MODULE TITLE	**Advanced Interdisciplinary Mathematics**	**CREDIT VALUE**	**15**
MODULE CODE	**ECM2912**	**MODULE CONVENER**	**Dr Tim Hughes (Coordinator)**

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

Number of Students Taking Module (anticipated)	**40**

DESCRIPTION - summary of the module content

This module follows on from Fundamentals of Interdisciplinary Mathematics/ Mathematics of the Environment. Continuing to work in small groups, you will integrate more advanced mathematical, computational and statistical modelling tools with key questions and issues from scientific and engineering applications. You will also broaden your understanding of scientific questions and engineering challenges and the relevance of modern mathematics to their solution.

Pre-requisite modules: "Fundamentals of Interdisciplinary Mathematics" (ECM1911 or ECM1913), or “Mathematics of the Environment (ECM2911), or equivalent.

Prerequisite modules are ECM1913 or ECM1911 or ECM2911.

AIMS - intentions of the module

In this module you will continue to develop the interdisciplinary perspective to mathematical sciences. Your learning will follow a three-stage cycle of colloquia, followed by group work, followed by sharing your work with the class: Contemporary, expert-led colloquia will address state of the art issues from ecology, environmental science, and renewable energy; Each colloquium will be followed by break out-sessions with you working in small groups, with guidance from the module leader and classroom assistants to further your understanding of mathematical modelling and scientific computing. Finally, you will present findings from the group work back to peers for discussion. Each of these three stages will be repeated three times to extend your knowledge of the underlying science and the relevant mathematical, statistical and computational approaches. You will also gain important experience of planning and carrying out research projects, scientific communication, and working in groups.

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 Apply and develop mathematical skills to model and analyse natural and technological phenomena;
2 Abstract key issues in engineering, environmental and life sciences into mathematical concepts;
Discipline Specific Skills and Knowledge:
3 Collect data;
4 Understand and develop sophisticated models for processes in ecology, renewable energy and social systems;
Personal and Key Transferable / Employment Skills and Knowledge:
5 Engage in group work;
6 Communicate to specialists and non-specialists both orally and in written form.

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

The syllabus is developed around three colloquia. These colloquia are delivered by experts from the engineering, environmental and life sciences. The exact details of each colloquium may vary from year to year because one key aim is to address contemporary issues from a mathematical sciences perspective. These colloquia will be representative of the scope of the engineering, environmental and life sciences and so will include colloquia from ecology; renewable energy and environmental sciences. To emphasise the interdisciplinary nature of the module, the focus of the colloquia will be on key scientific or engineering challenges. Each colloquia will then be followed by a lecture on mathematical and computational approaches to the challenges, which you will explore throughout the subsequent group work activity.
The learning and teaching will follow a 3-week cycle. Sample themes for purposes of illustration:

Weeks 1 – 3: Theme A. Optimal decision making for the energy economy:
To make renewable energy technologies cost-competitive and secure energy provision for consumers, efficiencies in the chain from generation, to distribution, to consumption have to be managed and optimised. This might be, e.g., at the level of the wind turbine, the electrical grid or smart efficient appliances within the internet of things. You will explore different routes of management and optimisation towards more sustainable energy. [1 hour colloquium, 2 hour lecture, 8 hours supported group work, 1 hour presentations and discussion].

Weeks 4 – 6. Theme B. Co-operation and Conflict:
Individual opinions on various societal challenges are formed within social networks. Opinions spread and can heavily influence how communities develop solutions for these challenges. Also, the outcome of an individual's decisions will depend on the decisions of others. Depending on the circumstances, this can lead to either competitive or cooperative behaviours. Similarly, competitive and cooperative behaviours emerge in biology as a result of natural selection. You will develop an understanding of simple mathematical models (e.g. agaent-based models/ game theoretic models) and apply these to understand and stimulate social network behaviours and/ or cooperation and competition in a biological setting. [1 hour colloquium, 2 hour lecture, 8 hours supported group work, 1 hours presentations and discussion].

Weeks 7 - 9: Theme C. Infectious diseases:
The spread of infectious diseases is influenced by various intrinsic and extrinsic factors related to the host, the pathogen and the mode of transmission. For example, transmission pattern may vary dramatically between different diseases depending on whether they are vector-borne, such as malaria or dengue, airborne, such as influenza or SARS-CoV-2, or transmitted through sexual contact, such as HIV. Similarly, susceptibility and virulence can also vary substantially between individual hosts and diseases. You will explore simple mathematical models of disease transmission and explore fundamental concepts in infectious disease epidemiology. [1 hour colloquium, 2 hour lecture, 8 hours supported group work, 1 hour presentations and discussion].

Weeks 10 & 11: Wrap-up
To reflect on the scientific themes and consolidate advanced mathematical modelling and scientific computing skills. [3 hours of academic support per week].

LEARNING AND TEACHING

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

Scheduled Learning & Teaching Activities	39.00	**Guided Independent Study**	111.00	**Placement / Study Abroad**	0.00

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

Category	Hours of study time	Description
Lectures	15	Colloquium lectures, regular lectures and wrap-up sessions
Group Activities	24	Guided mathematical investigation
Presentation	3	Presentation sessions
Guided Independent Study	108	Wider reading and preparation

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
Group discussions	Multiple discussions during group work sessions	1-7	Oral

SUMMATIVE ASSESSMENT (% of credit)

Coursework	100	Written Exams	0	Practical Exams	0

DETAILS OF SUMMATIVE ASSESSMENT

Form of Assessment	% of Credit	Size of Assessment (e.g. duration/length)	ILOs Assessed	Feedback Method
Portfolio	60	To comprise a group presentation (10 minutes plus questions), a group poster (1 side A2), and a group report (4 sides A4)	1-6	Written
Class Test	30	Approx. 1 hour	1-4	Written
Engagement	10	N/A	5-6	Written

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-assessment
All above	Individual Report 3000 words (or equivalent)	1-6	Submit by last week in August

RE-ASSESSMENT NOTES

If a module is normally assessed entirely by coursework, all referred/deferred assessments will normally be by assignment.
If a module is normally assessed by examination or examination plus coursework, referred and deferred assessment will normally be by examination. For referrals, only the examination will count, a mark of 40% being awarded if the examination is passed. For deferrals, candidates will be awarded the higher of the deferred examination mark or the deferred examination mark combined with the original coursework mark.

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:

MATLAB:
McMahon, D., MATLAB Demystified Higham, D., Higham, N., MATLAB Guide
Kharab, A., Guenther, R., An Introduction to Numerical Methods: A MATLAB Approach Hahn, B.D., Essential MATLAB for Engineers and Scientists

Optimisation and Energy Systems:
Sørensen, B., Renewable Energy: Physics, Engineering, Environmental Impacts, Economy and Planning Great Britain. Department of Trade and Industry, Our energy future: creating a low carbon economy Greig, D.M., Optimisation

Infectious diseases:
Keeling, M., Rohani, P., Modelling Infectious Disease in Humans and Animals
Vynnycky, E., White, R.G., An Introduction to Infectious Disease Modelling

Cooperation and conflict:
Scott, J., Carrington, P.J. (eds.), The SAGE Handbook of Social Network Analysis Newman, M.E.J., Networks: An Introduction
Grimm, V., Railsback, S.F., Individual-Based Modeling and Ecology

Reading list for this module:

Type	Author	Title	Edition	Publisher	Year	ISBN	Search
Set	McMahon, D.	MATLAB Demystified		McGraw-Hill	2007	978-0071485517	[Library]
Set	Higham, D. and Higham, N.	MATLAB Guide	3rd	SIAM	2017	978-1611974652	[Library]
Set	Kharab, A. and Guenther, R.B.	An Introduction To Numerical Methods: A MATLAB Approach		Chapman & Hall	2012	978-1439868997	[Library]
Set	Hahn, Brian D.	Essential MATLAB for Engineers and Scientists	4th	Academic Press	2010	9780123748836012	[Library]
Set	Sorensen, B.	Renewable Energy: Physics, Engineering, Environmental Impacts, Economics and Planning	5th	Academic Press	2017		[Library]
Set	Greig, D.M.	Optimisation		Longman	1980		[Library]
Set	Vynnycky, E. and White, R.G.	An Introduction to Infectious Disease Modelling	1st	Oxford University Press, USA	2010		[Library]
Set	Scott, J., Carrington, P.J. (eds.)	The SAGE Handbook of Social Network Analysis	1st	Sage Publications Ltd	2011		[Library]
Set	Newman, M.E.J.	Networks: An Introduction		Oxford University Press	2010	978-0199206650	[Library]
Set	Grimm, V. and Railsback, S.F.	Individual-based Modelling and Ecology		Princeton University Press	2005		[Library]

CREDIT VALUE	15	**ECTS VALUE**	7.5
PRE-REQUISITE MODULES	ECM1913, ECM1911, ECM2911		
CO-REQUISITE MODULES			
NQF LEVEL (FHEQ)	5	**AVAILABLE AS DISTANCE LEARNING**	No
ORIGIN DATE	Thursday 07 May 2015	**LAST REVISION DATE**	Wednesday 08 February 2023
KEY WORDS SEARCH	Interdisciplinary mathematics; Mathematical sciences; Ecology; Renewable Energy; Environmental Science		