MATH300

Geometry and Topology

S1 Day 2018

Dept of Mathematics

Contents

General Information

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

Richard Garner
richard.garner@mq.edu.au

Credit points
3

Prerequisites
(39cp at 100 level or above) 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://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

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).
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.

General Assessment Information

HURDLES: This unit has no hurdle requirements. This means that there are no second chance examinations and assessments if you happen to fail at your first attempt. Students should aim to get at least 60% for the course work in order to be reasonably confident of passing the unit.

IMPORTANT: If you apply for Disruption to Study for your final examination, you must make yourself available for the week of July 24–28, 2017. If you are not available at that time, there is no guarantee an additional examination time will be offered. Specific examination dates and times will be determined at a later date.

Assessment Tasks

Name	Weighting	Hurdle	Due
Three assignments	30%	No	See iLearn
One test	10%	No	See iLearn
Final examination	60%	No	University Examination Period

Three assignments

Due: **See iLearn**
Weighting: **30%**

Three assignments, each containing questions from both halves of the course

On successful completion you will be able to:

- 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: **See iLearn**
Weighting: **10%**

Mid-semester test on both halves of the course.

On successful completion you will be able to:
- 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%**

Covering the totality of the material lectured.

On successful completion you will be able to:

- 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).

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

Additional notes will be attached to the course's iLearn page.

Also recommended for the geometry half of the course is the following online text:

- The Four Pillars of Geometry by John Stillwell

Technology Used and Required

Students are expected to have access to an internet enabled computer with a web browser and Adobe Reader software. There are computers for student use in the Library and MUSE.

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

Unit Schedule

WEEK	GEOMETRY	TOPOLOGY
1	Euclidean geometry in the complex plane	Topological spaces
2	Euclidean geometry in the complex plane	Surfaces
3	Euclidean geometry in the complex plane	Surfaces and Surgery
4	Euclidean geometry in the complex plane	Characterising Surfaces
5	Affine geometry	Graphs on Surfaces
6	Affine geometry	Graphs and Map Colouring
	Recess	Recess
7	Projective geometry	Graphs and Map Colouring
8	Projective geometry	Knots and Links
9	Projective geometry	The Alexander Number of a Knot
10	Ruler and compass constructions	The Alexander Group of a Knot
11	Ruler and compass constructions	The Alexander Module
12	Ruler and compass constructions	The Alexander Polynomial
13	Revision	Revision

Learning and Teaching Activities

Lectures

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

Assignments

Write solutions to 3 assignments

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-centr

al). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- Academic Appeals Policy
- Academic Integrity Policy
- Academic Progression Policy
- Assessment Policy
- Fitness to Practice Procedure
- Grade Appeal Policy
- Complaint Management Procedure for Students and Members of the Public
- Special Consideration Policy *(**Note:** The Special Consideration Policy is effective from 4 December 2017 and replaces the Disruption to Studies Policy.)*

Undergraduate students seeking more policy resources can visit the Student Policy Gateway (https://students.mq.edu.au/support/study/student-policy-gateway). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

If you would like to see all the policies relevant to Learning and Teaching visit Policy Central (https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central).

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/study/getting-started/student-conduct

Results

Results shown in *iLearn*, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au.

Student Support

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

Learning Skills

Learning Skills (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 Services and 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.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

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.
- 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.
- 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

- Three assignments

Learning and teaching activity

- Write solutions to 3 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 an mathematical context.
- Be able to work effectively, responsibly and safely in an individual or team context.

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.
- 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.
- 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

- Three 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 3 assignments

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.
- 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.

Assessment tasks

- Three 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 3 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.
- 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.

Assessment tasks

- Three 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 3 assignments

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.
- 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.
- 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

- Three assignments
- Final examination

Learning and teaching activities

- Write solutions to 3 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

- Three 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.