MA146-10 Methods of Mathematical Modelling 1

24/25

Department
Warwick Mathematics Institute
Level
Undergraduate Level 1
Module leader
Bjorn Stinner
Credit value
10
Module duration
10 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

The module introduces the fundamentals of mathematical modelling and scaling analysis, before discussing and analysing difference and differential equation models in the context of physics, chemistry, engineering as well as the life and social sciences.

Module aims

To introduce the basic concepts of ODEs and difference equations and their solutions.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

1. Introduction to mathematical modelling: Mathematical modelling cycle, types of models (stochastic, deterministic, discrete, continuous, ….).
2. Scaling and dimensional analysis: Buckingham’s Pi Theorem, examples from chemical reac-

tions and projectile motion, perturbation methods (time-permitting).
3. First order linear equations: first order linear equations, examples of existence and uniqueness, integration techniques (integrating factors, ..).
4. Second order equations: general homogeneous equations and linear second order equations with constant coefficients, reduction to 2x2 systems, sketching the flow under a vector field (2d only, phase diagrams).
5. Nonlinear equations and 2x2 systems: linear stability such as predator and prey models.
6. Difference equation: discrete population models such as the logistic model/fishery management, stability and instability of solutions (6+7 could be moved before 4).
7. Discretisation techniques: explicit and implicit Euler, connection to difference equations, stability.

Learning outcomes

By the end of the module, students should be able to:

- understand the modelling cycle and be able to formulate and analyse simple models themselves
- use scaling, non-dimensionalisation and linear stability techniques to reveal and understand the main underlying dynamics/driving factors
- solve simple ODEs (first order and second order) and interpret their qualitative behavior
- solve simple difference equations and understand their connection to continuous ODEs
- understand the basic concepts of numerical approximation

Indicative reading list

Logan, David. A first course in differential equations. Springer, 2006.
Robinson, James C. An introduction to ordinary differential equations. Cambridge University Press, 2004.
Holmes, Mark H. Introduction to the foundations of applied mathematics. Springer, 2009.
Hermann, Martin, and Masoud Saravi. Nonlinear ordinary differential equations. Springer India, 2016.
Witelski, B. and Bowen, M., Methods of Mathematical Modelling: Continuous Systems and Differential Equations, Springer, 2015

Subject specific skills

The module introduces the fundamentals of mathematical modelling and scaling analysis, before discussing and analysing difference and differential equation models in the context of physics, chemistry, engineering as well as the life and social sciences.

Transferable skills

Students will acquire key modelling and problem solving skills which will empower them to address problems in a large range of scientific fields with confidence.

Study

Study time

Type	Required
Lectures	20 sessions of 1 hour (48%)
Online learning (independent)	9 sessions of 1 hour (21%)
Private study	13 hours (31%)
Total	42 hours

Private study description

Working on assignments, going over lecture notes, text books, exam revision.

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D

	Weighting	Study time	Eligible for self-certification
Assignments	15%	20 hours	No
In-person Examination	85%	38 hours	No

- Answerbook Pink (12 page)

Assessment group R

	Weighting	Study time	Eligible for self-certification
In-person Examination - Resit	100%		No

- Answerbook Pink (12 page)

Feedback on assessment

Marked homework (both assessed and formative) is returned and discussed in smaller classes.

Exam feedback is given.

Past exam papers for MA146

Availability

Courses

This module is Core for:

- Year 1 of UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
- Year 1 of UMAA-G100 Undergraduate Mathematics (BSc)
- UMAA-G103 Undergraduate Mathematics (MMath)
    - Year 1 of G100 Mathematics
    - Year 1 of G103 Mathematics (MMath)
- Year 1 of UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
- Year 1 of UMAA-G1NC Undergraduate Mathematics and Business Studies
- Year 1 of UMAA-G1N2 Undergraduate Mathematics and Business Studies (with Intercalated Year)
- Year 1 of UMAA-GL11 Undergraduate Mathematics and Economics
- Year 1 of UECA-GL12 Undergraduate Mathematics and Economics (with Intercalated Year)
- Year 1 of UMAA-G101 Undergraduate Mathematics with Intercalated Year