MA424-15 Dynamical Systems

26/27

Department
Warwick Mathematics Institute
Level
Undergraduate Level 4
Module leader
Richard Sharp
Credit value
15
Module duration
10 weeks
Assessment
Multiple
Study location
University of Warwick main campus, Coventry

Description

Introductory description

Dynamical Systems is one of the most active areas of modern mathematics. This course will be a broad introduction to the subject and will attempt to give some of the flavour of this important area.

Module web page

Module aims

The course will have two main themes. Firstly, to understand the behaviour of particular classes of transformations. We begin with the study of one dimensional maps: circle homeomorphisms and expanding maps on an interval. These exhibit some of the features of more general maps studied later in the course (e.g., expanding maps, horseshoe maps, toral automorphisms, etc.). A second theme is to understand general features shared by different systems. This leads naturally to their classification, up to conjugacy. An important invariant is entropy, which also serves to quantify the complexity of the system.

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.

We will cover some of the following topics:

1. Circle homeomorphisms and minimal homeomorphisms.
2. Expanding maps and Julia sets,
3. Horseshoe maps, toral automorphisms and other examples of hyperbolic maps.
4. Structural stability, shadowing, closing lemmas, Markov partitions and symbolic dynamics.
5. Conjugacy and topological entropy.
6. Strange attractors.

Learning outcomes

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

- Students who successfully complete the module will have developed an understanding of the modern qualitative theory of dynamical systems. This will include:a) familiarity with the basic concepts of topological dynamics, particularly minimality, topological transitivity, topological mixing and topological conjugacy and the ability to demonstrate that these properties are satisfied in appropriate examples;b) a familiarity with a range of examples of dynamical systems, including circle homeomorphisms, expanding maps, total automorphisms, horseshoes, solenoids, subshifts of finite type, and the relation of these examples to the concepts of hyperbolicity and structural stability;c) understanding of the concept of symbolic dynamical models and the proofs that such models exist in certain examples (e.g. the doubling maps, expanding circle maps, horseshoes)d) knowledge of the definition of topological entropy and the role it plays as an invariant of topological conjugacy, calculation of topological entropy in examples.

Subject specific skills

Students who have successfully taken the module will be equipped to use a variety of mathematical techniques to investigate and understand a range of dynamical systems exhibiting complex behaviour. They will have the background to carry of further study in the area, at graduate level, and to apply the techniques they have learned to various areas of applications where dynamical systems appear, such as control systems, engineering and meteorology. More generally, they will have had the opportunity to develop their analytic skills through the study of complex and abstract systems.

Transferable skills

Students who have successfully taken the module will be equipped to use a variety of mathematical techniques to investigate and understand a range of dynamical systems exhibiting complex behaviour. They will have the background to carry of further study in the area, at graduate level, and to apply the techniques they have learned to various areas of applications where dynamical systems appear, such as control systems, engineering and meteorology. More generally, they will have had the opportunity to develop their analytic skills through the study of complex and abstract systems.

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Tutorials	9 sessions of 1 hour (6%)
Private study	111 hours (74%)
Total	150 hours

Private study description

Review lectured material and work on set exercises.

Costs

No further costs have been identified for this module.

Assessment

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

Students can register for this module without taking any assessment.

Assessment group B1

	Weighting	Study time	Eligible for self-certification
Centrally-timetabled examination (On-campus) 3 hour exam, no books allowed	100%		No

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- Answerbook Gold (24 page)

Assessment group R

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

	Weighting	Study time	Eligible for self-certification

- Answerbook Gold (24 page)

Feedback on assessment

Marked assignments and exam feedback.

Past exam papers for MA424

Availability

Courses

This module is Optional for:

- TMAA-G1PE Master of Advanced Study in Mathematical Sciences
  - Year 1 of G1PE Master of Advanced Study in Mathematical Sciences
  - Year 1 of G1PE Master of Advanced Study in Mathematical Sciences
- Year 1 of TMAA-G1PD Postgraduate Taught Interdisciplinary Mathematics (Diploma plus MSc)
- Year 1 of TMAA-G1P0 Postgraduate Taught Mathematics
- TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
  - Year 1 of G1PC Mathematics (Diploma plus MSc)
  - Year 2 of G1PC Mathematics (Diploma plus MSc)

This module is Core option list F for:

- Year 4 of UMAA-GV19 Undergraduate Mathematics and Philosophy with Specialism in Logic and Foundations

This module is Option list A for:

- TMAA-G1PD Postgraduate Taught Interdisciplinary Mathematics (Diploma plus MSc)
  - Year 1 of G1PD Interdisciplinary Mathematics (Diploma plus MSc)
  - Year 2 of G1PD Interdisciplinary Mathematics (Diploma plus MSc)
- Year 1 of TMAA-G1P0 Postgraduate Taught Mathematics
- Year 1 of TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
- Year 4 of UPXA-FG33 Undergraduate Mathematics and Physics (BSc MMathPhys)
- Year 4 of UPXA-FG31 Undergraduate Mathematics and Physics (MMathPhys)
- Year 4 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)

This module is Option list B for:

- TMAA-G1PD Postgraduate Taught Interdisciplinary Mathematics (Diploma plus MSc)
  - Year 1 of G1PD Interdisciplinary Mathematics (Diploma plus MSc)

    - Year 2 of G1PD Interdisciplinary Mathematics (Diploma plus MSc)
- Year 1 of TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
- Year 4 of UCSA-G4G3 Undergraduate Discrete Mathematics
- Year 5 of UCSA-G4G4 Undergraduate Discrete Mathematics (with Intercalated Year)

This module is Option list C for:

- UMAA-G105 Undergraduate Master of Mathematics (with Intercalated Year)
    - Year 3 of G105 Mathematics (MMath) with Intercalated Year
    - Year 4 of G105 Mathematics (MMath) with Intercalated Year
    - Year 5 of G105 Mathematics (MMath) with Intercalated Year
- UMAA-G103 Undergraduate Mathematics (MMath)
    - Year 3 of G103 Mathematics (MMath)
    - Year 4 of G103 Mathematics (MMath)
- Year 4 of UMAA-G107 Undergraduate Mathematics (MMath) with Study Abroad
- UMAA-G106 Undergraduate Mathematics (MMath) with Study in Europe
    - Year 3 of G106 Mathematics (MMath) with Study in Europe
    - Year 4 of G106 Mathematics (MMath) with Study in Europe

This module is Option list E for:

- Year 5 of USTA-G301 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics (with Intercalated