Term Information

Effective Term	Spring 2015

General Information

Course Bulletin Listing/Subject Area	Mathematics
Fiscal Unit/Academic Org	Mathematics - D0671
College/Academic Group	Arts and Sciences
Level/Career	Graduate, Undergraduate
Course Number/Catalog	5421
Course Title	Mathematics of Infectious Disease Dynamics
Transcript Abbreviation	Math Infect Dynam
Course Description	This course provides an introduction to mathematical modeling of infectious diseases, including techniques for building and analyzing disease models, and discussions of calibration and comparison of models with data. This course is intended for graduate students in public health or other related disciplines and for upper level undergraduate and graduate mathematics students.
Semester Credit Hours/Units	Fixed: 3

Offering Information

Length Of Course	14 Week, 7 Week, 12 Week (May + Summer)
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	Prerequisite: 1152, 1172 or credit for 153; or permission of instructor.
Exclusions	Not open to students with credit for PUBHEPI 5421

Cross-Listings

Cross-Listings	PUBHEPI 5421

Subject/CIP Code

Subject/CIP Code	27.0101
Subsidy Level	Doctoral Course
Intended Rank	Junior, Senior, Masters, Doctoral

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Introduce students to the research literature on mathematical modeling of infectious disease dynamics, in particular highlighting key insights that have been gained from previous studies.
- Acquisition of mathematical and computing skills for creating, simulating, and analyzing mathematical models of infectious disease dynamics for use in the students' own research.
- Experience working with dynamic models together with infectious disease time series data.
- Experience working in an interdisciplinary team setting on a modeling project.

Content Topic List

- Analyzing differential equation disease models.
- Vaccination and disease eradication.
- Basic reproduction number: biological and mathematical definitions. Next generation matrix.
- Demography and disease dynamics.
- Age structured models.
- Stochastic models.
- Heterogeneity. Mixing patterns and R0. Multigroup models. Core groups, disease hot spots.
- Spatial models.
- Disease on networks.
- Parameter estimation.

Attachments

- TienProposal_MathInfectDis-Oct8.pdf: Syllabus

  (Syllabus. Owner: Husen,William J)

Comments

- Appeal information provided by Bill Husen by email to Hadad, 10/15/2014 *(by Hadad,Christopher Martin on 10/15/2014 12:38 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Husen,William J	10/15/2014 08:57 AM	Submitted for Approval
Approved	Husen,William J	10/15/2014 09:02 AM	Unit Approval
Approved	Hadad,Christopher Martin	10/15/2014 12:38 PM	College Approval
Pending Approval	Nolen,Dawn Vankeerbergen,Bernadette Chantal Hanlin,Deborah Kay Jenkins,Mary Ellen Bigler Hogle,Danielle Nicole	10/15/2014 12:38 PM	ASCCAO Approval

The Ohio State University College of Public Health
Mathematics of Infectious Disease Dynamics
MATH / PUBH-EPI 5421
3 Credit Hour – Spring 2015

FACULTY: Prof. Joe Tien

Office Hours: TBD

CLASS TIME AND LOCATION: TBD

PREREQUISITES: One year of calculus, or permission of instructor.

COURSE DESCRIPTION: Mathematical models are an important tool for understanding infectious disease dynamics, and are increasingly used by public health workers and agencies for assessing disease risk and helping inform intervention strategies. This course provides an introduction to mathematical modeling of infectious diseases. We will learn techniques for building and analyzing disease models, and discuss calibration and comparison of models with data.

This course is intended for graduate students in public health or other related disciplines (e.g. ecology, veterinary medicine) wishing to learn about infectious disease models, for example for incorporating mathematical models into their own research. The course is also intended for mathematics students wishing to learn about infectious disease modeling, including both upper level undergraduates and graduate students (in particular, MMS Bio students interested in mathematical epidemiology).

Theoretical topics will be discussed in the context of specific case studies, including smallpox eradication, spatiotemporal measles dynamics pre- and post-vaccination, rotavirus and demography, influenza vaccination strategies, gonorrhea and "core" groups in the U.S., contact tracing, superspreaders and SARS, and social networks and HIV. Assignments will involve hands-on work with empirical time series data from disease outbreaks.

COURSE FORMAT: Lecture plus supplemental computer labs.

COURSE OBJECTIVES: Course objectives include: 1) introducing students to the research literature on mathematical modeling of infectious disease dynamics, in particular highlighting key insights that have been gained from previous studies, 2) acquisition of mathematical and computing skills for creating, simulating, and analyzing mathematical models of infectious disease dynamics for use in the students' own research, 3) hands-on experience working with dynamic models together with infectious disease time series data, 4) experience working in an interdisciplinary team setting on a modeling project.

M.P.H./Ph.D. STUDENT COMPETENCIES:

Upon successful completion of this course, a student will have acquired competency in the following areas (U=Undergraduate, M=MPH, P=PhD):

U1) Summarize the historic milestones in public health
U2) Compare and contrast examples of major domestic and international public health issues

U3) Discuss various approaches / strategies for identification, response and intervention to address and attempt to resolve common public health issues
U4) Identify political, cultural, behavioral and socioeconomic factors related to global public health issues
U5) Apply the fundamental principles of the five core disciplines of public health (biostatistics; environmental health; epidemiology; health administration; health behavior / promotion) to domestic and international population issues

M1) Analysis and interpretation of data from epidemiological investigations, in particular with respect to infectious disease surveillance data
M2) Familiarity with basic content and issues in infectious disease epidemiology
M3) Natural histories of infectious diseases, particularly childhood and respiratory diseases, and selected STDs (e.g. HIV, gonorrhea), and their relevance to epidemiological investigations.
M4) Use of computer software for analysis of infectious disease data

P1) Formulate hypotheses and design a (modeling) research study using appropriate research methods and approaches.
P2) Apply relevant theories and conceptual (mathematical) models to inform and ground research and data analysis.
P3) Conduct a (modeling) research study.

COURSE READINGS:

. [1] J. G. Breman and I. Arita. The confirmation and maintenance of smallpox eradication. New England Journal of Medicine, 303(22):1263–1273, 1980.

. [2] A. D. Cliff, P. Haggett, J. K. Ord, and G. R. Versey. Spatial diffusion: an historical geography of epidemics in an island community. Cambridge University Press, 1981.

. [3] David J.D. Earn, P. Rohani, B. M. Bolker, and B. T. Grenfell. A simple model for complex dynamical transitions in epidemics. Science, 287:667–670, 2000.

. [4] O. Diekmann, H. Heesterbeek, and T. Britton. Mathematical tools for understanding infectious disease dynamics. Princeton University Press, 2012.

. [5] N. M. Ferguson, M. J. Keeling, W. J. Edmunds, R. Gani, B. T. Grenfell, R. M. Anderson, and S. Leach. Planning for smallpox outbreaks. Nature, 425:681–685, 2003.

. [6] N. C. Grassly and C. Fraser. Mathematical models of infectious disease transmission. Nature Reviews Microbiology, 6(6):477–487, 2008.

. [7] B. T. Grenfell, O. N. Bjørnstad, and J. Kappey. Travelling waves and spatial hierarchies in measles epidemics. Nature, 414(6865):716–723, 2001.

. [8] H. W. Hethcote and J. A. Yorke. Gonorrhea transmission dynamics and control, volume 56 of Lecture Notes in Biomathematics. Springer-Verlag, 1984.

. [9] J. Koopman. Modeling infection transmission. Annual Review of Public Health, 25:303–326, 2004.

. [10] J. O. Lloyd-Smith, S. J. Schreiber, P. E. Kopp, and W. M. Getz. Superspreading and the effect of individual variation on disease emergence. Nature, 438:355–359, 2005.

. [11] J. Medlock and A. P. Galvani. Optimizing influenza vaccine distribution. Science, 325(5948):1705–1708, 2009.

. [12] L. A. Meyers, B. Pourbohloul, M. E. Newman, D. M. Skowronski, and R. C. Brunham. Network theory and SARS: predicting outbreak diversity. Journal of Theoretical Biology, 232:71–81, 2005.

. [13] V. Pitzer, C. Viboud, L. Simonsen, C. Steiner, C. Panozzo, W. Alonso, M. Miller, R. Glass, J. Glasser, U. Parashar, and B. Grenfell. Demographic variability, vaccination, and the spatiotemporal dynamics of rotavirus epidemics. Science, 325(5938):290–294, 2009.

. [14] Y. Xia, O. N. Bjornstad, and B. T. Grenfell. Measles metapopulation dynamics: a gravity model for pre-vaccination epidemiological coupling and dynamics. American Naturalist, 164:267–281, 2004.

. [15] J. A. Yorke, N. Nathanson, G. Pianigiani, and J. Martin. Seasonality and the requirements for perpetuation and eradication of viruses in populations. American Journal of Epidemiology, 109(2):103– 123, 1979.

EXPECTATIONS: Students will be expected to read papers from the research literature on mathematical modeling of infectious disease dynamics, and to participate in discussion of these papers in class. Students will also be expected to complete the assigned homework, which will include both mathematical work as well computational work (e.g. fitting models to empirical data).

Students will participate in a final course project in small teams that involve both mathematics and public health / biology students. All students will be expected to contribute significantly to their team project. Team composition will be assigned by the instructor so that every group has strengths in mathematics, biology, and public health.

Final project evaluation will be based on a term paper (~10-15 pages). Graduate students must additionally present their project as an oral presentation to the class. Oral presentations will take place during the final exam period. All students are expected to attend the presentations and participate in a discussion of the projects.

COURSE EVALUATION AND GRADING:

Homework: 30%
Midterm: 20%
Final project: 45% (*Undergraduates*: term paper, *Graduate students*: term paper + oral presentation)
Class participation: 5% (Attendance, discussion of case studies, critiques of group projects)

Final grades will be assigned according to the following guide. The instructor reserves the right to change the grade cut-offs.

A 93 - 100
A- 90 - 92

B+	87 - 89
B	83 - 86
B-	80 - 82
C+	77 - 79
C	73 - 76
C-	70 - 72
D+	67 - 69
D	60 - 66
E	< 60

ACADEMIC INTEGRITY:

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University, the College of Public Health, and the Committee on Academic Misconduct (COAM) expect that all students have read and understood the University's *Code of Student Conduct* and the School's *Student Handbook*, and that all students will complete all academic and scholarly assignments with fairness and honesty. The *Code of Student Conduct* and other information on academic integrity and academic misconduct can be found at the COAM web pages (http://oaa.osu.edu/coam.html). Students must recognize that failure to follow the rules and guidelines established in the University's *Code of Student Conduct*, the *Student Handbook*, and in the syllabi for their courses may constitute "Academic Misconduct."

The Ohio State University's *Code of Student Conduct* (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the University, or subvert the educational process." Examples of academic misconduct include (but are not limited to) plagiarism, collusion (unauthorized collaboration), copying the work of another student, and possession of unauthorized materials during an examination. Please note that the use of material from the Internet without appropriate acknowledgement and complete citation is plagiarism just as it would be if the source were printed material. Further examples are found in the *Student Handbook*. Ignorance of the *Code of Student Conduct* and the *Student Handbook* is never considered an "excuse" for academic misconduct.

If I suspect a student of academic misconduct in a course, I am obligated by University Rules to report these suspicions to the University's Committee on Academic Misconduct. If COAM determines that the student has violated the University's *Code of Student Conduct* (i.e., committed academic misconduct), the sanctions for the misconduct could include a failing grade in the course and suspension or dismissal from the University. If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

ACCOMMODATION FOR SPECIAL NEEDS:

If you need an accommodation based on the impact of a disability, you should contact me to arrange an appointment as soon as possible. At the appointment we can discuss the course format, anticipate your needs and explore potential accommodations. I rely on the Office of Disability Services for assistance in verifying the need for accommodations and developing accommodation strategies. If you believe you need accommodation and have not previously contacted the Office of Disability Services, I encourage you to do so. The office is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; more information is available at http://www.ods.ohio-state.edu/

STUDENT SUPPORT AND ASSISTANCE**:**

A recent American College Health Survey found stress, sleep problems, anxiety, depression, interpersonal concerns, death of a significant other and alcohol use among the top ten health impediments to academic performance. Students experiencing personal problems or situational crises during the quarter are encouraged to contact the OSU Counseling and Consultation Services (292-5766; http://www.ccs.ohio-state.edu) for assistance, support and advocacy. This service is free to students and is confidential.

COURSE CONTENT OUTLINE:

Day/Date	Topic	Competency Addressed	Readings from Reading List
Week 1	Overview. Basic SIR model, introduction to compartmental differential equations.	U1, M2, M3	[4, handouts]
Week 2	Analyzing differential equation disease models.	M2	[4, handouts]
Week 3	Vaccination and disease eradication. Case studies: measles in the U.K., global smallpox eradication.	U1, U2, U3, U5, M1, M2, M4, P2	[1,3,5,15]
Week 4	Basic reproduction number: biological and mathematical definitions. Next generation matrix.	M1, M2, M3	[4, handouts]
Week 5	Demography and disease dynamics. Case study: rotavirus in the U.S.	U4, M1, M2, M3, M4, P2	[13]
Week 6	Age structured models. Age-based interventions. Case study: flu vaccination strategies in the U.S.	U2, U5, M1, M3, P2	[11]
Week 7	Stochastic models. Basics of branching processes; probability of extinction and R_0.	M1, M2, M3	[4, handouts]
Week 8	Stochastic models. Demographic fade-out. Critical community size. Gillespie simulations. Case studies: contact tracing and SARS, measles in Iceland.	U2, U3, U5, M1, M2, M3, M4, P2	[2,10]
Week 9	Review / catch-up. Midterm.		
Week 10	Heterogeneity. Mixing patterns and R_0. Multigroup models. Core groups, disease hot spots. Case study: gonorrhea in the U.S.	U2, U3, U4, U5, M1, M2, M3, M4, P2	[4, 8]
Week 11	Spatial models: gravity models. Case study: measles in the U.K.	U1, U2, U3, M1, M2, M3, M4, P2	[7, 14]
Week 12	Spatial models: patch models.	M2, M3	[handouts]
Week 13	Disease on networks. Case studies: SARS, HIV.	U2, U3, U4, U5, M1, M2, M3, P2	[6, 9, 12]
Week 14	Parameter estimation. Basic concepts of optimization,	U3, M1, M4	[handouts]

	software.		
Week 15	Parameter estimation. Sampling models, maximum likelihood.	U3, M1, M4	[handouts]
Exam Period	Final project presentations.	U3, U4, U5, M1, M2, M3, M4, P1, P2, P3	