ACE Network Subject Information Guide

MATH4413 Applied Mathematical Modelling

Semester 1, 2020

Administration and contact details

Host Department	School of Mathematics and Statistics
Host Institution	University of Sydney
Name of lecturer	Peter Kim and Robert Marangell
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Name of Honours coordinator	Marek Rutkowski
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Subject details

Handbook entry URL	**http://www.maths.usyd.edu.au/u/UG/HM/coordinator/applied2020.pdf**
Subject homepage URL	https://canvas.sydney.edu.au/courses/22782
Honours student hand-out URL	Click here to enter text.
Start date:	24 Feb 2020
End date:	28 May 2020
Contact hours per week:	4 hours: 3 lectures + 1 tutorial
Lecture day and time:	Mon 11am-1pm, Tue 11am-noon, Thu 11am-noon
Description of electronic access arrangements for students (for example, WebCT)	Zoom

Subject content

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1. **Subject content description**

The first half of the course focuses on partial differential equation (PDE) models in mathematical biology. PDE models capture a wide range of biological phenomena, including spatial and age-structured interactions. Particular topics will include age/maturity-structured models, diffusion and reaction-diffusion models (e.g., predator-prey systems and chemotaxis), and evolution (e.g., genetic drift). We will also discuss a recently developing area of mathematical modelling, that of bridging agent (or individual)-based models and PDEs. This particular topic is relatively new to the field, so the only prerequisite for this investigation is a creative outlook and a curiosity to compare and contrast some newly developed agent-based models with PDE systems. Assessment work will be evenly distributed throughout the semester rather than in the form of one or two big assignments and will include a reading assignment in the current research literature which will be presented as a talk to the class.

The second half of the course will focus on various mathematical techniques used to analyse the models introduced in the first half of the course, as well as others, including some from Chemistry and Physics as well as Biology. Particular topics may include the Nonlinear Schrodinger equation as it applies to optics, Turing Bifurcations, Insect outbreak, BZ models, relaxation oscillations, GSPT, the infante-chafee problems, Fisher's equation, the Allee equation, Gibbs phenomenon, Burgers and KdV equation, and anything else that suits the tastes of the class

2. **Week-by-week topic overview**

Age-structured models
Diffusion and Turing patterns
Chemotaxis
Fisher's equation
Travelling waves/fronts
Connecting PDEs to agent-based models
BZ Models
Relaxation oscillations
KdV
Gibbs Phenomenon
Turing Bifurcations
NLS and optics

3. Assumed prerequisite knowledge and capabilities

Undergraduate background in differential equations, including ordinary and partial differential equations. No background in biology, physics or chemistry is required.

4. Learning outcomes and objectives

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
Understand a variety of ODE and PDE models in mathematical biology chemistry and physics.	K1
Be able to analyse a range of simple models and discuss results in class.	S1, S5
Develop insight for programming discrete, agent-based models and linking them with continuous PDE formulations	S3, A2
Be able to critically read and summarise current research papers in mathematical biology give a brief presentation.	S5, K2
Understand a variety of PDE models.	K1
Develop insight for solving PDE and ODE models on a computer	S3, A2

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

Matlab and Mathematica software will be used to numerically solve ODEs and PDEs and to simulate simple agent-based models.

6. Assessment

Exam/assignment/classwork breakdown					
Exam	50%	**Assignment**	40%	**Class work**	10%
Assignment due dates		Week 3 (9-13 March)	Week 5 (23-27 March)	Week 6 (30 Mar-3 Apr)	Weeks 10 and 13
Approximate exam date				Week 14 (1-5 June)	

Institution Honours program details

Weight of subject in total honours assessment at host department	12.5%
Thesis/subject split at host department	50% - 50%
Honours grade ranges at host department:	
H1	80-100
H2a	75-79
H2b	70-74
H3	65-69