MODULE TITLE	Mathematical Biology and Ecology	**CREDIT VALUE**	15
MODULE CODE	MTH3006	**MODULE CONVENER**	Prof Marc Goodfellow (Coordinator)

DURATION: TERM	**1**	**2**	**3**
DURATION: WEEKS	11 weeks	0	0

Number of Students Taking Module (anticipated)	90

DESCRIPTION - summary of the module content

This module will give you the opportunity to learn how mathematics may be applied to the biosciences in order to quantitatively model biological processes, from molecular processes at work within living cells up to the behaviour of populations and demographic phenomena. The subject matter has been selected so as to give a wide-ranging overview of the role applied mathematics has to play in the biological disciplines. You will build and analyse models (typically as differential equations or iterated maps) using real world examples from nature. Examples that may be studied within the module include: the population dynamics of insects, animals or fish, competitive exclusion of species, the behaviour of the chemical reactions kinetics that power living cells and mechanisms of biological pattern formation from reaction-diffusion equations.

Pre-requisite module: MTH2003 or equivalent

AIMS - intentions of the module

This module is designed to illustrate the application of mathematics to the biological science, and emphasises realistic situations throughout. These include: population dynamics and stage-structured population models incorporating complex demographies. They also include harvesting models; competitive exclusion of species; reaction kinetics; biological waves; diffusion-driven instabilities and the effects of geometry on pattern formation in animals. On this module, you will learn how to use core applied mathematics techniques, such as differential equation modelling and matrix algebra. However, no previous biological knowledge will be assumed.

INTENDED LEARNING OUTCOMES (ILOs) (see assessment section below for how ILOs will be assessed)

On successful completion of this module, you should be able to:

Module Specific Skills and Knowledge:
1 Appreciate how mathematics can be usefully employed in various aspects of the life sciences;

Discipline Specific Skills and Knowledge:
2 Understand the role of mathematical modelling in real-life situations;
3 Recognise how many aspects of applied mathematics learned in earlier modules have practical uses;
4 Develop considerable expertise in using analytical and numerical techniques to explore mathematical models, including the use of appropriate software (e.g. MATLAB, Python, R etc.)
5 Formulate simple models;
6 Study adeptly the resulting equations;
7 Draw conclusions about likely behaviours.

Personal and Key Transferable/ Employment Skills and Knowledge:
8 Display enhanced numerical and computational skills via the suite of practical exercises that accompany the formal lecture work;
9 Show enhanced literature searching and library skills in order to investigate various phenomena discussed;
10 Demonstrate enhanced time management and organisational abilities.

SYLLABUS PLAN - summary of the structure and academic content of the module

- Continuous models for a single species; analysis of models using linear stability theory; Hysteresis effects; harvesting a single natural population; discrete models and cobwebbing; discrete logistic growth and the route to chaos;
- Two-dimensional models; introduction to simple phase plane analysis; realistic models for various cases (e.g. predator-prey interactions) and the principles of competitive exclusion and mutualism;
- Introduction to population projection models; geometric growth, stable stage structures and reproductive value for stage-structured ecological populations; asymptotic analysis and transient bounds;
- Tools for analysing PPMs; sensitivity and elasticity; use of transfer function analysis to achieve exact perturbations; applications to managed conservation strategies; reaction kinetics and the law of mass action;
- Enzyme-substrate kinetics; Michaelis-Menten theory and activation/inhibition phenomena;
- Reaction-diffusion problems and biological waves; the Fisher equation; Turing instabilities and diffusion-driven instabilities in two-component systems; generation of patterning by domain geometry; minimal domains for stable pattern formation

LEARNING AND TEACHING

LEARNING ACTIVITIES AND TEACHING METHODS (given in hours of study time)

Scheduled Learning & Teaching Activities	33.00	**Guided Independent Study**	117.00	**Placement / Study Abroad**	0.00

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Scheduled Learning and Teaching Activities	33	Lectures, example classes
Guided Independent Study	117	Lecture and assessment preparation; wider reading

ASSESSMENT

FORMATIVE ASSESSMENT - for feedback and development purposes; does not count towards module grade

Form of Assessment	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Four Coursework Sheets	5-6 questions per sheet	1-10	Feedback sheet and in-class review of model solutions

SUMMATIVE ASSESSMENT (% of credit)

Coursework	20	**Written Exams**	80	**Practical Exams**	0

DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Coursework 1 – based on questions submitted for assessment	10	15 hours	All	Annotated script and written/verbal feedback
Coursework 2 - based on questions submitted for assessment	10	15 hours	All	Annotated script and written/verbal feedback
Written Exam	80	2 hours (Summer)	1-7	Written/Verbal on request, SRS

DETAILS OF RE-ASSESSMENT (where required by referral or deferral)

Original Form of Assessment	Form of Re-assessment	ILOs Re-assessed	Time Scale for Re-reassessment
Written Exam*	Written Exam (2 hours) (10%)	All	August Ref/Def Period
Coursework 1	Coursework 1 (10%)	All	August Ref/Def Period
Coursework 2	Coursework 2 (80%)	All	August ref/Def Period

*Please refer to reassessment notes for details on deferral vs. Referral reassessment

RE-ASSESSMENT NOTES

Deferrals: Reassessment will be by coursework and/or written exam in the deferred element only. For deferred candidates, the module mark will be uncapped.

Referrals: Reassessment will be by a single written exam worth 100% of the module only. As it is a referral, the mark will be capped at 40%.

RESOURCES

INDICATIVE LEARNING RESOURCES - The following list is offered as an indication of the type & level of information that you are expected to consult. Further guidance will be provided by the Module Convener

ELE - http://vle.exeter.ac.uk
Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	Murray, J.D.	Mathematical Biology	2nd	Springer	1993	000-3-540-57204-X	[Library]
Set	Jones, D.S. & Sleeman, B.D.	Differential Equations and Mathematical Biology	Electronic	Allen & Unwin	2003	000-0-045-15001-X	[Library]
Set	Fife, P.C.	Mathematical Aspects of Reacting and Diffusing Systems		Springer	1979	000-3-540-09117-3	[Library]
Set	May, R.M.	Theoretical Ecology. Principles and Applications	Electronic	Blackwell Scientific Publications	2007	000-0-632-00762-1	[Library]
Set	Alstad, D.	Basic Populus Models of Ecology		Prentice-Hall	2001	978-0130212894	[Library]
Set	Caswell, H.	Matrix Population Models: Construction, Analysis, and Interpretation	2nd	Sinauer Associates	2001	9780878930937	[Library]
Set	Britton, N.F.	Essential Mathematical Biology		Springer	2005	978-1852335366	[Library]

CREDIT VALUE	15	**ECTS VALUE**	7.5
PRE-REQUISITE MODULES	MTH2003		
CO-REQUISITE MODULES			
NQF LEVEL (FHEQ)	6	**AVAILABLE AS DISTANCE LEARNING**	No
ORIGIN DATE	Tuesday 10 July 2018	**LAST REVISION DATE**	Thursday 26 January 2023
KEY WORDS SEARCH	Mathematical Biology; Ecology; Nonlinear Dynamics; Systems Biology; Population Dynamics; Mathematical Modelling; Linear Algebra; Differential Equations		