MA4E0-15 Lie Groups

20/21

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

Description

Introductory description

The concept of continuous symmetry suggested by Sophus Lie had an enormous influence on many branches of mathematics and physics in the twentieth century. Created first as a tool in a small number of areas (e.g. PDEs) it developed into a separate theory which influences many areas of modern mathematics such as geometry, algebra, analysis, mechanics and the theory of elementary particles, to name a few.

Module web page

Module aims

In this module we shall introduce the classical examples of Lie groups and basic properties of the associated Lie algebra and exponential map.

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.

- Topological Groups
- Manifolds

- Lie Groups
- Lie Algebras
- Tangent Space
- The Lie Algebra of a Lie Group
- Integrating Vector Fields and the Exponential Map
- Lie Subgroups
- Continuity implies Smoothness
- Outlook: Differential Geometry and Representation Theory

Learning outcomes

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

- After taking this module, students will have working knowledge of Lie groups. They will be familiar with connections of Lie groups to Algebra, Differential Geometry and Representation Theory. Students will learn examples of Lie groups and their Lie algebras.

Subject specific skills

Students who successfully complete the module will have developed understanding of the Lie group theory and their connections with the Lie algebra theory. This will include:

- familiarity with the basic concepts of manifolds, vector fields and topological groups to the extend they are used in the theory of Lie groups;
- detailed knowledge of all classical simple Lie groups and their Lie algebras;
- understanding of the invariant vector fields on a Lie group, the exponential map, the Cartan theorem and the orbit-stabiliser theorem for Lie groups;
- familiarity with some advanced topics in the theory of Lie groups such as their representation theory, symmetric spaces and holonomy.

Transferable skills

Students who have successfully taken the module will be equipped to use Lie groups in a variety of situations where they appear in Physics, Algebra, Analysis, Geometry, Number Theory or Topology. They will have background to carry research in the area or to undertake further, more advance studies on the subject. More generally, they will have had the opportunity to develop their analytic skills through the study of Lie theory, a unique blend of Algebra, Analysis and Geometry,

---

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
In-person Examination 3 hour exam, no books allowed	100%	

- Answerbook Gold (24 page)

Assessment group R

	Weighting	Study time
In-person Examination - Resit	100%	

- Answerbook Gold (24 page)

Feedback on assessment

Exam feedback

Past exam papers for MA4E0

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-G1P0 Postgraduate Taught Mathematics
- Year 1 of TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
- USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics
  - Year 3 of G300 Mathematics, Operational Research, Statistics and Economics
  - Year 4 of G300 Mathematics, Operational Research, Statistics and Economics

This module is Core option list D for:

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

This module is Option list A for:

- Year 1 of TMAA-G1PD Postgraduate Taught 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 USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)

This module is Option list B for:

- Year 1 of TMAA-G1PD Postgraduate Taught 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 3 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- Year 4 of USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (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 5 of G105 Mathematics (MMath) with Intercalated Year
- UMAA-G103 Undergraduate Mathematics (MMath)
  - Year 3 of G103 Mathematics (MMath)
  - Year 3 of G103 Mathematics (MMath)

    - Year 4 of G103 Mathematics (MMath)
    - Year 4 of G103 Mathematics (MMath)
- 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 4 of USTA-G300 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics
- Year 5 of USTA-G301 Undergraduate Master of Mathematics,Operational Research,Statistics and Economics (with Intercalated