# MATH300

## Geometry and Topology

S1 Day 2015

*Dept of Mathematics*

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General Information

Unit convenor and teaching staff
Unit Convenor
Michael Batanin
michael.batanin@mq.edu.au
Contact via michael.batanin@mq.edu.au

Chris Meaney
chris.meaney@mq.edu.au

Credit points
3

Prerequisites
39cp including MATH235

Corequisites

Co-badged status

Unit description
This unit is designed to widen geometric intuition and horizons by studying topics such as projective geometry, topology of surfaces, graph theory, map colouring, ruler-and-compass constructions, knot theory and isoperimetric problems. This unit is especially recommended for those students preparing to become teachers of high school mathematics.

Important Academic Dates
Information about important academic dates including deadlines for withdrawing from units are available at https://students.mq.edu.au/important-dates

Learning Outcomes

1. Demonstrate knowledge of the principles and concepts of elementary topology and Euclidean, affine, and projective geometry in the plane.
2. Present a broad outline of the scope of topology and geometry in two dimensions, their roles in other fields, and the way other fields contribute to their development.
3. Demonstrate the ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning. In particular, the ability to use axioms and definitions correctly within an argument.
4. Demonstrate the ability to formulate and model practical and abstract problems in
mathematical terms using methods from geometry and topology.

5. Be able to apply the principles, concepts, and techniques learned in this unit to solve practical and abstract problems.

6. Demonstrate appropriate interpretation of information communicated in mathematical form. Be able to understand what is being said in mathematical expressions.

7. Be able to present reasoning and conclusions informed by analysis involving geometry and topology, in a variety of modes, to diverse audiences (expert and non-expert).

8. Ethical application of mathematical approaches to solving problems and appropriately reference and acknowledge sources in an mathematical context.

9. Be able to work effectively, responsibly and safely in an individual or team context.

**Assessment Tasks**

<table>
<thead>
<tr>
<th>Name</th>
<th>Weighting</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eight assignments</td>
<td>20%</td>
<td>TBA</td>
</tr>
<tr>
<td>One Test</td>
<td>20%</td>
<td>TBA</td>
</tr>
<tr>
<td>Final examination</td>
<td>60%</td>
<td>University Examination Period</td>
</tr>
</tbody>
</table>

**Eight assignments**

Due: TBA
Weighting: **20%**

This Assessment Task relates to the following Learning Outcomes:

- Demonstrate knowledge of the principles and concepts of elementary topology and Euclidean, affine, and projective geometry in the plane.
- Demonstrate the ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning. In particular, the ability to use axioms and definitions correctly within an argument.
- Demonstrate the ability to formulate and model practical and abstract problems in mathematical terms using methods from geometry and topology.
- Be able to apply the principles, concepts, and techniques learned in this unit to solve practical and abstract problems.
- Demonstrate appropriate interpretation of information communicated in mathematical form. Be able to understand what is being said in mathematical expressions.
- Be able to present reasoning and conclusions informed by analysis involving geometry.
and topology, in a variety of modes, to diverse audiences (expert and non-expert).

- Ethical application of mathematical approaches to solving problems and appropriately reference and acknowledge sources in an mathematical context.
- Be able to work effectively, responsibly and safely in an individual or team context.

**One Test**

**Due:** TBA  
**Weighting:** 20%

This Assessment Task relates to the following Learning Outcomes:

- Demonstrate knowledge of the principles and concepts of elementary topology and Euclidean, affine, and projective geometry in the plane.
- Present a broad outline of the scope of topology and geometry in two dimensions, their roles in other fields, and the way other fields contribute to their development.
- Demonstrate the ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning. In particular, the ability to use axioms and definitions correctly within an argument.
- Demonstrate the ability to formulate and model practical and abstract problems in mathematical terms using methods from geometry and topology.
- Be able to apply the principles, concepts, and techniques learned in this unit to solve practical and abstract problems.
- Demonstrate appropriate interpretation of information communicated in mathematical form. Be able to understand what is being said in mathematical expressions.
- Be able to present reasoning and conclusions informed by analysis involving geometry and topology, in a variety of modes, to diverse audiences (expert and non-expert).

**Final examination**

**Due:** University Examination Period  
**Weighting:** 60%

This Assessment Task relates to the following Learning Outcomes:

- Demonstrate knowledge of the principles and concepts of elementary topology and Euclidean, affine, and projective geometry in the plane.
- Present a broad outline of the scope of topology and geometry in two dimensions, their roles in other fields, and the way other fields contribute to their development.
- Demonstrate the ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning. In particular, the ability to use axioms and definitions correctly within an argument.
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- Demonstrate the ability to formulate and model practical and abstract problems in mathematical terms using methods from geometry and topology.
- Be able to apply the principles, concepts, and techniques learned in this unit to solve practical and abstract problems.
- Demonstrate appropriate interpretation of information communicated in mathematical form. Be able to understand what is being said in mathematical expressions.
- Be able to present reasoning and conclusions informed by analysis involving geometry and topology, in a variety of modes, to diverse audiences (expert and non-expert).

**Delivery and Resources**

**Classes**

**Lectures:** you should attend two hours of each lecture stream each week, making a total of four hours.

**Required and Recommended Texts and/or Materials**

The required text for MATH300 is available for download on

- *MATH300 Geometry and Topology* by C. Cooper

You should download and study these.

The online notes are intended primarily as a source of reference. These are not intended to be treated as the only source for learning.

**ADDITIONAL NOTES**

- **Notes on knots.** The part that is relevant to us begins on Page 3 with "The next invariant we will discuss is the Conway polynomial."
- **Worked example** of calculating the Alexander polynomial.
- **Notes on modules.**
- **Notes on surfaces,** with nice pictures — compiled by N. Hitchen at Univ. of Oxford.

**Technology Used and Required**

Students are expected to have access to an internet enabled computer with a web browser and Adobe Reader software. Several areas of the university provide wireless access for portable computers. There are computers for student use in the Library and in the Numeracy Centre (C5A 255).

Difficulties with your home computer or internet connection do not constitute a reasonable excuse for lateness of, or failure to submit, assessment tasks.

https://unitguides.mq.edu.au/unit_offerings/49525/unit_guide/print
Unit Schedule

<table>
<thead>
<tr>
<th>WEEK</th>
<th>GEOMETRY</th>
<th>TOPOLOGY</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Rigid motions in the plane</td>
<td>Topological spaces</td>
</tr>
<tr>
<td>2</td>
<td>Linear algebra</td>
<td>Surfaces</td>
</tr>
<tr>
<td>3</td>
<td>Affine Geometry</td>
<td>Surfaces and Surgery</td>
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<tr>
<td>4</td>
<td></td>
<td>Characterising Surfaces</td>
</tr>
<tr>
<td>5</td>
<td>Projective Geometry</td>
<td>Graphs on Surfaces</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>Graphs and Map Colouring</td>
</tr>
<tr>
<td></td>
<td>Recess</td>
<td>Recess</td>
</tr>
<tr>
<td>7</td>
<td>Projective Geometry</td>
<td>Graphs and Map Colouring</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>Knots and Links</td>
</tr>
<tr>
<td>9</td>
<td>Conic sections</td>
<td>The Alexander Number of a Knot</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>The Alexander Group of a Knot</td>
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<tr>
<td>11</td>
<td>Ruler and Compass Constructions</td>
<td>The Alexander Module</td>
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<tr>
<td>12</td>
<td></td>
<td>Th Alexander Polynomial</td>
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<tr>
<td>13</td>
<td>Revision</td>
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Learning and Teaching Activities

Lectures
Attend 4 hours of lectures per week. Two in geometry, two in topology

Assignments
Write solutions to 8 assignments

Policies and Procedures
Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html
Student Support

Macquarie University provides a range of support services for students. For details, visit [http://students.mq.edu.au/support/](http://students.mq.edu.au/support/)

**Learning Skills**

Learning Skills ([mq.edu.au/learningskills](http://mq.edu.au/learningskills)) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

**Student Enquiry Service**

For all student enquiries, visit Student Connect at [ask.mq.edu.au](http://ask.mq.edu.au)

**Equity Support**

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.
IT Help

For help with University computer systems and technology, visit http://informatics.mq.edu.au/help. When using the University's IT, you must adhere to the Acceptable Use Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

Discipline Specific Knowledge and Skills

Our graduates will take with them the intellectual development, depth and breadth of knowledge, scholarly understanding, and specific subject content in their chosen fields to make them competent and confident in their subject or profession. They will be able to demonstrate, where relevant, professional technical competence and meet professional standards. They will be able to articulate the structure of knowledge of their discipline, be able to adapt discipline-specific knowledge to novel situations, and be able to contribute from their discipline to inter-disciplinary solutions to problems.

This graduate capability is supported by:

Learning outcomes

- Demonstrate knowledge of the principles and concepts of elementary topology and Euclidean, affine, and projective geometry in the plane.
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- Be able to apply the principles, concepts, and techniques learned in this unit to solve practical and abstract problems.
- Be able to present reasoning and conclusions informed by analysis involving geometry and topology, in a variety of modes, to diverse audiences (expert and non-expert).

Assessment tasks

- Eight assignments
- One Test
- Final examination
Learning and teaching activities

- Attend 4 hours of lectures per week. Two in geometry, two in topology
- Write solutions to 8 assignments

Problem Solving and Research Capability

Our graduates should be capable of researching; of analysing, and interpreting and assessing data and information in various forms; of drawing connections across fields of knowledge; and they should be able to relate their knowledge to complex situations at work or in the world, in order to diagnose and solve problems. We want them to have the confidence to take the initiative in doing so, within an awareness of their own limitations.

This graduate capability is supported by:

Learning outcomes

- Demonstrate knowledge of the principles and concepts of elementary topology and Euclidean, affine, and projective geometry in the plane.
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- Eight assignments
- One Test
- Final examination

Learning and teaching activities

- Attend 4 hours of lectures per week. Two in geometry, two in topology
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Effective Communication

We want to develop in our students the ability to communicate and convey their views in forms
effective with different audiences. We want our graduates to take with them the capability to read, listen, question, gather and evaluate information resources in a variety of formats, assess, write clearly, speak effectively, and to use visual communication and communication technologies as appropriate.

This graduate capability is supported by:

**Learning outcomes**

- Demonstrate knowledge of the principles and concepts of elementary topology and Euclidean, affine, and projective geometry in the plane.
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**Assessment tasks**

- Eight assignments
- Final examination

**Learning and teaching activities**

- Write solutions to 8 assignments

**Capable of Professional and Personal Judgement and Initiative**

We want our graduates to have emotional intelligence and sound interpersonal skills and to demonstrate discernment and common sense in their professional and personal judgement. They will exercise initiative as needed. They will be capable of risk assessment, and be able to handle ambiguity and complexity, enabling them to be adaptable in diverse and changing environments.

This graduate capability is supported by:

**Learning outcomes**

- Demonstrate the ability to construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning. In particular, the ability to use axioms and definitions correctly within an argument.
- Be able to present reasoning and conclusions informed by analysis involving geometry
and topology, in a variety of modes, to diverse audiences (expert and non-expert).

- Ethical application of mathematical approaches to solving problems and appropriately reference and acknowledge sources in a mathematical context.
- Be able to work effectively, responsibly and safely in an individual or team context.

**Critical, Analytical and Integrative Thinking**

We want our graduates to be capable of reasoning, questioning and analysing, and to integrate and synthesise learning and knowledge from a range of sources and environments; to be able to critique constraints, assumptions and limitations; to be able to think independently and systemically in relation to scholarly activity, in the workplace, and in the world. We want them to have a level of scientific and information technology literacy.

This graduate capability is supported by:

**Learning outcomes**

- Demonstrate knowledge of the principles and concepts of elementary topology and Euclidean, affine, and projective geometry in the plane.
- Present a broad outline of the scope of topology and geometry in two dimensions, their roles in other fields, and the way other fields contribute to their development.
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**Assessment tasks**

- Eight assignments
- One Test
- Final examination

**Learning and teaching activities**

- Attend 4 hours of lectures per week. Two in geometry, two in topology
- Write solutions to 8 assignments
Creative and Innovative

Our graduates will also be capable of creative thinking and of creating knowledge. They will be imaginative and open to experience and capable of innovation at work and in the community. We want them to be engaged in applying their critical, creative thinking.

This graduate capability is supported by:

**Learning outcomes**

- Demonstrate knowledge of the principles and concepts of elementary topology and Euclidean, affine, and projective geometry in the plane.
- Present a broad outline of the scope of topology and geometry in two dimensions, their roles in other fields, and the way other fields contribute to their development.
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- Be able to apply the principles, concepts, and techniques learned in this unit to solve practical and abstract problems.
- Be able to present reasoning and conclusions informed by analysis involving geometry and topology, in a variety of modes, to diverse audiences (expert and non-expert).

**Assessment task**

- Eight assignments

**Learning and teaching activity**

- Write solutions to 8 assignments

Engaged and Ethical Local and Global citizens

As local citizens our graduates will be aware of indigenous perspectives and of the nation's historical context. They will be engaged with the challenges of contemporary society and with knowledge and ideas. We want our graduates to have respect for diversity, to be open-minded, sensitive to others and inclusive, and to be open to other cultures and perspectives: they should have a level of cultural literacy. Our graduates should be aware of disadvantage and social justice, and be willing to participate to help create a wiser and better society.

This graduate capability is supported by:

**Learning outcomes**

- Ethical application of mathematical approaches to solving problems and appropriately
reference and acknowledge sources in an mathematical context.

• Be able to work effectively, responsibly and safely in an individual or team context.

**Assessment task**

• Eight assignments

**Socially and Environmentally Active and Responsible**

We want our graduates to be aware of and have respect for self and others; to be able to work with others as a leader and a team player; to have a sense of connectedness with others and country; and to have a sense of mutual obligation. Our graduates should be informed and active participants in moving society towards sustainability.

This graduate capability is supported by:

**Learning outcomes**

• Ethical application of mathematical approaches to solving problems and appropriately reference and acknowledge sources in an mathematical context.

• Be able to work effectively, responsibly and safely in an individual or team context.

**Extra Requirements**

Satisfactory performance on supervised assessment tasks, such as tests and the final exam, is necessary to pass this unit. If there is a significant difference between a student's marks on supervised assessment tasks and on unsupervised assessment tasks, the scaling of these tasks may be adjusted when determining the final grade, to reflect more appropriately that student's performance on supervised tasks.