



MATH338

Algebra IIIB

S2 Day 2019

Dept of Mathematics and Statistics

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General Information

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Credit points

3

Prerequisites

Corequisites

MATH337

Co-badged status

Unit description

This unit further develops the theory of algebraic structures commenced in MATH337, and involves the study of a selection of topics in field theory as well as a study of algorithms used in the application of linear algebra to the practical computational solution of real-world problems. The field theory strand develops the basic theory, including the notion of irreducibility of polynomials, simple, algebraic and transcendental extensions, and the tower law. The ideas of group theory studied in MATH337 are then applied to the study of field extensions via the notion of automorphisms, culminating in the study of the Galois correspondence theorem. The numerical linear algebra strand focuses on the study of large matrices and the use of matrix decomposition techniques appropriate to the computation of approximate solutions of the kinds of differential equations with specified boundary conditions that commonly arise in problems in science and engineering.

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 a well-developed knowledge of the principles, concepts, and techniques of Galois Theory and Advanced Linear Algebra.

Demonstrate an understanding of the breadth of Galois Theory and Advanced Linear Algebra, their multi-disciplinary role, and the way they contribute to the development of the mathematical sciences.

Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning as applied to Galois Theory and Advanced Linear Algebra.

Apply mathematical principles, concepts, techniques, and technology to solve practical and abstract problems in Galois Theory and Advanced Linear Algebra.

Appropriately interpret information concerning Galois Theory and Advanced Linear Algebra communicated in a wide variety of forms.

Appropriately present ideas, information, reasoning, and conclusions concerning Galois Theory and Advanced Linear Algebra in forms tailored to the needs of diverse audiences.

Work effectively, responsibly and safely in an individual context.

General Assessment Information

HURDLES: This unit has no hurdle requirements.

ATTENDANCE and PARTICIPATION: Please contact the unit convenor as soon as possible if you have difficulty attending and participating in any classes. There may be alternatives available to make up the work. If there are circumstances that mean you miss a class, you can apply for a [Special Consideration](#).

ASSIGNMENT SUBMISSION: Assignment submission will be online through the iLearn page.

Submit assignments online via the appropriate assignment link on the iLearn page. A personalised cover sheet is not required with online submissions. Read the submission statement carefully before accepting it as there are substantial penalties for making a false declaration.

- Assignment submission is via iLearn. You should upload this as a single scanned PDF file.
- Please note the quick guide on how to upload your assignments provided on the iLearn page.
- Please make sure that each page in your uploaded assignment corresponds to only one A4 page (do not upload an A3 page worth of content as an A4 page in landscape). If you are using an app like Clear Scanner, please make sure that the photos you are using are clear and shadow-free.

- It is your responsibility to make sure your assignment submission is legible.
- If there are technical obstructions to your submitting online, please email us to let us know.

You may submit as often as required prior to the due date/time. Please note that each submission will completely replace any previous submissions. It is in your interests to make frequent submissions of your partially completed work as insurance against technical or other problems near the submission deadline.

LATE SUBMISSION OF WORK: All assignments or assessments must be submitted by the official due date and time. No marks will be given to late work unless an extension has been granted following a successful application for [Special Consideration](#). Please contact the unit convenor for advice as soon as you become aware that you may have difficulty meeting any of the assignment deadlines. It is in your interests to make frequent submissions of your partially completed work. Note that later submissions completely replace any earlier submission, and so only the final submission made before the due date will be marked.

FINAL EXAM POLICY: examinations for individuals or groups of students. All students are expected to ensure that they are available until the end of the teaching semester, that is, the final day of the official examination period. The only excuse for not sitting an examination at the designated time is because of documented illness or unavoidable disruption. In these special circumstances, you may apply for special consideration via ask.mq.edu.au.

SUPPLEMENTARY EXAMINATIONS:

IMPORTANT: If you receive special consideration for the final exam, a supplementary exam will be scheduled in the interval between the regular exam period and the start of the next session. If you apply for special consideration, you must give the supplementary examination priority over any other pre-existing commitments, as such commitments will not usually be considered an acceptable basis for a second application for special consideration. Please ensure you are familiar with the policy prior to submitting an application. You can check the supplementary exam information page on FSE101 in iLearn (<https://bit.ly/FSESupp>) for dates, and approved applicants will receive an individual notification sometime in the week prior to the exam with the exact date and time of their supplementary examination.

Assessment Tasks

Name	Weighting	Hurdle	Due
Assignment 1	10%	No	see iLearn
Assignment 2	10%	No	see iLearn
Assignment 3	10%	No	see iLearn
Project	10%	No	see iLearn
Final examination	60%	No	Formal University Examination Period

Assignment 1

Due: **see iLearn**

Weighting: **10%**

Assignment based on both components of the unit.

On successful completion you will be able to:

- Demonstrate a well-developed knowledge of the principles, concepts, and techniques of Galois Theory and Advanced Linear Algebra.
- Demonstrate an understanding of the breadth of Galois Theory and Advanced Linear Algebra, their multi-disciplinary role, and the way they contribute to the development of the mathematical sciences.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning as applied to Galois Theory and Advanced Linear Algebra.
- Apply mathematical principles, concepts, techniques, and technology to solve practical and abstract problems in Galois Theory and Advanced Linear Algebra.
- Appropriately interpret information concerning Galois Theory and Advanced Linear Algebra communicated in a wide variety of forms.
- Appropriately present ideas, information, reasoning, and conclusions concerning Galois Theory and Advanced Linear Algebra in forms tailored to the needs of diverse audiences.
- Work effectively, responsibly and safely in an individual context.

Assignment 2

Due: **see iLearn**

Weighting: **10%**

Assignment based on both components of the unit.

On successful completion you will be able to:

- Demonstrate a well-developed knowledge of the principles, concepts, and techniques of Galois Theory and Advanced Linear Algebra.
- Demonstrate an understanding of the breadth of Galois Theory and Advanced Linear Algebra, their multi-disciplinary role, and the way they contribute to the development of the mathematical sciences.
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- Appropriately present ideas, information, reasoning, and conclusions concerning Galois Theory and Advanced Linear Algebra in forms tailored to the needs of diverse audiences.
- Work effectively, responsibly and safely in an individual context.

Assignment 3

Due: **see iLearn**

Weighting: **10%**

Assignment based on both components of the unit.

On successful completion you will be able to:

- Demonstrate a well-developed knowledge of the principles, concepts, and techniques of Galois Theory and Advanced Linear Algebra.
- Demonstrate an understanding of the breadth of Galois Theory and Advanced Linear Algebra, their multi-disciplinary role, and the way they contribute to the development of the mathematical sciences.
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Project

Due: **see iLearn**

Weighting: **10%**

In this project the student will apply the techniques of Galois to the study of two specific polynomial equations.

On successful completion you will be able to:

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Final examination

Due: **Formal University Examination Period**

Weighting: **60%**

Two hour (plus 10 min reading time) exam covering all course material/topics.

On successful completion you will be able to:

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- Apply mathematical principles, concepts, techniques, and technology to solve practical and abstract problems in Galois Theory and Advanced Linear Algebra.
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Delivery and Resources

Classes

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

Required and Recommended Texts and/or Materials

The required text for the Galois Theory part of MATH338 is Ian Stewart, *Galois Theory* Chapman and Hall 4th Edition. Lecture notes will be provided for the Advanced Linear Algebra part of MATH338.

ADDITIONAL TEXTS

Galois Theory

- John A. Beachy, *Introductory Lectures on Rings and Modules* Cambridge 1999.
- Harold M. Edwards, *Galois Theory* Springer, 1984, Graduate Texts in Mathematics 101 (written in the spirit of "Read the masters!", there is a definite attempt to expose Galois' original ideas).
- Emil Artin, *Galois Theory* Notre Dame Mathematical Lectures 2, 1959 (the pithy work of a master - very thin).
- Francis Borceux and George Janelidze, *Galois Theories* Cambridge Studies in Advanced Mathematics 72, 2001 (the early sections are appropriate for this unit; the keen student can then find how Galois' ideas have developed in recent times).
- Tom Petsinis, *The French Mathematician, A Novel* Penguin, 1997 (non-technical novel written in the first person as Galois, sets the historical stage for Galois' work; a fun read of a sad tale!).

Advanced Linear Algebra

- Gilbert Strang, *Linear Algebra and its Applications* Brooks/Cole, 1988 (contains useful supporting material, but too elementary for this course).
- B. Hartley and T.O. Hawkes, *Rings, Modules, and Linear Algebra*, Chapman and Hall.

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.

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

The following table gives an approximate timetable for the topics covered week-by-week.

Week	Advanced Linear Algebra	Galois Theory
1	Overview and review of basic Linear Algebra	Rings and Fields
2	The group GL_n of invertible matrices	Rings and Fields
3	The group GL_n of invertible matrices	Polynomials
4	Computation with Matrices	Polynomials (Galois Theory)

Week	Advanced Linear Algebra	Galois Theory
5	Singular Value Decomposition (Adv Linear Algebra)	Polynomials
6	Rings and Modules	Field Extensions
7	Invertible matrices over Euclidean domains	Field Extensions
	Mid Session Break	
8	Invertible matrices over more general rings	Field Extensions
9	Further theory of modules	Field Maps
10	Structure theorem for modules over a Euclidean domain	Fundamental Theorem of Galois Theory
11	Structure theorem for modules over a Euclidean domain	Fundamental Theorem of Galois Theory
12	Rank and dimension for modules over a general ring	Solvability in Radicals
13	Revision	

Policies and Procedures

Macquarie University policies and procedures are accessible from [Policy Central \(https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central\)](https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central). 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 \(https://students.mq.edu.au/support/study/student-policy-gateway\)](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 \(http://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policy-central\)](http://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 published on platform other than [eStudent](#), (eg. iLearn, Coursera etc.) 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 or if you are a Global MBA student contact globalmba.support@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

If you are a Global MBA student contact globalmba.support@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 a well-developed knowledge of the principles, concepts, and techniques of Galois Theory and Advanced Linear Algebra.
- Demonstrate an understanding of the breadth of Galois Theory and Advanced Linear Algebra, their multi-disciplinary role, and the way they contribute to the development of the mathematical sciences.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning as applied to Galois Theory and Advanced Linear Algebra.
- Apply mathematical principles, concepts, techniques, and technology to solve practical and abstract problems in Galois Theory and Advanced Linear Algebra.

Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3
- Project
- Final examination

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 a well-developed knowledge of the principles, concepts, and techniques of Galois Theory and Advanced Linear Algebra.
- Demonstrate an understanding of the breadth of Galois Theory and Advanced Linear

Algebra, their multi-disciplinary role, and the way they contribute to the development of the mathematical sciences.

- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning as applied to Galois Theory and Advanced Linear Algebra.
- Apply mathematical principles, concepts, techniques, and technology to solve practical and abstract problems in Galois Theory and Advanced Linear Algebra.
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- Assignment 2
- Assignment 3
- Project
- Final examination

Commitment to Continuous Learning

Our graduates will have enquiring minds and a literate curiosity which will lead them to pursue knowledge for its own sake. They will continue to pursue learning in their careers and as they participate in the world. They will be capable of reflecting on their experiences and relationships with others and the environment, learning from them, and growing - personally, professionally and socially.

This graduate capability is supported by:

Learning outcomes

- Demonstrate a well-developed knowledge of the principles, concepts, and techniques of Galois Theory and Advanced Linear Algebra.
- Demonstrate an understanding of the breadth of Galois Theory and Advanced Linear Algebra, their multi-disciplinary role, and the way they contribute to the development of the mathematical sciences.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning as applied to Galois Theory and Advanced Linear Algebra.

Assessment tasks

- Assignment 1
- Assignment 2

- Assignment 3
- Project
- Final examination

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 a well-developed knowledge of the principles, concepts, and techniques of Galois Theory and Advanced Linear Algebra.
- Demonstrate an understanding of the breadth of Galois Theory and Advanced Linear Algebra, their multi-disciplinary role, and the way they contribute to the development of the mathematical sciences.
- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning as applied to Galois Theory and Advanced Linear Algebra.
- Apply mathematical principles, concepts, techniques, and technology to solve practical and abstract problems in Galois Theory and Advanced Linear Algebra.

Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3
- Project
- Final examination

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

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- Project
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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.

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Learning outcomes

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- Assignment 2

- Assignment 3
- Project
- Final examination

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

- Appropriately interpret information concerning Galois Theory and Advanced Linear Algebra communicated in a wide variety of forms.
- Appropriately present ideas, information, reasoning, and conclusions concerning Galois Theory and Advanced Linear Algebra in forms tailored to the needs of diverse audiences.

Assessment tasks

- Assignment 1
- Assignment 2
- Assignment 3
- Project
- Final examination

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

- Demonstrate a well-developed knowledge of the principles, concepts, and techniques of Galois Theory and Advanced Linear Algebra.
- Demonstrate an understanding of the breadth of Galois Theory and Advanced Linear

Algebra, their multi-disciplinary role, and the way they contribute to the development of the mathematical sciences.

- Construct logical, clearly presented and justified mathematical arguments incorporating deductive reasoning as applied to Galois Theory and Advanced Linear Algebra.
- Appropriately interpret information concerning Galois Theory and Advanced Linear Algebra communicated in a wide variety of forms.
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- Work effectively, responsibly and safely in an individual context.

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