ACE Network Subject Information Guide

Mathematical Biology

Semester 2, 2020

Administration and contact details

Host Department	**School of Science (Mathematical Sciences)**
Host Institution	**RMIT University**
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Subject details

Handbook entry URL	NA
Subject homepage URL	NA
Honours student hand-out URL	NA
Start date:	**Wednesday 29 July, 2020**
End date:	**Wednesday 14 October, 2020**
Contact hours per week:	**2**
Lecture day and time:	**Wednesday 11am – 1pm (TBC)**
Description of electronic access arrangements for students (for example, WebCT)	NA

Subject content

1. Subject content description

This course will introduce students to the highly interdisciplinary field known as mathematical biology but sometimes referred to as theoretical biology, wherein mathematical approaches are used to gain insight and understanding into biological systems. It is a hugely diverse area of research that draws on all areas of mathematics to

investigate the complexity of living systems. The course will begin with a thorough treatment of mathematical epidemiology and then cover topics ranging from mathematical models of wound healing to analysing mutualistic networks of plants and animals.

2. Week-by-week topic overview

Simple models of epidemics in humans and animals

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; 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.

Spatial models of infectious disease

Week 4. Modelling techniques used to describe spatial dynamics of infectious disease; percolation theory; metapopulation structure; partial differential equations.

Week 5. Examples of spatial disease systems; plague in great gerbils in Central Asia; the potential release of Cyprinid Herpes virus (CyHV-3) in Australia.

Host heterogeneities and multi-host pathogens

Week 6. Host heterogeneity arising from multiple host species, age structure and risk structure; next-generation matrix (NGM) techniques to derive R_0.

Genetics

Week 7. Population genetics; Mendelian rules of inheritance; first and second order difference equations.

Week 8. Introduction to complex networks; the scale-free degree distribution; types of biological networks.

Week 9. Clustering in gene co-expression networks and guilt by association (GBA); centrality.

Population dynamics and Ecology

Week 10. Models of population growth; demography and matrix models; predator-prey dynamics.

Week 11. Networks in ecology; mutualism; food webs; network stability.

Cell and molecular biology

Week 12. Wound healing and scar tissue formation; cancer growth; the cell cycle.

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 generate insight into biological systems. They will gain experience in translating the known biological properties of a system into a set of mathematical equations (a model) and vice versa be able to interpret equations in terms of the biology they capture. Students will be able to use epidemiological reasoning to characterise a pathogen in terms of its basic reproduction ratio and understand the usefulness and limitations of this quantity. Students will be able to numerically solve systems of differential equations to explore their behaviour and dynamics and draw biological conclusions.

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

Lecture notes, recommended journal articles and recommended books will be made available over the course of the semester.

6. Assessment

Exam/assignment/classwork breakdown					
Exam	**40%**	**Assignment**	**20%+20%+20%**	**Class work**	**-**
Assignment due dates		**04/09/2020**	**25/09/2020**	**16/10/2020**	
Approximate exam date				**4/11/2018**	

Institution Honours program details

Weight of subject in total honours assessment at host department	**12.5%**
Thesis/subject split at host department	**37.5% thesis/62.5% course work**
Honours grade ranges at host department:	

H1	**80-100 %**
H2a	**75-79 %**
H2b	**70-74 %**
H3	**65-69 %**