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THE UNIVERSITY OF BRITISH COLUMBIA

FACULTY OF SCIENCE
DEPARTMENT OF MATHEMATICS

2024 Winter Term 2
January - April, 2025
Mathematical Biology (3 credits)
MATH 459/559

The Faculty of Science acknowledges that the land on which we are situated is the unceded territory of the Syilx (Okanagan) People

This course is being delivered as a seminar-discussion course held in-person. Classes will be live-streamed, however, so that any students who are feeling unwell can still join the course virtually. Classes will not be recorded.

Your Instructor

- *Professor Rebecca Tyson*
- *Web: http://cmps-people.ok.ubc.ca/rtyson*
- *Email: rebecca.tyson@ubc.ca, or Canvas Mail. Please put Math459 or Math559 in the subject line*
- *Office Hours: As posted in the Office Hours document. For this class I have an open-door policy, but my availability outside of class and official office hours is limited, so it's best to check with me to see if I will be available.*

Here is a little autobiography I wrote for a newsletter a few years ago. It will tell you a little about my circuitous career path and how I ended up here at UBCO!

Location

FIP 140, with option to attend online if you are sick. The zoom link is posted on Canvas.

Email Correspondence

The best way to contact me is to attend lectures and office hours. I have very limited time available for any other appointments, so please get to know your classmates! I will make sure that the course provides opportunities to do so. I will be on campus, however, all day MWF, so feel free to drop by my office. I'll do my best to make time for you!

You can also reach me by email, but I am virtually never able to answer all of the emails that I receive, and so if I don't reply within a day or two, you can assume that your email is buried in the backlog. You can increase

your chances of getting a reply by making sure that the subject line is informative. If you have special needs or you are struggling at any point in the course, please keep in contact with me so I can offer help and support.

Textbook

The textbooks for the course are freely available as e-books from the UBC library:

- Mathematical Biology by James D. Murray (Springer)
- Essential Mathematical Biology by Nick Britton (Springer)
- Mathematical Models in Biology by Leah Edelstein-Keshet (SIAM)

Course Description (calendar - the more congenial description is below!)

MATH 459 (3) Mathematical Biology Mathematical modelling in biological disciplines such as population dynamics, ecology, pattern formation, tumour growth, immune response, biomechanics, and epidemiology. Theory of such models formulated as difference equations, ordinary differential equations, and partial differential equations. [3-0-0] Prerequisite: MATH 225. MATH 319 is recommended.

MATH 559 (3) Mathematical Biology Mathematical methods in modelling biological processes at levels from cell biochemistry to community ecology. [3-0-0]

Course Format

This course will be offered in a solely synchronous format, with whole class sessions occurring three times per week. Before each class section, everyone will be expected to complete a reading assignment, and the assigned homework problems. Class sessions will be used for discussions of the assigned reading and homework problems, and for term project presentations.

Course Overview, Content and Objectives

In this course we are learning to build and analyse nonlinear partial differential equation models. The focus of the course will be models of ecological systems, but the techniques learned apply broadly across application areas. We learn a wide variety of analytic, graphic, and simplification techniques which elucidate the behaviour of these mathematical models, whether or not a closed-form solution is available. By the end of the class, the students will be able to competently read and follow a research paper presenting and analysing a differential equation model from a wide variety of application areas.

One of the exciting aspects of Math 459/559, is the relevance of this course to understanding models of diseases like COVID-19. We will therefore spend some time learning about disease models, and understanding the mathematical basis of concepts that have been talked about regularly in the media: The reproductive number, flattening the curve, epidemic wave, peak size, and final size. We will also discuss the effect of spatial movement on disease progression in the population.

Broadly, the topics that we cover are applications of ecological applications of travelling waves, disease models, and pattern formation in reaction-diffusion and reaction-diffusion-chemotaxis models.

Learning Outcomes

By the end of this course, students will be able to:

- *Recognise* a wide range of mathematical models in ecology
- *Analyse* such models using a variety of techniques possibly including, but not limited to, linear analysis, phase plane analysis, bifurcation analysis, and simulation analysis
- *Create and interpret* simple models of novel ecological systems
- *Read and understand current literature* in mathematical ecology and other application areas using models similar to those studied in class

Assessment

Assessment will be based on homework assignments, and a term project consisting of an oral presentation, questions asked at other students' presentations, an abstract, and a written report.

Pre-Reading Quizzes: Short pre-reading quizzes are due on the dates listed in the agenda. These are timed open-book quizzes based on reading assignments that prepare you for upcoming lecture material.

Homework Assignments: Homework assignments are due on the dates listed in the agenda. It is fine to discuss the homework problems with classmates, but you must hand in your own work. Assignments are to be handed in on Canvas. For each assignment, please upload a single pdf that is clean and readable.

Term Project: Each student will find a published paper with a model that can be understood using the techniques taught in class. Students will select three potential papers and then, in consultation with the instructor, select the one to be studied. In the oral presentation and written report students will demonstrate their understanding of the model, the assumptions used to build the model, the implications of the results, and how the model is connected to the material learned during the course. Students are also encouraged to identify shortcomings of the model, and to run their own simulations of the model. The mark for the term project is based on the four items below:

- (a) *Oral presentation*: Each student will read and understand the selected paper, and prepare an oral presentation for the class to be delivered sometime during the last 3 1/2 weeks of the course.
- (b) *Questions asked at other students' presentations:* After each presentation, there will be time for questions from the class. Each student is expected to ask at least one question per whole class period.
- (c) *Abstract:* Each student is required to write an abstract for their presentation. These will be assembled and sent out to the entire class in advance of the start of the term project presentations.
- (d) *Written report:* Each student will prepare a written report about the selected paper. For undergraduate students, this report will be 3-4 pages long (including figures!) and for graduate students this report will be 5-7 pages long (also including figures!). You will find the page limits very tight, so this is an exercise in writing efficiently, and identifying the most important components of the paper.

For further details about the Term Project, please see the term project document in the welcome module on Canvas.

Your final course mark will be computed as follows:

Item	Description	Value
Homework	Individual work on assigned homework problems. Due dates	50%

Assignments & Pre-Reading Quizzes	are listed in the agenda. All of the pre-reading quizzes together will count as one homework assignment.	
Term Project, Proposal & Abstract	written	5%
Term Project, Questions	questions asked of other students after their presentations (a student wishing full marks must ask at least one question during each term project presentation class)	5%
Term Project, Presentation	oral presentation (graduate student presentations will be 5 minutes longer than undergraduate student presentations)	20%
Term Project, Report	written report, 3-5 pages for undergraduates, 5-7 pages for graduates (including figures!), includes Turnitin report.	20%

Final grades will be based on the evaluations listed above and the final grade will be assigned according to the standardized grading system outlined in the UBC Okanagan Calendar.

Math 459 vs Math 559 Work
Math 559 students are expected to show a higher level of understanding of the material than Math 459 students. Graduate students will have extra homework problems, deliver longer oral term project presentations, and write longer term project reports. The longer oral and written term project items will allow graduate students to demonstrate an in-depth understanding of the material.

Course Schedule
Please see the course agenda.

Final Examinations:
There is no final exam in this course.

Calculators
A scientific calculator is not required. Students are encouraged to download the student version of Matlab, available through UBC.

Technical Support Resources for Students
The Student Learning Hub's technical support can be found at
https://students.ok.ubc.ca/academic-success/learning-hub/tech-support-for-online-learning/

Aboriginal Programs and services
The primary goal of the Aboriginal Programs and Services is to provide culturally appropriate services and support to First Nation, Metis and Inuit students.

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UNC 212
http://students.ok.ubc.ca/aboriginal/welcome.html

International Program and Services
International Program and services (IPS) provides advising, transition services and programs for international students, and IPS works to foster an intercultural campus community where differences are embraced and respected and adapting is multidirectional.
UNC 227
http://students.ok.ubc.ca/international/welcome.html

Grading Practices
Faculties, departments, and schools reserve the right to scale grades in order to maintain equity among sections and conformity to University, faculty, department, or school norms. Students should therefore note that an unofficial grade given by an instructor might be changed by the faculty, department, or school. Grades are not official until they appear on a student's academic record. For more information, please go to the following web page: http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,41,90,1014.

Academic Integrity
The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

Specific Format for Online Tests: The examinations in this course are all open-book, i.e., you have access to any of the course materials, including your notes, during the exam. It is important to note, however, that you will not have enough time to look up answers and complete the exam. You should therefore prepare for these exams as if you had to do them under supervised conditions, which means that proper studying will be necessary if you wish to succeed.

Activities that are NOT allowed during tests, quizzes, or exams:
Transgression of any of the rules below consitutes cheating. Students who cheat will be given a zero for the test on which cheating occurred, and referred to the Dean's Office for Academic Misconduct.

1. You are NOT allowed to discuss questions and answers with your peers or classmates.
2. You are NOT allowed to be help from tutors of any sort (local or online).
3. You are NOT allowed to use software such as Maple, Matlab, or Wolfram Alpha to do the calculations for you.

A more detailed description of academic integrity, including the University's policies and procedures for dealing with academic misconduct, may be found in the Academic Calendar at http://okanagan.students.ubc.ca/calendar/index.cfm?tree=3,54,111,0.

Cooperation vs. Cheating
Working with others on assignments is a good way to learn the material and we encourage it. However, there are limits to the degree of cooperation that we will permit. Any level of cooperation beyond what is permitted is considered cheating. When working on assignments, working together to find a good approach for solving a problem is cooperation; listening while someone dictates a solution is cheating. Anything that you hand in must be written by you, from scratch, in your own words and mathematical symbols.

Copyright Disclaimer
Diagrams and figures included in lecture presentations adhere to Copyright Guidelines for UBC Faculty, Staff and Students http://copyright.ubc.ca/requirements/copyright-guidelines/ and UBC Fair Dealing Requirements for Faculty and Staff http://copyright.ubc.ca/requirements/fair-dealing/. Some of these figures and images are subject to copyright and will not be posted to Canvas. All material uploaded to Canvas that contain diagrams and figures are used with permission of the publisher; are in the public domain; are licensed by Creative Commons; meet the permitted terms of use of UBC's library license agreements for electronic items; and/or adhere to the UBC Fair Dealing Requirements for Faculty and Staff. Access to the Canvas course site is limited to students currently registered in this course. Under no circumstance are students permitted to provide any other person with means to access this material. Anyone violating these restrictions may be subject to legal action. Permission to electronically record any course materials must be granted by the instructor. Distribution of this material to a third party is forbidden.

Grievances and Complaints Procedures
A student who has a complaint related to this course should follow the procedures summarized below:

- The student should attempt to resolve the matter with the instructor first.
- In rare circumstances, the student my justifiably feel the need to first talk to someone other than the instructor. Talking to the instructor first, however, is strongly encouraged.
- If the complaint is not resolved to the student's satisfaction, the student should e-mail the Associate Head, Dr. Heinz Bauschke at heinz.bauschke@ubc.ca or the Department Head, Dr. John Braun at john.braun@ubc.ca

Student Services Resources

Academic Integrity Matters (AIM) Program
LIB 237 250.807.9185
email: csc.okanagan@ubc.ca
web: http://library.ok.ubc.ca/wrs/aim/

UBC Okanagan Disability Resource Centre
UNC 227A
tel: 250.807.9263
email *drc.questions@ubc.ca*
web: http://students.ok.ubc.ca/drc/welcome.html

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Equity, Human Rights, Discrimination, and Harassment
UNC 227C
tel: 250.807.9291
email: *equity.ubco@ubc.ca*
web: http://www.ubc.ca/okanagan/equity/welcome.html

Health & Wellness
UNC 337
tel: 250.807.9270
web: students.ok.ubc.ca/health-wellness/welcome.html
Early Alert: https://facultystaff.students.ubc.ca/systems-tools/early-alert

Sexual Violence Prevention and Response Office (SVPRO)
tel: 250.807.9640
web: svpro.ok.ubc.ca

Independent Investigations Office (IIO)
tel: 604.827.2060.
email: director.of.investigations@ubc.ca
web: https://investigationsoffice.ubc.ca/

The Hub
LIB 237
tel: 250.807.9185
web: https://students.ok.ubc.ca/student-learning-hub/

SAFEWALK
tel: 250.807.8076.
web: https://security.ok.ubc.ca/safewalk/
mobile app: UBC SAFE – Okanagan