Subject Information Guide

Mathematical Epidemiology: Modelling Wildlife Disease

Semester 2, 2018

Administration and contact details

Host Department	School of Science (Mathematical Sciences)
Host Institution	RMIT University
Name of lecturer	Dr Stephen Davis
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Subject details

Handbook entry URL	NA
Subject homepage URL	NA
Honours student hand-out URL	NA
Start date:	Wednesday 25 July, 2018
End date:	Wednesday 10 October, 2018
Contact hours per week:	2
Lecture day and time:	Tuesday 3pm – 5pm
Description of electronic access arrangements for students (for example, WebCT)	NA

Subject content

1. Subject content description

This course will introduce students of Applied Mathematics to the field of mathematical epidemiology and the modelling of disease dynamics in animals. Following a careful treatment of the spread of an infectious disease in a closed population, the course will explore the impact of complexities introduced by heterogeneity in the host population, seasonality in either the demography of the host or transmission of the pathogen, or when hosts have a fixed spatial location or territory that creates spatial dynamics of spread.

2. Week-by-week topic overview

Simple epidemic models

Week 1. Introduction to epidemiological reasoning, compartment models and the basic reproduction ratio (R_0); the epidemic in a closed population.

Week 2. A detailed mathematical analysis of the SIR model (Exercise 1.21 from Diekmann & Heesterbeek); the final size equation.

Week 3. The SIR model with demography; the SIR model with infection-induced mortality; the SEIR model; the art of translating biology into a set of differential equations and back again.

Host Heterogeneities

Week 4. Host heterogeneity arising from multiple host species, age structure and risk structure; next-generation matrix (NGM) techniques to derive R_0.

Week 5. *Case study 1*: Lyme disease in the north-eastern United States.

Week 6. The (precise) relationship between compartment models and the next-generation matrix technique to obtain R_0.

Seasonality

Week 7. Including seasonality in births and aggregation behaviour of wildlife populations in disease models; temporally forced models and their behaviour.

Week 8. *Case study 2*: The potential release of Cyprinid Herpes virus (CyHV-3) in Australia.

Week 9. *Case study 3*: Mathematical modelling of dengue fever and Zika virus.

Spatial dynamics

Week 10. Introduction to modelling techniques used to describe spatial dynamics of infectious disease including percolation theory, metapopulation structure, and partial differential equations.

Week 11. *Case study 4*: Plague in great gerbils in Central Asia.

Week 12. *Case study 5*: The potential spread of rabies in wild dogs in Australia.

3. Assumed prerequisite knowledge and capabilities

Students will be assumed to be familiar with systems of differential equations and the techniques used to analyse their behaviour and dynamics; it is advantageous to have completed an undergraduate course in differential equations or modelling with differential equations.

It is also assumed that students are comfortable with writing/modifying code in one or more programming environments such as R or Matlab.

4. Learning outcomes and objectives

Students will acquire a working knowledge of the mathematical techniques used to characterise and describe the dynamics of infectious disease in animals. They will be able to translate the biology of the host population(s) and the pathogen into a set of differential equations, and vice versa be able to interpret a set of differential equations in terms of the biology of the infectious agent and its hosts. Students will be able to use epidemiological reasoning to characterise a pathogen in terms of its basic reproduction ratio and have an understanding of the usefulness and limitations of this quantity. Students will be able to numerically solve systems of differential equations to explore their behaviour and dynamics.

AQF specific Program Learning Outcomes and Learning Outcome Descriptors (if available):

AQF Program Learning Outcomes addressed in this subject	Associated AQF Learning Outcome Descriptors for this subject
Problem Solving - You will have the ability to apply knowledge and skill to characterise, analyse and solve a wide range of problems.	**S1: cognitive skills to review, analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problem with intellectual independence** **S2: cognitive and technical skills to demonstrate a broad understanding of a body of knowledge and theoretical concepts with advanced understanding in some areas** **A2: to adapt knowledge and skills in diverse contexts**

Learning Outcome Descriptors at AQF Level 8
Knowledge
K1: coherent and advanced knowledge of the underlying principles and concepts in one or more disciplines
K2: knowledge of research principles and methods
Skills
S1: cognitive skills to review, analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problem with intellectual independence
S2: cognitive and technical skills to demonstrate a broad understanding of a body of knowledge and theoretical concepts with advanced understanding in some areas
S3: cognitive skills to exercise critical thinking and judgement in developing new understanding
S4: technical skills to design and use in a research project
S5: communication skills to present clear and coherent exposition of knowledge and ideas to a variety of audiences
Application of Knowledge and Skills
A1: with initiative and judgement in professional practice and/or scholarship
A2: to adapt knowledge and skills in diverse contexts
A3: with responsibility and accountability for own learning and practice and in collaboration with others within broad parameters
A4: to plan and execute project work and/or a piece of research and scholarship with some independence

5. Learning resources

Mathematical Tools for Understanding Infectious Disease Dynamics. Princeton Series in Theoretical and Computational Biology. By Odo Diekmann, Hans Heesterbeek and Tom Britton. xiv + 502 pp. Princeton, NJ: Princeton University Press. 2014.

Modeling Infectious Diseases in Humans and Animals. M. J. Keeling and P. Rohani (2008). NJ, USA: Princeton University Press. ISBN: 978-0-691-11617-3

6. Assessment

Exam/assignment/classwork breakdown					
Exam	**50%**	**Assignment**	**40%**	**Class work**	**10%**
Assignment due dates		**03/09/2018**	**1/10/2018**		
Approximate exam date				**22/10/2018**	

Institution Honours program details

Weight of subject in total honours assessment at host department	**12.5%**
Thesis/subject split at host department	**25% thesis/75% course work**
Honours grade ranges at host department:	
H1	**80-100 %**
H2a	**75-79 %**
H2b	**70-74 %**
H3	**65-69 %**