University of Dundee Division of Mathematics

MA41002 Mathematical Biology I: Course Guide 2011/12 (Semester 2)

AIMS

The aim of this course is to introduce you to some biological phenomena and their formulation in terms of mathematical models, which lead to difference equations and ordinary differential equations, and to investigate the solutions of these equations. A deep, theoretical study of difference/differential equations is not involved.

ORGANISATION

The course is given in the first teaching session and consists of 33 hours of lectures and tutorials, meeting 3 times per week for 11 weeks. Check BlackBoard for details of class times and places.

The lecturer is Dr. Gibin Powathil whose office is room 1.43K, MSI Building, Old Hawkhill. He is responsible for the teaching and organization of the course.

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SYLLABUS

Single Species Population dynamics

Difference equations: graphical analysis, fixed points and linear stability analysis.
First order systems of ordinary differential equations: logistic equation, steady states, linearisation, and stability.
Harvesting and fisheries

Interacting Species

Systems of difference equations (host-parasitoid systems)
Systems of ordinary differential equation (predator-prey and competition models)

Molecular Dynamics

Biochemical kinetics: Michaelis-Menten kinetics.
Metabolic pathways: activation and inhibition.

LEARNING OBJECTIVES

Knowledge and Understanding

By the end of the course you will be expected to demonstrate knowledge of:

The role of mathematical modelling in biology.

The biological significance of the various terms and quantities, which appear in some mathematical models.

Solutions of difference equations and their stability. Period-doubling and chaotic solutions.

Ordinary differential equations in the phase plane; critical points and their stability.

Applications of ordinary differential models to some biological phenomena including interacting species and biochemical pathways.

Skills

By the end of the course you will be expected to be able to:

Formulate mathematical models of some biological phenomena.

Express mathematical models in terms of non-dimensional variables and discuss the effects of changes in the parameters in the models.

Find steady states and analyse their stability for both difference and differential equations.

Find period-two solutions for some model difference equations and give a descriptive account of chaos.

Sketch cobweb diagrams for simple iterations and discuss the behaviour of the iterates.

Sketch the phase plane for a system of two ordinary differential equations.

Write down the system of ordinary differential equations for the rates of change of the concentrations of the reactants in a chemical reaction.

ASSESSMENT

There will be two class tests and one assignment during the course, which will count towards 30 % of your total degree mark.

The course is also assessed by a two-hour degree examination, which is taken in the May Degree Examination Diet. This will count towards 70% of your total degree mark.

You require a combined mark of 40% to pass the module.

STUDENT FEEDBACK

You should make an appointment to see Dr. Powathil if you have a problem regarding the course. You may also bring any matters of concern to you about the course to the attention of the Staff/Student Committee, which meets each term. A list of representatives is posted on the notice boards in the Mathematics Division. You will have the opportunity to make constructive comments on the course via an anonymous questionnaire, which will be handed out towards the end of the module.

RECOMMENDED TEXTS

N. F. Britton, Essential Mathematical Biology, (Springer 2003).

J D Murray, Mathematical Biology, (Springer 1989; 2nd ed. 1993; 3rd ed.2003).

L Edelstein-Keshet, Mathematical Models in Biology, (Birkh¨auser 1987).