Department of Epidemiology and Population Health
Faculty of Health Sciences
American University of Beirut

EPHD 318
Introduction to Mathematical Modelling of Infectious Diseases
(2-credits)
Spring Semester - Academic Year 2023/2024

Course Instructor

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Office hours: By appointment

Class time and location

	Day	Time	Location
Lecture:	Tuesday	12:00-13:15	Van Dyck, Room 332
Application:	Friday	12:00-14:00	Van Dyck, Room 332

Course details

Course description

Mathematical modelling of infections is increasingly developing as a key tool for understanding transmission patterns, emergency planning, and assessing control strategies - hence playing a critical role in policy making. This graduate course introduces students to the basic concepts of mathematical modelling of infectious diseases and allows them to acquire a hands-on practical experience in designing simple, yet informative models to predict the course of epidemics and estimate the impact of interventions. The course consists of lectures and practical sessions that include class exercises and discussion, computer applications, and article discussion. Applications to different types of infectious diseases and control interventions will be discussed. Students will build and run basic disease models using Berkeley Madonna, a user-friendly mathematical package. Students should be comfortable with basic calculus and have an interest in infectious diseases epidemiology.

Prerequisites

There are no prerequisites for the course.

Course format & software

The course consists of a mix of didactic lectures and practical sessions. The latter include both paper-based exercises and computer-assisted applications using the specialized software for the course, Berkeley Madonna. You will be provided with a license to install Berkeley Madonna on your personal laptop. It is preferable that you have your laptop with you at all times. The application sessions consist

of structured exercises that guide you step by step to achieve the learning outcome. You will be provided with the applications handouts ahead of time. It is preferable that you familiarize yourself with their content before class. At times, you may be required to attempt solving the exercise prior to class.

Course textbook

There is no assigned textbook for this course. All the material will be provided in the lecture slides and in readings/material shared with students. Students are expected to read any material provided prior to coming to class.

To refresh your memory about basic math concepts, the following reference book is uploaded on Moodle: *Catch Up Maths & Stats: For the Life and Medical Sciences* (1st edition). M. Harris, G. Taylor, & J. Taylor. Scion Publishing Ltd, 2005. The most relevant chapters are 2, 5, 7-9, 15-17, 19, and 20. This is optional.

A guide to the course software, Berkeley Madonna, is also uploaded on Moodle.

Competencies of the Council on Education for Public Health (CEPH) mapped to this course

[CC3]: Analyze quantitative and qualitative data using biostatistics, informatics, computer-based programming and software, as appropriate

[CC4]: Interpret results of data analysis for public health research, policy or practice.

[EB1]: Discuss the extent, distribution and determinants of common and emerging communicable and non-communicable diseases, and mental health disorders of local, regional and global importance

[EB3]: Design epidemiological studies to investigate public health research questions

[EB8]: Appraise the quality of epidemiological evidence by evaluating studies for bias and other sources of systematic errors

Course learning objectives (LOs)

By the end of the course, students should be able to:

[LO1]: Discuss key concepts of infectious disease epidemiology and control, and the differences with non-infectious diseases

[LO2]: Design simple compartmental models for different types of infectious disease, including SARS-CoV-2, influenza, TB, HIV, and/or others

[LO3]: Implement simple compartmental infectious disease models using Berkeley Madonna and Excel

[LO4]: Fit models to empirical data and estimate key epidemiological measures

[LO5]: Discuss the transmission dynamics of infections

[LO6]: Model and interpret the impact of public health interventions (including vaccination, treatment, social distancing, and others) on the course of epidemics

[LO7]: Appraise a modelling paper

Mapping of Course Learning Objectives to CEPH Competencies

CEPH Competencies	Course Learning Objectives						
	LO1	LO2	LO3	LO4	LO5	LO6	LO7
CC3		X	X	X		X	
CC4					X	X	
EB1	X			X	X	X	
EB3		X				X	
EB8			X				X

Student evaluations

Students will be evaluated with two practical assessments, a final exam, and participation and performance in class exercises:

Assessment method	Date/Deadline	LOs covered	Grade percentage
Assessment 1	March 1	2,3	25%
In this in-class open-book assessment, you will be asked to design a mathematical model of a specific infection. The assessment consists in drawing the flow diagram, defining parameters, and writing the equations of a model depicting transmission of this infection based on the provided description of its natural history.			
Assessment 2	April 12	2-6	30%
In this take home group assignment, you will design an extension of the SARS-CoV-2 model that you would have worked on during the previous practical sessions. The assessment consists in 1) updating the model structure, equations, and parameters, 2) applying changes to the Berkeley Madonna code and running the model, and 3) estimating epidemiological measures and commenting on observed transmission dynamics.			
Final exam	TBA by registrar	1-6	35%
The final exam is paper-based and will cover the material covered throughout the course. It will include knowledge-based questions as well as subjective questions that will assess the students' critical thinking and ability to link course material.			
Participation & class exercises		1-7	10%
You are encouraged to attend all classes, especially that a substantial volume of the learning will take place through the applications and class interactions. Class participation extends beyond just attendance and will be assessed through active engagement in class discussions. Class applications include guided exercises that will be completed in class. Students will be given some time to answer the questions individually or in groups, followed by a class discussion. You may also be given such exercises to do at home before coming to class. Your work on these exercises will be assessed.			

AUB policies and other class regulations

Attendance

Attendance will not be counted as part of the course grade. However, keep in mind that most of the learning will take place through the class applications and discussions. Missing classes will therefore

impact your learning, especially that knowledge and skills are built gradually from session to session. While attendance will not count as part of the course grade, active participation in class will be assessed as described above.

Punctuality
Please make sure to arrive to class on time. Punctuality also means meeting deadlines. Please read the syllabus carefully and take note of all deadlines and exam dates to be able to plan your time accordingly. Time management is an essential skill that will greatly affect your performance on the course.

Exams must be taken on their assigned time. Make-up exams will be given only in case of emergencies or major illness (authorized medical report is required).

Academic Integrity
Education is demanding and time management is essential. Do not hesitate to use the resources around you but do not cut corners. Cheating and plagiarism will not be tolerated. If you are in doubt about what constitutes plagiarism, ask your instructor because it is your responsibility to know. Please review the Student Code of Conduct in your handbook and familiarize yourself with definitions and penalties. The American University of Beirut has a strict anti-cheating policy. Any such incident will be reported by the course instructor to the Office of the Dean and subsequently to the Student Affairs Committee. Penalties include failing marks on the assignment in question, suspension or expulsion from University, and a permanent mention of the disciplinary action in the student's records.

Students with Special Needs
"If you have documented special needs and anticipate difficulties with the content or format of the course due to a physical or learning disability, please contact me and/or your academic advisor, as well as the Counselling Center in the Office of Student Affairs (Ext. 3196), as soon as possible to discuss options for accommodations. Those seeking accommodations must submit the Special Needs Support Request Form along with the required documentation."

Non-Discrimination – Title IX – AUB
AUB is committed to facilitating a campus free of all forms of discrimination including sex/gender-based harassment prohibited by Title IX. The University's non-discrimination policy applies to, and protects, all students, faculty, and staff. If you think you have experienced discrimination or harassment, including sexual misconduct, we encourage you to tell someone promptly. If you speak to a faculty or staff member about an issue such as harassment, sexual violence, or discrimination, the information will be kept as private as possible, however, faculty and designated staff are required to bring it to the attention of the University's Title IX Coordinator. Faculty can refer you to fully confidential resources, and you can find information and contacts at www.aub.edu.lb/titleix. **To report an incident**, contact the University's Title IX Coordinator Trudi Hodges at 01-350000 ext. 2514, or titleix@aub.edu.lb. An anonymous report may be submitted online via EthicsPoint at www.aub.ethicspoint.com.

Detailed course schedule

	Date	Topic	Assessment
Week 1	Jan 19	No class	
Week 2	Jan 23	Introduction to course: syllabus and ice breaker	Final Exam
	Jan 26	Lecture: Basic principles of infectious disease epidemiology + Unique features of infectious diseases	Final Exam
Week 3	Jan 30	Lecture: Basic principles of transmission dynamics	Final Exam
	Feb 2	Application: Basic principles of transmission dynamics (part A)	Final Exam
Week 4	Feb 6	Application: Basic principles of transmission dynamics (part B)	Final Exam
	Feb 9	No class – Saint Maroun holiday	
Week 5	Feb 1 (starts 11 am)	Lecture: How models are set up + Differential equations	Final Exam Assessment 1,2
	Feb 16	Application: designing models (sexually transmitted infection)	Final Exam Assessment 1,2
Week 6	Feb 20 (starts 11 am)	Application: designing models (respiratory infection) (SARS-CoV-2 practical Part 1)	Final Exam Assessment 1,2
	Feb 23	Berkeley Madonna (BM)-assisted lecture: Dynamics of the SIR family of models and R0: Natural dynamic of immunizing infections (Part A)	Final Exam Assessment 2
Week 7*	Feb 27	BM-assisted lecture: Dynamics of the SIR family of models and R0: Natural dynamic of immunizing infections (Part B)	Final Exam Assessment 2
	Mar 1	Assessment 1 – in-class / open book	
Week 8	Mar 5	Correction of assessment 1 + mini-review session	
	TBA Make up	Application: Model parameterization and fitting (SARS-CoV-2 practical Part 2)	Final Exam Assessment 2
	Mar 8	No class – Ghina Travel	
Week 9	Mar 12	No class – Ghina Travel	
	Mar 15	Guest webinar: "HIV and Malaria- when elephants flirt: A story of a scientific modelling study" Speaker: Prof. Laith Abu-Raddad, Weill Cornell Medicine Qatar.	
Week 10	Mar 19	Lecture: Estimating key epidemiological measures from mathematical models	Final Exam Assessment 2
	Mar 22	Application: Estimating key epidemiological measures from mathematical models (SARS-CoV-2 practical Part 3)	Final Exam Assessment 2
Week 11	Mar 26 (start 11 am)	Application: Modelling the impact of interventions – imposing and easing social distancing restrictions (SARS-CoV-2 practical Part 4)	Final Exam Assessment 2
	Mar 29	No class – Latin Easter	
Week 12	Apr 2	Application: Modelling the impact of interventions – imposing and easing social distancing restrictions (SARS-CoV-2 practical Part 4 – cont'd)	Final Exam Assessment 2

	Date	Topic	Assessment
	Apr 5	Lecture + Application: Modelling the impact of interventions – vaccination (SARS-CoV-2 practical Part 5)	Final Exam Assessment 2
Week 13	Apr 9	Appraising a modeling paper	Class exercises
	Apr 12	No class – Eid el Fitr	
	Apr 12	Assessment 2 Due – Group assignment	
Week 14	Apr 16	Lecture: Introduction to stochasticity	Final Exam Assessment 2
	Apr 19	Application: The Reed-Frost stochastic model	Final Exam Assessment 2
Week 15	Apr 23	Correction of Assessment 2	
	Apr 26	Paper discussion	Class exercises
		Final Exam – TBA by registrar	

BM: Berkeley Madonna

Note: A pre-recorded lecture on Introduction to Berkeley Madonna as a tool for modelling will be provided for viewing prior to starting with BM assisted lectures and applications