THE UNIVERSITY OF SYDNEY
Semester 2, 2017

Information Sheet for **MATH2968 Algebra (Advanced)**

Websites: It is important that you check the following webpages regularly.

Intermediate Mathematics webpage: `http://www.maths.usyd.edu.au/u/UG/IM/`
MATH2968 webpage: `http://www.maths.usyd.edu.au/u/UG/IM/MATH2968/`

Both pages may be accessed through the Learning Management System (Blackboard):

`https://elearning.sydney.edu.au`

There will also be a question-and-answer forum for MATH2968 on the Ed site:

`https://edstem.com.au/login`

Important announcements relating to Intermediate Mathematics as a whole will be posted on the Intermediate Mathematics page. On the MATH2968 page you will find online resources as described below and other useful links. Announcements regarding assessment tasks will be made on this page at various times throughout the semester, as well as on the Ed forum.

Lectures: The lecturer for this unit is Professor Anthony Henderson. This class has three lectures and one practice class per week, which will be held at the following times and locations. Lectures run for 13 weeks, from the first lecture on Monday 31 July to the last lecture on Thursday 2 November.

Time	**Location**
4pm Mon	Carslaw 275
9am Tue	Carslaw 175
9am Wed	Carslaw 175
9am Thu	Carslaw 175

The Thursday 9am time will be for practice classes in Weeks 1-4, 6-8, 10 and 12; for quizzes in Weeks 5 and 11; and for lectures in Weeks 9 and 13. Note that there will be no classes during the mid-semester break or on Monday 2 October (public holiday).
Lectures will be recorded by the Echo system, and the recordings will be available through the Learning Management System (Blackboard) website. Handwritten lecture notes will be posted on the MATH2968 webpage.

Consultation times: Prof Henderson will be available for consultation from 1pm to 2pm on Tuesday. His office is Carslaw 717. If you are not able to come at that time, email `anthony.henderson@sydney.edu.au` to make another appointment.

Tutorials: Tutorials (one per week) run from Week 2 to Week 13. You should attend the tutorial given on your personal timetable. The tutorial in Week n relates to the material from the lectures in Week $n-1$. The exercise sheets for the tutorials will be available on the MATH2968 webpage, for you to print out beforehand or access online during the tutorial as you prefer. Solutions to tutorial exercises for Week n will be posted on the afternoon of the Monday of Week n, after all the tutorials.

Assessment: Your final mark for this unit of study will be calculated as follows:

60%:	Exam at end of Semester 2.
15%:	Quiz 1 mark (using the better mark principle).
15%:	Quiz 2 mark (using the better mark principle).
5%:	Assignment 1 mark.
5%:	Assignment 2 mark.

The *better mark principle* means that the quiz mark counts if and only if it is better than or equal to your exam mark. If your quiz mark is less than your exam mark, the exam mark will be used for that portion of your assessment instead. The assignment marks count for 5% each, regardless of whether they are better than your exam mark or not.
Final marks are returned within one of the following bands:

> **High Distinction (HD), 85–100:** representing complete or close to complete mastery of the material; **Distinction (D), 75–84:** representing excellence, but substantially less than complete mastery; **Credit (CR), 65–74:** representing a creditable performance that goes beyond routine knowledge and understanding, but less than excellence; **Pass (P), 50–64:** representing at least routine knowledge and understanding over a spectrum of topics and important ideas and concepts in the course.

A student with a passing or higher grade should be well prepared to undertake further studies in mathematics which are dependent on this unit of study.

Examination: There is one examination of 2 hours' duration during the examination period at the end of Semester 2, which will test the learning outcomes attained in lectures, tutorials and computer labs. No notes, books or calculators will be allowed. Further information about the exam will be posted later on the webpage.

Quizzes: Quizzes will be held in Carslaw 175 during the usual 9am class times on Thursday 31 August (Week 5) and Thursday 19 October (Week 11). The quizzes will consist of short-answer questions testing your understanding of basic concepts and computational methods from the lectures and practice classes. No notes, books or calculators will be allowed. Further information about the quizzes will be posted later on the webpage.

Assignments: There are two assignments, which must be submitted electronically in Turnitin (an internet-based plagiarism-prevention service), via the Learning Management System (Blackboard) website, by the deadline. Note that a submission will not be marked if it is illegible, sideways or upside down. It is your responsibility to check your submission receipt (which will be automatically emailed to you) to ensure that your assignment has been submitted correctly. The assignments, including more detailed submission instructions, will be released on the webpage according to the schedule below.

Assessment and feedback schedule:

Task	**Available**	**Deadline/date**	**Latest extension***	**Feedback**
Assignment 1	Thu 3 Aug	11:59pm Thu 17 Aug	11:59pm Thu 24 Aug	9am Mon 28 Aug
Quiz 1		9am Thu 31 Aug		9am Thu 7 Sep
Assignment 2	Thu 14 Sep	11:59pm Thu 5 Oct	11:59pm Thu 12 Oct	9am Mon 16 Oct
Quiz 2		9am Thu 19 Oct		9am Thu 26 Oct

*Extensions for assignments are only possible for students registered with Disability Services or applying for Special Consideration or Special Arrangements.

Special consideration and special arrangements: While studying at the University of Sydney, you may need to apply for special consideration or special arrangements as follows:

> Special consideration may be granted to students where well-attested illness, injury, or misadventure occurs to them (or someone they have carer's responsibility for) during the semester or the exam period. Special arrangements may be granted for essential community commitments. Further information on eligibility, document requirements, and how to apply is available at `http://sydney.edu.au/science/cstudent/ug/forms.shtml#special_consideration`. Applications must be made using the University's formal application process.

You should *not* submit an application of either type

- if you are absent from a lecture, tutorial or practice class, since there is no assessment associated with the missed class, or
- if you miss the quiz, since the better mark principle applies.

The assessment category for the assignments is "Submitted Work".

Simple extensions: Part 14 of the University Coursework Policy allows students to apply for a Simple Extension of up to 2 working days on a (non-examination) assessment task. Any request must be made by email to the lecturer, detailing the reason for the request, the students name, student identification number and the unit of study code. Lecturers are not obliged to grant Simple Extensions and the decision is not subject to appeal; in this unit, Simple Extensions for the assignments will only be granted on rare occasions when the lecturer is satisfied that it is appropriate. Special Consideration, as described above, is the usual method for a student to seek consideration for an assessment task such as an assignment.

Where to go for help: For help with mathematics, you can post a question on the Ed forum (anonymously from other students if you prefer), ask your tutor during a tutorial, consult the lecturer in his consultation time (see above), or email `anthony.henderson@sydney.edu.au` . For administrative questions, first check carefully whether the answers are on this information sheet or on the MATH2968 webpage; if not, ask on the Ed forum or (if the question is specific to your situation) ask at the Student Services Office (Carslaw 520) or email `MATH2968@sydney.edu.au` . Ensure that any emails that you send contain your name and SID, because anonymous emails will be ignored. If your email includes questions that other students would benefit from seeing the answers to, you may be asked to post them on the Ed forum so that they can be answered there.

Unit outline: This unit aims to introduce the theory of groups, which is the basis of modern algebra. Groups provide a unifying framework for topics such as geometric symmetry, permutations, matrix arithmetic and more. Group theory is vital in multiple areas of mathematics (algebra, number theory, differential geometry, harmonic analysis, representation theory, geometric mechanics etc.) and in areas of science such as theoretical physics and quantum chemistry.
MATH2968 is the keystone of the sequence of algebra units, marking the point at which powerful abstract theory enters and takes the subject to a more sophisticated plane. It expands and clarifies the linear algebra introduced in MATH1902 and MATH2961, and lays the foundation for the advanced algebraic topics in MATH3962 and Pure Mathematics Honours, as well as for the applications of algebra in other areas of mathematics and science.

Learning outcomes: Students who successfully complete this unit should be able to:

- know a range of examples of groups, and their varying properties;
- understand the axioms and basic definitions of group theory;
- carry out calculations in specific groups of permutations and matrices, using general results;
- conceive and construct proofs of general results concerning elements, subgroups, homomorphisms, conjugacy, etc.;
- understand the relationship between homomorphisms and quotients, expressed in the Fundamental Homomorphism Theorem;
- state and use elementary results in group theory such as Lagrange's Theorem, Cauchy's Theorem, Sylow Theorems, the Isomorphism Theorems, and the Jordan–Hölder Theorem, with a fair understanding of how these results are proved;
- state and use the Jordan Canonical Form Theorem and Cayley–Hamilton Theorem in matrix theory, with some understanding of how these results are proved;
- state and use the classification of finite abelian groups, and appreciate the subtlety of the classification problem for non-abelian groups.

Reference books:
The content of the unit is defined by the lectures rather than by a set text, but introductory group theory is covered in a multitude of sources, which you may find it helpful to consult for extra problems or alternative explanations. Most online mathematical encyclopedias contain material relevant to this unit, as do the following books in the library (among hundreds of others). Be aware that conventions and notation may differ slightly from those of the lectures.

- *Topics in Algebra* by I. N. Herstein, Scitech 512.8 13 A
- *Abstract Algebra* by I. N. Herstein, Scitech 512.8 97
- *Algebra* by T. W. Hungerford, Scitech 512 58
- *Basic Algebra Vol. 1* by N. Jacobson, Scitech 512 37 A
- *Concrete Abstract Algebra* by N. Lauritzen, Scitech 512.02 5
- *Introduction to the Theory of Finite Groups* by W. Ledermann, Fisher 512.86 337
- *Indra's Pearls: The Vision of Felix Klein* by D. Mumford, C. Series and D. Wright, Scitech 511.8 74
- *An Introduction to the Theory of Groups* by J. J. Rotman, Scitech 512.86 83 B

Week-by-week outline:

Week	Topics
1	Definition and examples of groups and subgroups
2	Permutations, symmetric and alternating groups
3	Cosets, Lagrange's Theorem, orders
4	Homomorphisms, isomorphisms, conjugacy
5	Normal subgroups, quotient groups, Fundamental Homomorphism Theorem
6	Isomorphism Theorems, simple groups, rotation groups
7	Similarity of matrices, Jordan Canonical Form
8	Applications of JCF to matrix arithmetic, Cayley–Hamilton Theorem
9-10	Group actions, Orbit-Stabilizer Relation, Sylow Theorems
11	Direct products, classification of finite abelian groups
12	Semi-direct products, composition series, Jordan–Hölder Theorem
13	Revision