# MAP 6487 (Section 0228/27708): Biomath Seminar I

## Infectious disease and economic growth modeling

## Course, class meetings and instructor information

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| **Term** | Fall 2023 |
| **Course** | MAP 6487 |
| **Section** | 0228 |
| **Credits** | 3 |
| **Days** | Mondays, Wednesdays, Fridays |
| **Time** | 12:50 - 13:40 ($6^{\text{th}}$ period) |
| **Venue** | LIT 205 |

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| **Instructor** | Calistus N. Ngonghala |
| **Telephone** | (352) 294-2335 |
| **Email** | *calistusnn@ufl.edu* |
| **Office hours** | 1) Monday: 11:45-12:35 ($5^{\text{th}}$ period, in-person)<br>2) Wednesday: 11:45-12:35 ($5^{\text{th}}$ period, in-person)<br>3) Friday: 11:45-12:35 ($5^{\text{th}}$ period, in-person)<br>4) By appointment (in-person or Zoom) |

**Remark:** *Don't feel constrained by the scheduled office hours. You are welcome to drop in or contact me by phone or e-mail for an appointment.*

## Announcements

Course announcements and updates will be disseminated during class sessions and via the Canvas platform. Consequently, students are strongly advised to attend classes regularly and to check their Canvas messages daily.

## Reading material

Relevant papers or links to valuable resources for the course will be shared during class sessions or through canvas. While the acquisition of the textbooks listed below is not obligatory, students may find them to be beneficial supplementary materials for the course.

1. M. Martcheva. An introduction to mathematical epidemiology. Vol. 61 (New York Springer, 2015)

2. M. J. Keeling and P. Rohani. Infectious diseases in humans and animals (Princeton University Press, 2008)

3. R. M. Anderson and R. M. May. Infectious diseases of humans. Dynamics and Control (Oxford University Press, 1991)

4. C. I. Jones and D. Vollrath. Introduction to economic growth (W. W. Norton & Company Inc., 2013)

## Pre-requisites

Knowledge of nonlinear dynamical systems, basic statistics, and a programming language (MATLAB, R, Mathematica, Maple, C, C++, Python, etc.) will be useful.

## Course Description

Infectious diseases are among the oldest natural enemies and leading killers of humans. Specifically, humans have experienced numerous outbreaks of devastating infectious disease outbreaks in history, including the plague, cholera, influenza, Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS), and more recently, the 2019 SARS-CoV-2 virus (COVID-19) pandemic. Developing and using mathematical models to acquire insights into the dynamics of these diseases, inform disease control and mitigation measures, motivate new studies, and to assess the impact of human response to control measures, as well as the socio-economic impacts of infectious diseases on human populations is increasing attracting much attention across disciplines such as public health, the natural sciences, and the social sciences. For example, mathematical models have been very useful in the fight against the ongoing COVID-19 pandemic (especially during the early days of the outbreak, when there was limited data). Additionally, mathematical models have been used in planning for and predicting outbreaks, understanding the impacts of outbreaks on populations, predicting the effects of disease control and mitigation measures, and in the design of new empirical studies and disease control and mitigation strategies.

MAP 6487 (Biomath Seminar I) is a 3 credit hours graduate-level course in infectious disease and economic development modeling that introduces students to 1) empirical and theoretical concepts of infectious diseases and 2) the methods and applications of infectious disease modeling from an epidemiological and socio-economic perspective. Students will receive rigorous training on the analytical and computational fundamentals of infectious disease modeling through lectures, hands-on computer coding sessions, projects, and peer presentations. Specific topics will include: a review of basic mathematical concepts (e.g., systems of differential equations, existence and stability of equilibria, bifurcation theory, etc.), formulating good research questions in mathematical biology, introduction to infectious diseases and data, basic and effective reproduction numbers, deterministic, stochastic, network, and agent-based models, model calibration and alternative approaches to model fitting, sensitivity analysis, model identifiability and evaluation, and integrating disease models with human behavioral and socio-economic factors. Lecture examples and projects will include real-time disease outbreaks (e.g., the ongoing COVID-19 pandemic, the 2015 Zika virus outbreak, and the 2014 West African Ebola virus outbreak).

## Course Objectives and Learning Outcomes

The primary objective of this course is to introduce students to infectious diseases and infectious disease models. Students will develop and use differential equations and stochastic models, as well as real-world disease data and numerical techniques to study disease outbreaks and the impacts of disease control and mitigation measures. They will integrate infectious disease models with infectious disease data, human behavioral processes, and socio-economic factors in a meaningful way to address real-world questions at the interface between disease epidemiology and economic growth, and infer possible public health and economic growth policies from the analyses of the models.

By the end of the course, students will be able to 1) develop, analyze, and interpret the results of infectious disease models, analyze and interpret infectious disease data; 2) use mathematical models to predict the effects of disease control measures and the impact of changes in human behavior in response to disease and disease control measures; 3) explore interactions between infectious diseases and economic development; and to 4) formulate and pursue important questions in infectious disease epidemiology and/or health economics.

## Course outline

1. Review of useful mathematical concepts
   (a) Basic concepts from linear algebra, e.g., matrices, eigenvalues, eigenvectors, etc.
   (b) Review of systems of ordinary differential equations
   (c) Review of equilibria, stability analysis and bifurcation theory
   (d) Gillespie Algorithm
2. Introduction
   (a) Introduction to infectious diseases
   (b) Thinking about data

   (c) Introduction to mathematical modeling of infectious diseases
   (d) Formulating good research questions

3. Dynamic disease models
   (a) Deterministic models
   (b) Stochastic models
   (c) Metapopulation models
   (d) Network models
   (e) Individual-based models

4. Dynamic disease models and data
   (a) Model parametrization
   (b) Alternative model fitting approaches
   (c) Local and global sensitivity analyses
   (d) Model evaluation

5. Applications of dynamic disease models
   (a) Impact of various control measures
   (b) Impact of human response to control measures

6. Coupled infectious disease-economic growth systems
   (a) Introduction to economic growth theory
   (b) Coupled infectious disease economic growth models
   (c) Coupled disease-economic-human behavior models

## Course Policies/Procedures

### Student responsibilities

Students are expected to attend and play an active role in all class meetings. It is the student's responsibility not to miss any announcement made in class and to check his/her canvas account regularly. Please, do not hesitate to ask questions or seek additional assistance to ensure that you are staying on pace with the class.

### Assessment

Students will be evaluated through in-class presentations, homework, and a project. Students are welcome to suggest their own projects or request for projects from the instructor. The purpose of the project will be to apply the concepts learned in class directly to real-world problems. Comprehensive guidelines outlining the criteria for a completed project and important deadlines will be communicated during class and through Canvas. Unless otherwise stated, exam, quiz and homework grades will be posted on canvas as soon as they are graded.

### Grading and Grade Scale

| Assessment item | Points |
|---|---|
| Presentations | 100 |
| Homework | 120 |
| Project | 150 |
| Attendance | 30 |
| **Total** | **400** |

| Grade | Range |
|---|---|
| A | 360-400 |
| B | 320-359 |
| C | 280-319 |
| D | 240-279 |
| E | 000-239 |

## Academic Honesty

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://www.dso.ufl.edu/sccr/process/student-conduct- honor-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, consult with the instructor.

## Student Evaluation

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://ufl.bluera.com/ufl/. Guidance on how to give feedback in a professional and respectful manner is available at https://gatorevals.aa.ufl.edu/students/. Evaluations are typically open during the last two or three weeks of the semester. Students will be notified when the evaluation period opens, and can complete evaluations through the link included in the email they receive from GatorEvals, in their Canvas course menu un- der GatorEvals, or via https://ufl.bluera.com/ufl/. Summary results of these assessments are available to students at https://gatorevals.aa.ufl.edu/public-results/.

In addition to the final evaluation, I encourage students to furnish me with feedback, either in person, by voice mail, by email, through a note left under my office door (LIT 468), etc., throughout the semester. I look forward to reading your valuable, constructive, and objective comments.

## Special Accommodations

Students requesting classroom accommodations or special arrangements during ex- aminations must first register with the Dean of Students Office (352-392-8565, www.dso.ufl.edu/drc/). The Dean of Students Office will provide documentation. The student must then make arrangements with the instructor to meet the requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

## U Matter We Care

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu, so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 911.

## Diversity

Both the University of Florida and the Department of Mathematics are committed to fostering diversity and inclusion of all students. We recognize the diversity of backgrounds and unique learning needs of our students and strive to create a more inclusive and welcoming environment for everyone. We strongly believe that an inclusive learning environment promotes higher academic accomplishments.