SYLLABUS Spring 2023
The University of Iowa
The College of Liberal Arts and Sciences
Department of Mathematics
Mathematical Biology II, MATH:5760:0AAA
Time and Location: MWF 12:30-1:20 PM, 105 MLH

Prerequisites: None.
Corequisites: MATH:5600 and MATH:5700, if not taken as prerequisites.

Some of the policies relating to this course (such as the drop deadline) are governed by its administrative home, the College of Liberal Arts and Sciences, 120 Schaeffer Hall.

Instructors:
This course is divided into 3 modules (each module for five weeks). Each module is lectured by a different instructor. The instructions related to each module (topics, assignments, exam(s)) are described below in detail.

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<th>Module 4</th>
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<tr>
<td><strong>instructors</strong></td>
<td>Zahra Aminzare</td>
<td>Bruce Ayati</td>
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<tr>
<td><strong>Office location</strong></td>
<td>B1H MLH</td>
<td>25G MLH</td>
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<tr>
<td><strong>Office hours</strong></td>
<td>MW 10:30 AM – 12:00 PM or by appointment all in person</td>
<td>MWF 1:30-2:30 PM or by appointment</td>
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<tr>
<td><strong>E-mails</strong></td>
<td><a href="mailto:zahra-aminzare@uiowa.edu">zahra-aminzare@uiowa.edu</a></td>
<td><a href="mailto:bruce-ayati@uiowa.edu">bruce-ayati@uiowa.edu</a></td>
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TA: Ethan Rook: ethan-rooke@uiowa.edu
Discussion: MATH:5760:0A01 (Thursday 3:30 PM – 4:20 PM, 71 SH)

Supervisor: For this course, see the DEO.

DEO Contact Information: Professor Ryan Kinser, 14 MLH, ryan-kinser@uiowa.edu

Catalog Description of Course: This course describes a number of topics in mathematical biology and covers canonical mathematical modeling and analysis of problems in the biological sciences. This is the second of a two-semester sequence.

Objectives and Goals of the Course: Students are expected to be able to identify, build, and (theoretically and/or numerically) solve models associated with pattern formation in biological systems and models for biomechanics of growth. They are also expected to be able to perform basic machine learning analysis of biological data.

Grading: Homework in all 3 modules (25%), Exam 1 in Module 4 (25%), Exam 2 in Module 5 (25%), Exam 3 in Module 6 (25%). This course uses the plus/minus grading system.

See below for information regarding Required text/Material to be covered/Tentative Timetable/Exams.
MODULE 4 (weeks 1-5)

Pattern Formation in Biological Systems

Student Collaboration: Student collaboration is permitted on Homework only (however you must typeset and submit your solutions yourself). It is NOT permitted for the exam. Any attempt to collaborate during the exam will result in a 0 score on that test.

Exam 1: Monday Feb 20, 2022, 6:30 PM – 8:00 PM (room TBD)

Description: Pattern formation has been observed in biology in a diversity of forms: animal coat patterns (zebra's stripes; leopard's spots), organized cell growth, visual hallucinations patterns, traveling waves of activity across brain tissues, and so on. Possible mechanisms of pattern formation in biological systems include classical reaction-diffusion models as well as integro-differential equations (when long range diffusion and non-local effects need to be considered). In this module we will investigate spatiotemporal properties of solutions of several models in biology, in particular traveling fronts, traveling pulses, and standing waves. These have direct applicability to the study of neuronal firing in brain networks and to embryonic cell morphogenesis.

Required text: (Both references will be made available in pdf format in ICON.)

Material to Be Covered & Tentative Timetable:
- **Week 1**: Reaction diffusion in biological systems/modeling using partial differential equations (sec. 11.1 - 11.4 in Ref. #1)
- **Weeks 2-3**: Pattern formation in biological systems (sec. 13.1; sec. 13.2 in Ref.#1 & sec. 1.5 in Ref.#2; sec. 13.5 in Ref.#1 and sec. 1.6 in Ref.#2)
- **Weeks 4-5**: Neural models of pattern formation (sec. 11.5 in Ref.#1; sec. 12.1 in Ref.#2)

Course Policies for Module 4:
- Students are expected to attend all lectures, do the homework, and take the exam. Students are responsible for everything covered in the lectures, textbook, and the prerequisites. Important announcements about changes (if necessary) to the syllabus, homework, exam, etc. will be done in the lectures or they will be e-mailed to your UI e-mail address.
- University regulations require that students be allowed to make up examinations which have been missed due to illness or other unavoidable circumstances. Students with mandatory religious obligations or UI authorized activities must discuss their absences with me as soon as possible. Religious obligations must be communicated within the first three weeks of classes.

MODULE 5 (weeks 6-10)

Student Collaboration: Student collaboration is permitted on Homework only, however you must typeset and submit your solutions yourself. Student collaboration is NOT permitted for the exam. Any attempt to collaborate during the exam will result in a 0 score on that test.

Exam 2: Monday April 3, 2022 (6:30 PM – 8:30 PM, timed take-home via ICON)
Description: This module will extend instruction on PDE-based models in biology to include models for biological growth. This is a topic that spans many disciplines, including biophysics and bioengineering. We will take a more mathematically based approach that aims to complement approaches in other disciplines. The course will build the theory by specializing the full model to one dimension, to two dimensions, and then to the details in three dimensional models.


Material to Be Covered & Tentative Timetable:
The five weeks of Module 5 will correspond to the five sections in the text:
1. In week 1 we will cover the basics and how to learn Jupyter notebooks, Markdown, and other aspects of turning in the homework; the first part of Chapter 11 setting up the full system of equations.
2. In week 2 we will cover Chapters 1-2 from Part I, and 4-6 from Part II, to set up the One-Dimensional Models.
3. In week 3 we will cover Chapter 7-9 from Part III on Two-Dimensional Models.
4. In week 4 we will cover the remainder of Chapters 11 and Chapter 12 from Part IV on Three-Dimensional Models.
5. In week 5 we will review the material, including perhaps the thoughts from Part V of the text, and prepare for the exam. We may need time in week 5 to finish the material from week 4.

Course Policies for Module 5:
- Module 5 will meet in person for lectures and discussions. In-person discussions and activities will occur in your assigned classroom. Your classroom appears on the course schedule and on your personal schedule in MyUI.
- Students are expected to attend all lectures, do the homework, take the exam. Students are responsible for everything covered in the lectures, textbook and the prerequisites. Important announcements about changes (if necessary) to the syllabus, homework, exam, etc. will be done in the lectures or they will be e-mailed to your UI e-mail address.
- University regulations require that students be allowed to make up examinations which have been missed due to illness or other unavoidable circumstances. Students with mandatory religious obligations or UI authorized activities must discuss their absences with me as soon as possible. Religious obligations must be communicated within the first three weeks of classes.

MODULE 6 (weeks 11-15)

Student Collaboration: Student collaboration is permitted on Homework only, however you must typeset and submit your solutions yourself. Any significant collaboration should be acknowledged. You should also cite any sources that you use including online resources. It is NOT permitted for any exam/quiz. Any attempt to collaborate during the exam/quiz will result in a 0 score on that test. The University policies on scholastic dishonesty will be strictly enforced including reporting any misconduct to the college.

Exam 3: Exam 3 will be held during Final exam week. Exam 3 will consist of 3 parts: Python project (which you will work on during the discussion section), presentation, and ICON exam.
**Description:** Students will learn the basics of machine learning and be introduced to python in order to use python to analyze biological data. Benefits and pitfalls of machine learning will also be discussed.

**Required text:** Scikit-learn Machine Learning in Python, available at [https://scikit-learn.org](https://scikit-learn.org)

**Material to Be Covered & Tentative Timetable:**
- Week 1: Introduction to python, data analysis and machine learning (supervised vs unsupervised learning).
- Week 2: The curse of dimensionality, sparsity, PCA, linear regression.
- Week 3: Linear and logistic regression.
- Week 4: Introduction to ridge, lasso, and elastic net regression.
- Week 5: Discussion of results/issues that have arisen in students' analysis of data. Reproducible research, publication bias, data privacy.

**Course Policies for Module 6:**
- You should bring a computer to the discussion section. If you do not have a laptop, you can borrow one from the library. You will.
- Students are expected to attend all lectures, do the homework, take the exam. Students are responsible for everything covered in the lectures, textbook and the prerequisites. Important announcements about changes (if necessary) to the syllabus, homework, exam, etc. will be done in the lectures or they will be e-mailed to your UI e-mail address.
- University regulations require that students be allowed to make up examinations which have been missed due to illness or other unavoidable circumstances. Students with mandatory religious obligations or UI authorized activities must discuss their absences with me as soon as possible. Religious obligations must be communicated within the first three weeks of classes.

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**Date and Time of the Final Exam**
The final examination date and time will be announced by the Registrar generally by the fifth week of classes and it will be announced on the course ICON site once it is known. Do not plan your end of the semester travel plans until the final exam schedule is made public. It is your responsibility to know the date, time, and place of the final exam. According to Registrar's final exam policy, students have a maximum of two weeks after the announced final exam schedule to request a change if an exam conflict exists or if a student has more than two exams in one day (see the policy here).

**Academic Honesty and Misconduct**
All students in CLAS courses are expected to abide by the [CLAS Code of Academic Honesty](https://clas.uiuc.edu/honors CODE-OF-ACADEMIC-HONESTY). Undergraduate academic misconduct must be reported by instructors to CLAS according to these procedures. Graduate academic misconduct must be reported to the Graduate College according to Section F of the [Graduate College Manual](https://gradcol.uiuc.edu/GRAD-COLL-GRADUATE-COLLEGE-MANUAL).

**Student Complaints**
Students with a complaint about a grade or a related matter should first discuss the situation with the instructor and/or the course supervisor (if applicable), and finally with the Director or Chair of the school, department, or program offering the course.
Undergraduate students should contact CLAS Undergraduate Programs for support when the matter is not resolved at the previous level. Graduate students should contact the CLAS Associate Dean for Graduate Education and Outreach and Engagement when additional support is needed.

**Drop Deadline for this Course**
You may drop an individual course before the deadline; after this deadline you will need collegiate approval. You can look up the drop deadline for this course here. When you drop a course, a “W” will appear on your transcript. The mark of “W” is a neutral mark that does not affect your GPA. Directions for adding or dropping a course and other registration changes can be found on the Registrar’s website. Undergraduate students can find policies on dropping and withdrawing here. Graduate students should adhere to the academic deadlines and policies set by the Graduate College.

**University Policies**
- [Accommodations for Students with Disabilities](#)
- [Basic Needs and Support for Students](#)
- [Classroom Expectations](#)
- [Exam Make-up Owing to Absence](#)
- [Free Speech and Expression](#)
- [Mental Health](#)
- [Military Service Obligations](#)
- [Non-discrimination](#)
- [Religious Holy Days](#)
- [Sexual Harassment/Misconduct and Supportive Measures](#)
- [Sharing of Class Recordings](#)