Subject Information Guide

Mathematical Biology: A nonlinear dynamics approach

Semester 2, 2014

Administration and contact details

Host Department	**School of Mathematical and Geospatial Sciences**
Host Institution	**RMIT University**
Name of lecturer	**Prof. Lewi Stone**
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Subject details

Handbook entry URL	
Subject homepage URL	
Honours student hand-out URL	
Start date:	**28th July**
End date:	**8th October**
Contact hours per week:	**2**
Lecture day and time:	**Monday 2pm - 4 pm**
Description of electronic access arrangements for students (for example, WebCT)	**NA**

Subject content

1. Subject content description

This course is designed for Honours students of both mathematics and statistics, and will attempt to survey exciting concepts in mathematical biology that have arisen over the last few decades. There will be an emphasis on nonlinear dynamical systems approaches with applied

bifurcation theory. While in the past, mathematics has taken the back seat in biological sciences, this view has changed in the extreme in recent years. Mathematical modelling has become one of the more important research tolls in biological research. This course will attempt to provide students with a suitable background for pursuing advanced research in biological modelling. The assessment of this course will involve implementing the techniques encountered in the lectures in a programming environment such as Mat Lab. Students should be comfortable with programming or be prepared to learn how to use Matlab.

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

   Week 1 Math Biology overview. Deterministic and stochastic models of birth-death processes. Mean time to extinction.

   Week 2: Biological models: equilibria, stability, basic bifurcations (saddle node,transcritical); Time delays; Metapopulation models; competitive hierarchies; Matlab brush-up

   Week 3&4 Logistic map: stability, dynamics; period doubling route to chaos; lyapunov exponent; Controlling and detecting chaos

   Week 5: Guest lecture. MatlabLab

   Week 6: Phase oscillators; Biological synchronization.

   Week 7-8: 2-Dimensional 2'nd order differential equation systems: Linear systems: Classification (Focus, Saddle, Node). Nonlinear systems: Phase plane dynamics

   Week 9: Applications: Ecological foodwebs; Disease models; Love affairs; When will a large complex system be stable?

   Week 10: Limit cycles; Hopf bifurcations.

   Week 11: Excitable systems (Hodgkin Huxley, Fitzhugh Nagumo neuron dynamics); Relaxation oscillator (Van der Pol's cardiac oscillator); Genetic circuits;

   Week 12: Biological networks

Text Books

Strogatz S. Nonlinear Dynamics And Chaos: With Applications To Physics, Biology, Chemistry, And Engineering. Perseus Books (1994)

Murray, JD Mathematical Biology. Springer (2000)

3. **Assumed prerequisite knowledge and capabilities**

   Students should be comfortable with basic programming or be prepared to learn to use Matlab.

4. Learning outcomes and objectives

Advanced knowledge of the classical and modern techniques used in the rapidly expanding field of Mathematical Biology.

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

Insert texts, printed notes and/or software required

6. Assessment

Exam/assignment/classwork breakdown					
Exam	**50 %**	**2 Assignment2**	**Total 50 %**	**Class work**	**0 %**
Assignment due dates		**9th September**	**7th October**	**1T**	**1T**
Approximate exam date				**Exam: 24 October (tentative date)**	

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 %**