MA9N5-15 Topics in Algebra

23/24

Department
Warwick Mathematics Institute
Level
Research Postgraduate Level
Module leader
Christian Boehning
Credit value
15
Module duration
10 weeks
Assessment
100% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

This is a topics module. Such modules are designed to address material of particular interest in the year of delivery. By their nature, the specific topics rotate, which means that the course will also be of use to PhD students in later years, even if they took the course for credit already. However, in each year the topics will be in algebra.

Module aims

Assuming only a modest background and some familiarity with basic techniques in algebra, the course will introduce students to more advanced topics in the field that make up some of the prerequisites and toolkit of modern research. In the academic year 2023-24 the module will provide an introduction to modern techniques in homological algebra, in particular the language of derived and triangulated categories and some of their applications in neighbouring fields such as algebraic geometry, representation theory and topology.

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.

Possible topics comprise:

-Some basic notions from category theory, including additive and abelian categories and functors in abelian categories
-Simplicial sets
-Localisation and derived category of an abelian category
-Derived functors
-Spectral sequences and derived functor of a composition
-Triangulated categories and exact functors
-Exceptional sequences and semiorthogonal decompositions
-Cores and t-structures
-Some view towards dg- categories and A-infinity categories

We will also make every attempt to bring this material to life with lots of examples and applications in other fields of mathematics. Which areas these will mainly be taken from (algebraic geometry/coherent sheaves on varieties, representation theory, topology), will depend on the background of the participants.

Learning outcomes

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

- command fundamental tools from the theory of derived and triangulated categories
- understand of a selection of the concepts, theorems and calculations related to triangulated and derived categories
- apply properties and features of triangulated and derived categories to problems in other fields of mathematics.

Indicative reading list

-S.I. Gelfand, Y.I. Manin: Methods of Homological Algebra, 2nd ed., Springer Monographs in Math. (2003)
-D. Huybrechts: Fourier-Mukai Transforms in Algebraic Geometry, Oxford Math. Monographs (2006)
-A. Yekutieli, Derived categories, Cambridge studies in advanced math. 183, (2020)
-P. Seidel, Fukaya categories and Picard-Lefschetz theory, European Math. Society (2008)

Subject specific skills

The students will acquire the basic skills needed to apply derived category techniques in various areas of mathematics such as algebraic and complex analytic geometry, representation theory, and algebraic topology. They will learn to view and approach problems in those areas from the point of view of advanced homological algebra and triangulated categories. In various instances, this will also provide them with a unifying perspective on seemingly unrelated questions in different parts of mathematics.

Transferable skills

- sourcing research material
- prioritising and summarising relevant information
- absorbing and organising information
- presentation skills (both oral and written)

Study

Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Private study	120 hours (80%)
Total	150 hours

Private study description

Review lectured material.
Work on suplementary reading material.
Source, organise and prioritise material for additional reading.

Costs

No further costs have been identified for this module.

Assessment

You must pass all assessment components to pass the module.

Assessment group B

Assessment component	Weighting	Study time	Eligible for self-certification
Oral Exam	100%		No

An oral exam involving a presentation by the student, followed by questions from the panel (2 members of the department)

Reassessment component is the same

Feedback on assessment

Students will receive feedback from the course instructor after the oral exam, to cover also areas like presentation skills and use of technologies (or blackboard)

Past exam papers for MA9N5

Availability

Courses

This module is Optional for:

- Year 1 of RMAA-G1P1 Postgraduate Research Interdisciplinary Maths
- RMAA-G1P4 Postgraduate Research Mathematics
    - Year 1 of G1P4 Mathematics (Research)
    - Year 1 of G1P4 Mathematics (Research)
    - Year 1 of G1P4 Mathematics (Research)
    - Year 1 of G1P4 Mathematics (Research)
- Year 1 of RMAA-G1PG Postgraduate Research Mathematics of Systems
- Year 1 of TMAA-G1PF Postgraduate Taught Mathematics of Systems