9	T	Oct 29	Introduction to Matlab		
	W	Oct 30	LAB - P4		
	TH	Oct 31	Stages, States, and Classes	Project 4 DUE	Sign up for Final Project Check In
Week 10	T	Nov 05	Age Class Models		Project 5 Assigned
	W	Nov 06	LAB - P5		
	TH	Nov 07	Age Class Models		
Week 11	T	Nov 12	Markov Models		
	W	Nov 13	OPEN LAB		
	TH	Nov 14	Final Project Info		Project 5 DUE
Week 12	T	Nov 19	FINAL PROJECT CHECK IN		
	W	Nov 20	OPEN LAB		
	TH	Nov 21	FINAL PROJECT CHECK IN		
Week 13	T	Nov 26	Thanksgiving Break		
	W	Nov 27	Thanksgiving Break		
	TH	Nov 28	Thanksgiving Break		
Week 14	T	Dec 03	POSTER SESSION		
	W	Dec 04	OPEN LAB		
	TH	Dec 05	No Class - Work on Final Projects		
FINALS	T	Dec 10		FINAL PROJECTS DUE 5pm	