POPM*6800 Infectious Disease Modeling

Winter 2021
Section(s): C01

Department of Population Medicine
Credit Weight: 0.50
Version 1.00 - December 04, 2020

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1 Course Details

1.1 Calendar Description

This course serves as a basic introduction to mathematical modeling of infectious diseases using examples from public and veterinary health. Students completing this course will have the ability to critically appraise published mathematical models, and to build, parameterize, and analyze simple compartmental models.

Pre-Requisites: POPM*6200
Restrictions: Instructor consent required.

1.2 Course Description

This course will serve as a basic introduction to mathematical modeling of infectious diseases using examples from public and veterinary health. Students completing this course will have the ability to critically appraise published mathematical models, and to build, parameterize, and analyze simple compartmental models.

How can we prevent and control infectious disease outbreaks? This is why you are here – to answer this question. If you understand what drives the transmission dynamics of infectious pathogens in populations, then you can better act to prevent and control the spread of pathogens. This course covers ten broad content and methods areas related to mathematical epidemiology of infectious diseases, which combine a substantive focus (i.e., relevant clinical, pathological, and ecological information about a given pathogen or group of pathogens) with methodological tools useful for their representation via modeling. Each session is 3 hours in length. Most weeks will include an initial 30-60 min. introductory lecture, followed by hands-on exercises. With other weeks entirely focused on hands-on exercises

and discussion. I believe that this material is difficult to understand without practice so you will need to bring a laptop to class to participate in the laboratory exercises.

1.3 Timetable

During typical years, the modelling course is a 3-hour time block on Wednesday mornings. During this time I usually spend the first 45-60 minutes introducing the topic of the day. The remaining 2 hours of in-class time is focused on actually coding, running, and analyzing model examples and case studies. These in class, hands-on exercises are how you actually learn to **DO** modelling. Reading papers and watching lectures is not sufficient to give you hands-on experience and the associated troubleshooting that is required to really learn about how to do this sort of work.

Due to our inability to meet face-to face I am hoping to find ways to provide you with the necessary information and experiences to achieve the same goals while supporting your learning needs, building community, and hopefully having some fun at the same time. As a result, things will look a bit different and we may need to adjust as we go along and adapt if we see that some things are working well and some are not.

1) **LECTURE**. In order to facilitate the needs of all students, lectures will be asynchronous. A weekly reading and recorded video will be posted in MS Teams at least a week in advance to allow time for you to complete the reading and view the lecture.

2) **LABS.** Hands on exercises and demo code will be posted in MS Teams at least a week in advance. Students will be assigned to a small group for the week and will need to schedule a mutually agreed upon 1-2 hour time slot to meet in Teams to review and discuss the hands-on exercises. If we were in class, this would look like students walking through the code as a group, discussing and then working through the exercise and drafting results and discussion for the exercise. This shared knowledge forms the basis of your weekly skills practice submissions (assignments). Each of these exercises contributes to your learning portfolio so it is in your best interest to work with your group to discuss your questions and to get feedback from others. This works best when you have looked through the material in advance. It is not a good use of your group meeting time to spend the time reading what you are supposed to be doing. At your 1 hour “lab meeting” you will designate 1 member of your group as the “discussant”. This person will be the group spokesperson at the weekly feedback session and will be required to attend the feedback session on behalf of your group.

3) **FEEDBACK**. Synchronous Discussion and feedback sessions will be held at 10:30am, each week on Wednesdays. The group nominated “discussant” will be required to attend the session to pose any questions that the group had. Everyone is welcome to join (and encouraged to join) but at least 1 member from each small group is required to attend. This is a chance to ask questions about the weeks material and get feedback and suggestions on the hands-on exercises. The team “discussant” will ask any clarifying questions that the team had about the hands-on exercises and I will respond. These discussion sessions will be recorded and uploaded for students to view if they are not able to attend during the synchronous meeting time. The discussant will also post any notes or feedback they receive that is specific to their group in the Teams group channel.

1.4 Final Exam

This class does not have a final exam.

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2 Instructional Support

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3 Learning Resources

3.1 Required Resources

Microsoft Teams (Software)

Course material, news, announcements, discussion items, assessments, and feedback will be regularly posted to the POPM*6800 Microsoft Teams group. You are responsible for checking the group regularly. Students will be added to the group by the course instructor. The Teams group (and the associated OneNote notebooks) will also be the tool used for peer and self-assessment and all collaborative work assignments completed in class.

Computer Resources (Equipment)

You will be expected to have access to a computer in order to perform the modeling exercises that are the core of this course. R Studio and MS Teams will be required in order to complete the exercises (both of which are available free to students).

Much of the course material that we will cover in this course will be completed using R.

This means that developing an understanding of **HOW** to program mathematical models in R requires that you spend a bit of time thinking about R programming in general.

3.2 Additional Resources

Suggested Resources (Textbook)

There is **no required text** for this course, and all required and recommended readings will be provided on MS Teams. However, the course is built upon approaches to disease modeling described in two texts, both of which are available in the library, and which can be readily purchased from a variety of sources.

1. Vynnycky E and White RG. *An Introduction to Infectious Disease Modelling*. Oxford University Press, New York, NY 2010.
2. Keeling MJ and Rohani P. *Modeling Infectious Diseases in Humans and Animals*. Princeton University Press, Princeton NJ. 2008.

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4 Learning Outcomes

4.1 Course Learning Outcomes

By the end of this course, you should be able to:

1. Demonstrate a basic understanding of the subject area (e.g., factual knowledge, methods, principles, generalizations, theories)
2. Apply course material (to improve thinking, problem solving, and decisions) to both veterinary and human health problems.
3. Analyze and critically evaluate scientific ideas, arguments, and points of view
4. Demonstrate appropriate methods for collecting, analyzing, and interpreting numerical information
5. Demonstrate the specific skills, competencies, and points of view needed by professionals in human and veterinary health

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5 Teaching and Learning Activities

5.1 Lecture

Week 1

Topics: What will I learn from this course, how will I learn it, and how will I be assessed?

Week 2

Topics: **Laying the foundation – Infectious Disease Epidemiology**

What are the fundamental properties of communicable diseases that contribute to disease transmission?

Review:

1) Portfolios

2) Learning conferences

3) Peer review project

Week 3

Topics: **Introduction to dynamic systems**

How do you translate host-pathogen biology into a system of mathematical equations?

Week 4

Topics: **Contact patterns and mixing**

What about populations with more specific mixing patterns? Why is it important to consider the population contact patterns?

Week 5

Topics: **Disease prevention and control**

How can we implement health interventions such as vaccination programs into models?

Week 6

Topics: **WINTER BREAK (no class)**

Week 7

Topics: **Model fitting and parameter estimation**

What can we learn from the basic reproductive number of a pathogen and why is it important?

Week 8

Topics: **Parameter uncertainty and sensitivity analysis**

How do we analyze models to better understand the uncertainty that exists and the relationship between model inputs and model outputs?

Week 9

Topics: **Stochastic models**

What is a stochastic model? How is it different from a deterministic model? How do we implement stochasticity into our model equations?

Week 10

Topics: **Peer review project work period**

Week 11

Topics: **Vector-borne diseases**

What do insects, healthcare workers, and spinach have in common? How do you incorporate disease transmission routes that include vectors into your compartment models?

Week 12

Topics: **Discussion of final peer review project.**

Week 13

Topics: **Individual portfolio reviews and final learning conferences**

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6 Assessments

6.1 Assessment Details

Exit ticket 1 (4%)
Due: Wed, Jan 13
Learning Outcome: 1, 5

Exit ticket 2 (4%)
Due: Wed, Jan 20
Learning Outcome: 1, 5

Assignment 1 (8%)
Due: Wed, Jan 27
Learning Outcome: 1, 2, 3, 4, 5

Assignment 2 (8%)
Due: Wed, Feb 3
Learning Outcome: 1, 2, 3, 4, 5

Exit ticket 3 (4%)
Due: Wed, Feb 3
Learning Outcome: 1, 2, 3, 4, 5

Exit ticket 4 (4%)
Due: Wed, Feb 10
Learning Outcome: 1, 2, 3, 4, 5

Midterm learning conference - evidence journal (6%)
Due: Wed, Feb 24
Learning Outcome: 1, 2, 3, 4, 5

Midterm learning conference - Self assessment (6%)

Due: Wed, Feb 24
Learning Outcome: 1, 2, 3, 4, 5

Midterm learning conference (6%)
Due: Wed, Feb 24
Learning Outcome: 1, 2, 3, 4, 5

Assignment 3 (8%)
Due: Wed, Mar 3
Learning Outcome: 1, 2, 3, 4, 5

Assignment 4 (8%)
Due: Wed, Mar 10
Learning Outcome: 1, 2, 3, 4, 5

Peer Review Project (16%)
Due: Wed, Mar 31
Learning Outcome: 1, 2, 3, 4, 5

Final learning conference - evidence journal (6%)
Due: Fri, Mar 27
Learning Outcome: 1, 2, 3, 4, 5

Final learning conference - Self assessment (6%)
Due: Fri, Mar 27
Learning Outcome: 1, 2, 3, 4, 5

Final learning conference (6%)
Due: Wed, Apr 1
Learning Outcome: 1, 2, 3, 4, 5

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7 University Statements

7.1 Email Communication

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

7.2 When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Graduate Calendar - Grounds for Academic Consideration
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions
https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml

7.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml

Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml

Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml

7.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

7.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to book their exams at least 7 days in advance and not later than the 40th Class Day.

For Guelph students, information can be found on the SAS website
https://www.uoguelph.ca/sas

For Ridgetown students, information can be found on the Ridgetown SAS website
https://www.ridgetownc.com/services/accessibilityservices.cfm

7.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community-faculty, staff, and students-to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

Graduate Calendar - Academic Misconduct
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml

7.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

7.8 Resources

The Academic Calendars are the source of information about the University of Guelph’s procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars
https://www.uoguelph.ca/academics/calendars

7.9 Disclaimer

Please note that the ongoing COVID-19 pandemic may necessitate a revision of the format of course offerings and academic schedules. Any such changes will be announced via CourseLink and/or class email. All University-wide decisions will be posted on the COVID-19 website (https://news.uoguelph.ca/2019-novel-coronavirus-information/) and circulated by email.

7.10 Illness

The University will not normally require verification of illness (doctor's notes) for fall 2020 or winter 2021 semester courses. However, requests for Academic Consideration may still require medical documentation as appropriate.
