

# MA4J7-15 Cohomology and Poincare Duality

**22/23**

**Department**

Warwick Mathematics Institute

**Level**

Undergraduate Level 4

**Module leader**

Saul Schleimer

**Credit value**

15

**Module duration**

10 weeks

**Assessment**

Multiple

**Study location**

University of Warwick main campus, Coventry

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## Description

### Introductory description

N/A

[Module web page](#)

### Module aims

To introduce cohomology and products as an important tool in topology. Give a proof of the Poincare duality theorem and go on to use this theorem to compute products. There will be many applications of products including using products to distinguish between spaces with isomorphic homology groups. To use products to study the classical Hopf maps.

### 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. Cochain complexes and cohomology.
2. The duality between homology and cohomology.

3. Chain approximations to the diagonal and products in cohomology.
4. The cohomology ring.
5. The cohomology ring of a product of spaces and applications.
6. The Poincare duality theorem.
7. The cohomology ring of projective spaces and applications.
8. The Hopf invariant and the Hopf maps.
9. Spaces with polynomial cohomology.
10. Further applications of cohomology

## Learning outcomes

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

- Define cup and cap products.
- Use the Poincare duality theorem.
- Compute the cohomology ring of many spaces including product spaces and projective spaces.
- Apply the cohomology ring to get topological results.
- Define, calculate and apply the Hopf invariant.

## Indicative reading list

Algebraic Topology, Allen Hatcher, CUP 2002

Algebraic Topology a first course, Greenberg and Harper, Addison-Wesley 1981

## Subject specific skills

See learning outcomes

## Transferable skills

Students will acquire key reasoning and problem solving skills which will empower them to address new problems with confidence.

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## Study

### Study time

Type	Required
Lectures	30 sessions of 1 hour (20%)
Seminars	10 sessions of 1 hour (7%)
Private study	110 hours (73%)
Total	150 hours

## Private study description

110 hours private study and revision.

## Costs

No further costs have been identified for this module.

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## Assessment

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

### Assessment group D1

	<b>Weighting</b>	<b>Study time</b>
Assignments	15%	
In-person Examination	85%	

- Answerbook Gold (24 page)

### Assessment group R

	<b>Weighting</b>	<b>Study time</b>
In-person Examination - Resit	100%	

- Answerbook Gold (24 page)

## Feedback on assessment

Marked assignments and exam feedback.

[Past exam papers for MA4J7](#)

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## 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
- Year 1 of TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)

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
- TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
  - Year 1 of G1PC Mathematics (Diploma plus MSc)
  - Year 2 of G1PC Mathematics (Diploma plus MSc)
- Year 4 of USTA-G1G3 Undergraduate Mathematics and Statistics (BSc MMathStat)
- Year 5 of USTA-G1G4 Undergraduate Mathematics and Statistics (BSc MMathStat) (with Intercalated Year)

This module is Option list B for:

- TMAA-G1PC Postgraduate Taught Mathematics (Diploma plus MSc)
  - Year 1 of G1PC Mathematics (Diploma plus MSc)
  - Year 2 of G1PC 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 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 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