Course Outline

MATH1251

Mathematics for Actuarial Studies and Finance

School of Mathematics and Statistics

Faculty of Science

Semester 2, 2018

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1. Staff

Position	Name	Email	Room
Course Convenor	A/Prof Jonathan Kress	j.kress@unsw.edu.au	RC-3073
Lecturer (Algebra)	Dr Denis Potapov	d.potapov@unsw.edu.au	RC-6111
Lecturer (Calculus)	A/Prf Guoyin Li	g.li@unsw.edu.au	RC-2082
Lecturer-in-charge of computing (Matlab)	Dr Thong Quoc Le Gia	glegia@unsw.edu.au	RC-2084

Staff consultation times will be posted on Moodle and on the School of Mathematics and Statistics website on the *Current Students* > *Undergraduate* > *Student Services* > *Help for Students* page by the beginning of week 2 each semester.

2. Administrative matters

Contacting the Student Services Office

Please visit the School of Mathematics and Statistics web-site for a wide range of information on School Policies, Forms and Help for Students by visiting the "**Student Services"** page.

For information on Courses, please go to "Current Student", "Undergraduate and/or Postgraduate", "**Courses Homepage**" for information on all **course offerings.**

The "Student Notice Board" can be located by going to the "Current Students" page; Notices are posted regularly for your information here. Please familiarise yourself with the information found in these locations. The School web page is: http://www.maths.unsw.edu.au

If you cannot find the answer to your queries on the web you are welcome to contact the Student Services Office directly. The First Year Advisor in the Student Services Office is Mrs Markie Lugton. All administrative enquiries concerning first year Mathematics courses should be sent to Markie Lugton, either:

- By email to fy.mathsstats@unsw.edu.au
- By phone: 9385 7011
- Or in person to the Red Centre building, level 3, room 3072

Change of tutorials, due to timetable clashes or work commitments, permission to take class tests outside your scheduled tutorial, advice on course selection and other administrative matters are handled in the Student Services Office. Constructive comments on course improvement may also be emailed to the Director of First Year Mathematics, Dr Jonathan Kress. Should we need to contact you, we will use your official UNSW email address of Zstudentno@unsw.edu.au in the first instance. **It is your responsibility to regularly check your university email account. Please state your student number in all emails to the Student Services Office.**

3. Course information

Units of credit: 6

Pre-requisite(s): MATH1151

Exclusions for MATH1251: MATH1021, MATH1031, MATH1231, MATH1241, ECON1202, ECON2291.

Teaching times and locations: see the link on the Handbook web pages:

Handbook entry for MATH1251:

http://www.handbook.unsw.edu.au/undergraduate/courses/2018/MATH1251.html

Offered in Semester 2 only

Course summary

MATH1251 will provide you with an in-depth knowledge of topics in Calculus and Linear Algebra and show applications in interdisciplinary contexts through lectures and exercises. It will enhance your skills in analytical critical thinking and problem solving through illustrative examples in lectures and problem based tutorials. The course will also engage you in independent and reflective learning through your independent mastery of tutorial problems and MATLAB.

The mathematical problem-solving skills that you will develop are generic problem-solving skills, based on logical arguments, that can be applied in multidisciplinary work. You will develop your communication skills through active participation in tutorials, and by writing clear, logical arguments when solving problems.

Course aims

The Aim of MATH1251 is that by the time you finish the course you should understand the concepts and techniques covered by the syllabus and have developed sk8ills in applying those concepts and techniques to the solution of appropriate problems. Students who achieve good competence in this course should be well equipped both technically and psychologically to cope with the mathematics that they will meet later in their program.

The algebra component contains a topic on complex numbers but the main emphasis of the course is on linear algebra – vector spaces, linear transformations and eigenvectors of matrices. There are a variety of topics to be covered in the calculus section – techniques of integration, differential equations, sequences and series and the calculus of functions of two real variable. (A detailed syllabus can be found later in this booklet.) The syllabus includes a computing component, based on the software package MATLAB. The computer-based tutorial problems and assignments define the level of proficiency you are expected to achieve in using MATLAB.

Course learning outcomes (CLO)

At the successful completion of this course you (the student) should be able to:

1. State definitions as specified in the syllabus,
2. State and prove appropriate theorems,
3. Explain how a theorem relates to specific examples,
4. Apply the concepts and techniques of the syllabus to solve appropriate problems,
5. Prove specific and general results given specified assumption,

6. Use mathematical and other terminology appropriate to communicate information and understanding,
7. Use the computer package MATLAB as an aid to solve appropriate problems.

4. Learning and teaching activities

Lecturers & Tutorial Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
Lectures	12-1pm Alg. Potapov **K. Burrows Theatre** 1-2pm Calc. Li				10-11am Calc. Li **CLB 7** 11-12pm Alg. Potapov
Tutorials	10-11am Calc.	12-1pm Calc. 4-5pm Calc.	10-11am Calc. 2-4pm Alg.	9-10am Alg. 10-1am Alg.	

Lectures

There are two algebra lectures and two calculus lectures per week. Lectures commence in week 1 and run until week 12 as indicated in your timetable on myUNSW. Please check your myUNSW timetable for times and locations of lectures.

Algebra lecturer: Dr Denis Potapov, Room 6111, Red Centre. Phone 9385 7003

Calculus lecture: Dr Guoyin Li, Room 2082, Red Centre. Phone 9385 7095

The **Course Authority** is A/Prof Jonathan Kress, to contact please email: j.kress@unsw.edu.au
Jonathan's office location is the Red Centre, room 3073.

Important announcements and handouts may be given out in lectures, so missing lectures (or arriving late) may cause significant difficulties for you.

Tutorials

Students are enrolled into two tutorials, one for algebra and one for calculus. The algebra tutorial is timetabled for the second half of the week, whilst the calculus tutorial is scheduled for the first half of the week. Students can change their tutorials, via myUNSW until the end of week 1. After that time, students can only change their tutorials with the agreement of the Student Services Office, RC-3072 or RC-3088. To change a tutorial, you will need to provide proof of a timetable clash or work commitments.

Note that:

- **All tutorials commence in week 2 and run until week 13**; and,
- Attendance at tutorials is compulsory and the roll will be called in tutorials.

Computing and self-paced online modules

In addition to the calculus and algebra components, there is a computing component in MATH1251. This is partly interwoven with the calculus and algebra components and partly independent of them. To assist in the self-directed learning of this component of the course, online self-paced learning modules are available in UNSW Moodle. These modules guide students through the computing component of this course and are integrated with, and enhance the lecture and tutorial presented in calculus and algebra.

Students are expected to work through and complete the specified online modules. Associated with each module is a graded quiz, done in Maple TA and the completed quizzes contribute 4% to the final grade. Learning content will be accessible at all times for learning and revision, but the online assessments will only be available for credit until the published deadlines.

The two booklets *Computing Laboratories Information for Students 2017* and *Introduction to* MATLAB *2017* are freely available from the MATH1251 module on UNSW Moodle, and also on the computers in the mathematics computing laboratories.

UNSW Moodle

The School of Mathematics and Statistics uses the Learning Management System called Moodle. To log into Moodle, use your zID and zPass at the following URL: http://moodle.telt.unsw.edu.au

Here you will find announcements, general information, notes, lecture slide, classroom tutorial and homework problems and links to online tutorial and assessments.

5. Assessment

The final mark will be made up as follows:

Algebra and Calculus class tests	24%
(Best 3 halves: 8% each)	
Online Algebra, Calculus and Matlab Tests	16%
(Alg & Calc: 4%; Matlab 1-4: 4%; Matlab lab: 8%)	
End of semester exam	60%

Note:

- You will be able to view your final exam timetable once Exams Central has finalised the timetable. Please visit the web page: https://my.unsw.edu.au/student.unsw.edu.au/exams for details.
- It is very important that you understand the University's rules for the conduct of Examinations and the penalties for **Academic Misconduct Guide**. This information can be accessed through myUNSW at: https://student.unsw.edu.au/exams In recent years there have been cases where severe penalties have been imposed for misconduct in relation to tests and exams in Maths courses.
- Assessment criteria: UNSW assesses students under a standards based assessment policy. For how this policy is applied within the School of Mathematics and Statistics, please visit the web site:

  http://www.maths.unsw.edu.au/currentstudents/assessment-policies
- If you are unwell / miss your **final examination**, please refer to the Special Consideration Policy by visiting the website: https://student.unsw.edu.au/special-consideration

- Students with a **final mark in the range of 45-49** will be permitted to take the Additional Assessment Exam as a Concessional Additional Assessment (AA). There will be no notification to the individual student of the right to take the Concessional AA, but the details of the courses AA exam schedule will be provided on the School's website Notice Board, after the Provisional Results are published (normally 1 week after the exam period ends).

NB: The final mark after completing the Concessional AA will not increase to a mark higher than 50. Website to School Notice Board: http://www.maths.unsw.edu.au/currentstudents/current-students

Algebra, Calculus and Matlab Online Tests

Algebra and Calculus Online Tests

Before the algebra and calculus tutorial class tests you must complete a simple online test that is designed to help you prepare for the tutorial tests. These tests are on Maple TA and you will find a link to Maple TA and information on using Maple TA on the Moodle homepage for this course. Please read the information on using Maple TA that is provided on Moodle as it contains some important information on the syntax required for entering answers.

The material covered by these tests is the same as for the tutorial algebra and calculus tests, as given on pages 17 and 19. You will be allowed an unlimited number of attempts at each online algebra and calculus test but only your best mark for each test will count. Each test counts for 1% of your final mark.

Matlab Online Tests including week 10 lab test

For the computing (Matlab) component of the course there are two different forms of computing tests. Online tests that you can do at home and that will be run using Maple TA, followed by an online laboratory based test in week 10, again using Maple TA. Other than the week 10 lab test, the online tests may be completed on any suitable web browser in your own time, but you will need access to Matlab to answer the questions. Matlab is available in the School computing labs and via the myAccess service and you can also install your own copy of Matlab. These online Matlab computing tests are linked to the self-paced Matlab instruction modules in Moodle. Details on using Maple TA for online tests can be found on Moodle. These online Matlab computing tests will be available (almost) continuously but to gain marks the tests must be completed before the deadlines shown on page 10. The online tests (in Maple TA) are designed to get you used to using Matlab for simple problems and will test your knowledge of Matlab syntax. You will have an unlimited number of attempts at these online computing tests, both before and after the deadlines. Note that it is only your best mark on each test before the deadline that counts towards your final grade. Do NOT leave your attempts at these online tests until the last day.

The online MATLAB instruction modules are numbered from 0 to 10. In MATH1151 you completed the online tests for modules 1 to 6; for MATH1251 you must complete the online tests in Maple TA for modules 7 to 10. In the table above, Tests 1, 2, 3 and 4 cover the MATLAB modules 7, 8, 9 and 10 respectively. As in MAT1151, these online tests are designed to get you used to using MATLAB for simple problems and will test your knowledge of MATLAB syntax.

The second form of computing test will be run under exam conditions in the School's laboratories. The format of the laboratory test will be similar the one you took in MATH1151, but the content will be more challenging with more emphasis on the programming features in MATLAB. Details of the laboratory test are given on Moodle. All computing tests are linked to the algebra and calculus material, so you should make sure you understand the course work before trying them.

Finally, the end of semester exam may contain one or two sub-questions requiring a knowledge of MATLAB.

To give you some familiarity with the online testing system a practice test called "Using Maple TA" will be available from week 1. You must pass this test before you will be allowed access to algebra, calculus and Matlab online tests.

Note:

- Each attempt at these tests must be your own work, but you are encouraged to discuss the methods required with other students;
- Each version of the test will be slightly different, so don't just copy answers from one attempt to the next;
- Only a limited number of users can have simultaneous access to Maple TA, so **do NOT leave your attempts at these tests to the last day.** Problems with your own (home) computer, internet service or the UNSW IT systems are not considered to be an excuse for missing tests or test deadlines.

Class tests

Details of the dates and content of tests are given on pages 18 and 18 of this booklet. Sample copies of the tests are included in the Algebra Notes and in the Calculus problem booklet. Sample copies of the tests are included in the Algebra and Calculus Notes.

Note:

- You **MUST** be enrolled in an Algebra and a Calculus tutorial and YOU MUST TAKE EACH TEST IN THE CLASSROOM TUTORIAL TO WHICH YOU HAVE BEEN OFFICIAL ALLOCATED.
- To each test you **must bring** your **Student ID card**, some blank **A4 writing paper**, at least one **pen or pencil**, and a **Stapler** (so that you can staple a cover sheet to your answers).
- Normal exam conditions apply in tests.
- You will **not** be allowed to use a calculator in class tests.
- Your **best three scores** in the four halves of the two class tests will be counted towards your final assessments mark.
- If you miss a **class test** due to illness, please apply for Special Consideration on-line.
  Policy available by visiting the website: https://student.unsw.edu.au/special-consideration
- If your special consideration is approved, you will be able to choose a time, using the test booking link on Moodle, for a replacement test in week 8 (for class test 1) or week 13 (for class test 2).
- Your mark will be accessible via the "Maths & Stats Marks" link on the MATH1251 Moodle course page.
- It is your responsibility to check that these marks are correct and you should keep marked tests until the end of semester in case an error has been made in recording the marks. If there is an error, either speak to your tutor or bring your test paper to the Student Services Office as soon as possible, but no later than the day of the final exam.

Schedule of all class assessments

Week	Written Tests	Online Tests*
1		
2		
3		Matlab Online Test 1
4		Calculus Online Test 1
5		Algebra Online Test 1
6	Class Test 1 in Calculus Tutorial	Matlab Online Test 2
7		Matlab Online Test 3
8		Matlab Online Test 4
9		Calculus Online Test 2
10		Test in Laboratory
11		Algebra Online Test 2
12	Class Test 2 in Algebra Tutorial	
13		

*All Online Tests use Maple TA and have a deadline of 23:59 on Friday of the indicated week.

Examples of class tests are contained in the Algebra Notes booklet and the Calculus problems booklet.

Calculator Information

For end of semester UNSW exams, students must supply their own calculator. Only calculators on the UNSW list of approved calculators may be used in the end of semester exams. Before the exam period, calculators must be given a "UNSW approved" sticker, obtained from the School of Mathematics and Statistics Office, and other student or Faculty centres. The UNSW list of calculators approved for use in end of semester exams is available at: https://student.unsw.edu.au/exams

6. Expectations of students

School Policies

The School of Mathematics and Statistics has adopted a number of policies relating to enrolment, attendance, assessment, plagiarism, cheating, special consideration etc. These are in addition to the Policies of The University of New South Wales. Individual courses may also adopt other policies in addition to or replacing some of the School ones. These will be clearly notified in the Course Initial Handout and on the Course Home Pages on the Maths Stats web site.

Students in courses run by the School of Mathematics and Statistics should be aware of the School and Course policies by reading the appropriate pages on the Maths Stats web site starting at:

http://www.maths.unsw.edu.au/currentstudents/assessment-policies

The School of Mathematics and Statistics will assume that all its students have read and understood the School policies on the above pages and any individual course policies on the Course Initial Handout and Course Home Page. Lack of knowledge about a policy will not be an excuse for failing to follow the procedure in it.

Academic integrity, referencing and plagiarism

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits**:** honesty, trust, fairness, respect, responsibility and courage.[1] At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.

Further information about academic integrity and **plagiarism** can be located at:

- The *Current Students* site https://student.unsw.edu.au/plagiarism**,** and
- The *ELISE* training site http://subjectguides.library.unsw.edu.au/elise/presenting

The *Conduct and Integrity Unit* provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct.

8. Readings and resources

Course Pack

Your course pack should contain the following items:

1. *Information Booklet that you are now reading;*
2. *Algebra Notes (for MATH1251);*
3. *Calculus Notes (from MATH1231/1241 as an additional resource);*
4. *Calculus Problems Booklet;*
5. *Past Exam Papers Booklet.*

For the computing component of the course you will need to use Matlab. This is available for free to UNSW students. You can either download and install on you own computer or use the virtual Matlab application via the myAccess service. Details will be provided on Moodle.

Booklets contained in the Course Pack will **not** be available separately from the School of Mathematics and Statistics. However, the information in this booklet and the algebra and calculus problems can be accessed through the web from the MATH1251 module on the UNSW Moodle server.

9. Getting help outside tutorials

Staff Consultations

From week 3 there will be a roster which shows for each hour of the week a list of names of members of staff who are available to help students in the first year mathematics courses, no appointment is necessary. This roster is displayed on the same Notice Board as timetables, near the School Office (room 3070, Red Centre), it

is also available from the web page: http://www.maths.unsw.edu.au/currentstudents/consultation-mathematics-staff

Mathematics Drop-in Centre

The Maths drop-in centre provides free help to students with certain first and second year mathematics courses. First year courses supported are Math1011, Math1081, Math1231, Math1241 and Math1251. The Maths drop-in centre office is in RC-3064, and opening times during semester is from 10am – 12pm and 1pm to 3pm from Mondays to Thursday and from 10am to 12pm on Fridays. The Maths drop-in centre schedule will be available on the Schools website: https://www.maths.unsw.edu.au/currentstudents/Mathematics-Drop-in-Centre by the end of week 1. Please note that no appointment is necessary, this is a drop-in arrangement to obtain one-on-one help from tutors.

Lab Consultants

For help with the Maple computing component of the first year courses, consultants will be available in the Red Centre lab RC-G012B from 11am to 4pm each teaching day in weeks 1 to 9. For more details, visit website: http://www.maths.unsw.edu.au/currentstudents/maple-lab-consultants

Additional support for students

- The Current Students Gateway: https://student.unsw.edu.au/
- Academic Skills and Support: https://student.unsw.edu.au/academic-skills
- Student Wellbeing, Health and Safety: https://student.unsw.edu.au/wellbeing
- Disability Support Services: https://student.unsw.edu.au/disability-services
- UNSW IT Service Centre: https://www.it.unsw.edu.au/students/index.html

Applications for Special Consideration including Additional Assessments

If you feel that your performance in, or attendance at a final examination or another assessment scheduled has been affected by illness or circumstances beyond your control, or if you missed the examination because of illness or other compelling reasons, you may apply for special consideration.

It is essential that you take note of the rules listed below which apply to applications for special consideration in all first year Mathematics courses.

1. Applications must be submitted online within 3 working days of the assessment to which it refers to. In exceptional circumstances, an application may be accepted outside the 3-day limit. Please ensure you contact the Course Authority with advice if your application cannot be submitted within the 3-day limit.

Visit website for further information on how to Apply for Special Consideration, and important things to note: https://student.unsw.edu.au/special-consideration

2. If your course involves a Maple/Matlab lab test which you missed, you should contact the lecturer in charge of computing as soon as possible. A resit will be organised for later in the session.

3. If your application for Special Consideration refers to a missed class test, the School will provide advice of your application through your Moodle course website on the next scheduled class test.

4. With regards to the final examination application for Special Consideration to sit an "Additional Assessment", please do not expect an immediate response from the School. All applications will be considered together. See the information below.

5. Please note that y**ou will NOT be granted Additional Assessment in a course if your performance in the course** (judged by attendance, class tests, assignments and examinations) **does not meet a minimal standard**. A total mark of greater than 40% on all assessment not affected by a request for Special Consideration will normally be regarded as the minimal standard to allow an Additional Assessment.

6. It is YOUR RESPONSIBILITY to find out from the School of Mathematics and Statistics, whether you have been granted Additional Assessment and when and where the additional assessment examinations will be held. Please visit the School's Notice Board for information:
http://www.maths.unsw.edu.au/currentstudents/current-students

Information about award of Additional Assessment and a provisional list of results will be made available on the Maths & Stats Marks page later in the semester. A link to the Maths & Stats Marks page is provided on Moodle.

7. **The Additional Assessment exams for MATH1251 will be held between 8 to 15 December 2018 (Date TBA).** A link to the Additional Assessment timetable, including locations, will be placed on the Current Students Notice Board under heading "Special Consideration and Additional Assessment" information.
Web link: http://www.maths.unsw.edu.au/currentstudents/current-students

8. If you have two Additional Assessment examinations scheduled for the same time, please consult the Student Services Office either by email or phone (fy.mathsstats@unsw.edu.au or 9385 7011), so that special arrangements can be made.

9. You will need to produce your UNSW Student Card to gain entry to the Additional Assessment examination.

Important Notes

- The Additional Assessment exam may be of a different form to the original exam and must be expected to be at least as difficult.

- If you believe your application for Special Consideration has not been processed, you should immediately consult the Director for First Year Mathematics, Dr Jonathan Kress (Room 3073, Red Centre).

- If you believe that the above arrangements put you at a substantial disadvantage, you should send full documentation of the circumstances to: Director of First Year Mathematics, School of Mathematics and Statistics, email to j.kress@unsw.edu.au at the earliest possible time.

- If you suffer from a chronic or ongoing illness that has, or is likely to, put you at a serious disadvantage, then you should contact the Disability Support Services who provide confidential support and advice. Their web site is: https://student.unsw.edu.au/disability

  Disability Support Services (DSS) may determine that your condition requires special arrangements for assessment tasks. Once the School has been notified of these we will make every effort to meet the arrangements specified by DSS.

- Additionally, if you have suffered misadventure during semester then you should provide full documentation to the Director of First Year Mathematics as soon as possible. In these circumstances, it may be possible to arrange discontinuation without failure or to make special examination arrangements.

  Professor B Henry
  Head, School of Mathematics and Statistics

University Statement on Plagiarism

This statement has been adapted from statements by the St James Ethics Centre, the University of Newcastle, and the University of Melbourne.

Plagiarism is the presentation of the thoughts or work of another as one's own. Examples include:

- Direct duplication of the thoughts or work of another, including by copying work, or knowingly permitting it to be copied. This includes copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement
- Paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- Piecing together sections of the work of others into a new whole;
- Presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and,
- Claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.
- Submitting an assessment item that has already been submitted for academic credit elsewhere may also be considered plagiarism.
- The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

Students are reminded of their Rights and Responsibilities in respect of plagiarism, as set out in the University Undergraduate and Postgraduate Handbooks, and are encouraged to seek advice from academic staff whenever necessary to ensure they avoid plagiarism in all its forms.

The Learning Centre website is the central University online resource for staff and student information on plagiarism and academic honesty. It can be located at: www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- Correct referencing practices;
- Paraphrasing, summarising, essay writing, and time management;
- Appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

10. Algebra

Lecture timetable and syllabus

The algebra course for Math1251 is based on chapters 6 to 9 of the MATH1251 Algebra Notes, which are essential reading and must be brought to all algebra tutorials. The lecturer will not cover all the material in these notes in their lectures as some sections of the notes are intended for reference and for background reading. An **approximate** lecture timetable is given below. The lecturer will try to keep to this timetable, but variations might be unavoidable. As in MATH1151, the computer package MATLAB will be used in the MATH1251 algebra course.

Chapter 6. Complex Numbers

Lectures 1-6
This section covers complex numbers in Cartesian and polar forms, complex arithmetic and geometry, factorization of polynomials and stability of dynamical systems.
Development of number systems and closure. Definition of complex numbers and of complex number addition, subtraction, multiplication and division.
Equality, real and imaginary parts, complex conjugates.
Argand diagram, polar forms, modulus, argument.
De Moivre's Theorem and Euler's Formula. Arithmetic of polar forms.
Powers and roots of complex numbers. Binomial theorem and Pascal's triangle.
Trigonometry and geometry.
Complex polynomials. Fundamental theorem of algebra, factorization theorem, factorization of complex polynomials of form $z^n - z_0$, real linear and quadratic factors of real polynomials.
Stability of discrete and continuous time systems.

Chapter 7. Vector Spaces

Lectures 7-14
The aim of this section of the course is to introduce the general theory of vector spaces and to give some basic examples. The majority of examples will be for the real vector space $\mathbb{R}^n$, but some examples will be given for the complex vector space $\mathbb{C}^n$, the vector space M_{mn} of $m \times n$ matrices, the vector space of polynomials and the vector space of real-valued functions.

Introduction to vector spaces. Examples of vector spaces. Properties of vector arithmetic.
Subspaces.
Linear combinations and spans.
Linear independence.
Basis and dimension, coordinate vectors.
Polynomials and real-valued functions as vector spaces.
Data fitting and polynomial (Lagrange) interpolation.

Chapter 8. Linear Transformations

Lectures 15-18
The basic aims of this section are to introduce the general theory of linear transformations, to give some geometric applications of linear transformations and to establish the close relationship between linear functions and matrices.

Introduction to linear maps. Linear maps and the matrix equation.
Geometrical examples.

Subspaces associated with linear maps.
Rank, nullity and solutions of $A\mathbf{x} = \mathbf{b}$. Further applications.
Linear maps between polynomial and real-valued function vector spaces.
Matrix representations for non-standard bases in domain and codomain.
Matrix arithmetic and linear maps.
Injective, surjective and bijective linear maps.

Chapter 9. Eigenvalues and Eigenvectors

Lectures 19-24
The aims of this section are to introduce the ideas of eigenvalue and eigenvector and to show some applications of these ideas to diagonalization of matrices, evaluation of powers of matrices and solution of simple systems of linear differential equations. Examples for hand calculation will be restricted to 2 x 2 matrices and very simple 3 x 3 matrices, with larger problems done using MATLAB.

Definition, examples and geometric interpretation of eigenvalues and eigenvectors.
Eigenvectors, bases and diagonalization of matrices.
Applications to powers of matrices and solution of systems of linear differential equations.
Markov Chain Processes.

Problem Sets

At the end of each chapter there is a set of problems. Some of the problems are very easy, some are less easy but still routine and some are quite hard. To help you decide which problems to try first, each problem is marked with an [R], an [H] or an [X]. The problems marked [R] form a basic set of problems which you should try first. Problems marked [H] are harder and can be left until you have done the problems marked [R]. You *do* need to make an attempt at the [H] problems because problems of this type will occur on tests and in the exam. If you have difficulty with the [H] problems, ask for help in your tutorial.

The problems marked [X] are extension material and are intended for students aiming for the grade of HD in MATH1251. They require more mathematical maturity and ingenuity than other suggested problems. Small parts of final exam questions may require similar mathematical understanding.

There are a number of questions marked [M], indicating that MATLAB is required in the solution of the problem.

Problem Schedule

The main purpose of tutorials is to give you an opportunity to get help with problems which you have found difficult and with parts of the lectures or the Algebra Notes which you don't understand. In order to get real benefit from the tutorials, it is essential that you try to do relevant problems *before* the tutorial, so that you can find out the areas where you need help. The following table shows the calculus problems which are relevant to each week's calculus tutorial. You should work on them at home or in the library between classes. Some of them will be worked through and discussed in the tutorials. Tutors may need to vary a little from this suggested problem schedule.

Week	Algebra problems
1	No tutorial, but try the revision questions
2	Chapter 6, 1-28
3	Chapter 6, 29-59
4	Chapter 6, 60-84
5	Chapter 7, 1-33
6	Chapter 7, 34-52 (Test 1)
7	Chapter 7. 53-82
8	Chapter 7, 83-104
9	Chapter 8, 1-23
10	Chapter 8, 24-43
11	Chapter 8, 44-59
12	Chapter 9, 60-72
	Chapter 9, 1-10 (Test 2)
13	Chapter 9, 11-34

Class Tests and Exams

Questions for the class tests in MATH1251 will be similar to the questions marked [R] and [H] in the problem sets. Since each class test is only twenty minutes in length only shorter straight forward tests of theory and practice will be set. As a guide, see the recent past class test papers (at the end of the algebra notes).

Examination questions are, by their nature, different from short test questions. They may test a greater depth of understanding. The questions will be longer, and sections of the course not covered in the class tests will be examined. As a guide, see the recent past exam papers in the separate past exam papers booklet.

Algebra class test 1 will be given in week 6 and will be based on the suggested problems from weeks 2 to 5.

Algebra class test 2 will be given in week 12 and will be based on the suggested problems for weeks 6 to 11.

Theory in the Algebra course

The theory is regarded as an essential part of this course and it will be examined both in class tests and in the end of year examination.

You should make sure that you can give **DEFINITIONS** of the following ideas**:**

Chapter 7. Subspace of a vector space, linear combination of a set of vectors, span of a set of vectors, linear independence of a set of vectors, spanning set for a vectors space, basis for a vector space, dimension of a vector space, coordinate vector of a vector with respect to an ordered basis.

Chapter 8. Linear function, kernel and nullity of a linear function, image and rank of a linear function.

Chapter 9. Eigenvalue and eigenvector, diagonalizable matrix.

You should be able to give **STATEMENTS** of the following theorems and propositions.

Chapter 7. Theorem 1 of §7.3, Propositions 1 and 3 and Theorem 2 of §7.4, Proposition 1 and Theorems 2,3,4,5 and 6 of §7.5, Theorems 1,2,3,4,5,6 and 7 of §7.6.

Chapter 8. Theorems 2,3 and 4 of §§8.1, Theorems 1 and 2 of §8.2, Theorems 1 and 5, Proposition 7 and Theorems 8,9 and 10 of §8.4.

Chapter 9. Theorems 1,2 and 3 of §9.1. Theorem 1 and 2 of §9.2.

You should be able to give **PROOFS** of the following theorems and propositions.

Chapter 7. Theorem 2 of §7.4, Theorems 2,3 and 4 of §7.5, Theorem 2 of §7.6.

Chapter 8. Theorem 2 of §8.1, Theorem 1 of §8.2, Theorems 1, 5 and 8 of §8.4.

Chapter 9. Theorem 1 of §9.1

11. Calculus

Lecture timetable and syllabus

The calculus syllabus below contains a number of topics which are part of the MATH1241 syllabus and in addition some topics that are generally taught to second year students – such as Lagrange multipliers and double integrals. The time given for each topic is approximate.

1. Integration techniques (2 hours)

The trigonometric integrals and reduction formulae, trigonometric and hyperbolic substitutions, rational functions and partial fractions, standard substitutions. (Salas and Hille, edition 10, Chapter 8, 8.1-8.6)

2. Ordinary differential equations (7 hours)

Terminology including particular, general, implicit and explicit solutions. First order equations including separable, linear and exact equations. Slope fields, integral curves, existence and uniqueness. Modelling. Linear differential operators as linear transformations, the solution space for homogeneous differential equations and the solution set for inhomogeneous differential equations. Constant coefficient differential equations including the method of undetermined coefficients. Applications. Dimension of the solution space. Euler's method for the numerical solutions of differential equations. (Salas and Hille, edition 10, Chapter 9, 9.1-9.3, Chapter 19, 19.1-19.4.)

3. Taylor series (7 hours)

Approximation of functions by Taylor polynomials and Taylor's Theorem with remainder. Applications to stationary points.
Sequences: Convergence and divergence, sums, products, quotients and composites of series. Upper and lower bounds, sup and inf, bounded monotonic sequences and the completeness of the real numbers. Recursively defined sequences. (Salas and Hille, edition 10, Chapter 11, 11.1-11.3.)

Series: Partial sums, convergence and divergence, the *k*th term test for divergence. Comparison, integral, ratio and root tests for convergence of series with positive terms. Absolute and conditional convergence, including the alternating series (Leibniz') test and rearrangement considerations. (Salas and Hille, edition 10, Chapter 12, 12.1-12.5.)

Power series: Taylor and Maclaurin series. The radius and interval of convergence. Manipulation of power series by addition, multiplication, differentiation, integration and simple substitutions. Commonly occurring power series. (Salas and Hille, edition 10, Chapter 12, 11.6-12.9.)

4. Further functions of several variables (3 hours)
Tangent planes and Taylor series for functions of two variables. Classification of critical points of functions of two variable. The method of Lagrange multipliers for constrained extrema. (Salas and Hille, Edition 10, Chapter 16, 16.4-16.7.)

5. Double integrals (4 hours)
The double integral as a repeated integral, interchange of order of integration, change of variable. (Salas and Hille, Edition 10, Chapter 17, 17.1-17.4)

Problem Sets

The Calculus problems are provided in a separate booklet in the course pack. Additional problems are located at the end of each chapter of the MATH1231 and MATH1241 Calculus Notes booklet. They are also available from the course module on the UNSW Moodle 2 server. Some of the problems are very easy, some are less easy but still routine and some are quite hard. All students should make sure that they attempt and can do the unstarred questions. The starred problems are slightly harder than the starred problems and the double starred problems are just plain difficult!

Remember that working through a wide range of problems is the key to success in mathematics.

Problem Schedule

The main reason for having tutorials is to give you a chance to get help with problems which you find difficult and with parts of the lectures or textbook which you don't understand. To get real benefit from tutorials you need to try the relevant problems *before* the tutorial so that you can find out the areas in which you need help.

The following table shows the calculus problems which are relevant to each week's calculus tutorial. You should work on them at home or in the library between classes. Some of them will be worked through and discussed in the tutorials. Tutors may need to vary a little from this suggested problem schedule.

Week	Calculus problems
1	No tutorial.
2	1-9
3	10-20
4	21-35
5	36-45
6	46-59 (Test 1)
7	60-69
8	70-83
9	84-85
10	86-95
11	96-104
12	105-116 (Test 2)
13	117-124

Note there is some overlap between the MATH1231 questions and those in the AMTH1251 calculus problems.

Class Tests and Exams

Questions for the class tests in MATH1251 will be similar to the unstarred and single starred questions in the MATH1251 calculus problem book, or the questions marked (R) and (H) in the MATH1231 problems. Since each class test is only twenty minutes in length, only shorter straight forward tests of theory and practice will be

set. As a guide, see the recent past class test papers (at the end of the Calculus problem booklet). The Calculus class tests will take place in tutorials in the following weeks:

Test 1 Week 6
Test 2 Week 12

The tests will cover sections of the syllabus as shown in the table below. The table also shows which problems are relevant to each test.

It is important to note that the class tests do not cover the whole syllabus.

Examination questions are, by their nature, different from short test questions. They may test a greater depth of understanding. The questions will be longer, and sections of the course not covered in the class tests will be examined. As a guide, see the recent past exam papers in the separate past exam papers booklet.

Test	Syllabus sections	Unstarred and starred problems in ranges
1	1. Integration techniques	1-13
	2. First order ordinary differential equations	14-42
2	3. Second order linear ordinary differential equations	43-62
	4. Sequences	63-69
	5. Series	70-83
	6. Power series	84-95
	7 Further functions of several variables	96-109

12. Computing Information

How much?

In MATH1251 there are online computing tests worth 4% of your final mark and **there will be a laboratory test, in week 10 worth 8% of your final mark.** Further, there will be exam questions worth at least another 3% of your final mark so in total 15% of your final mark is derived from the computing component of the course. The Computing component depends on the other components and will require a knowledge of the appropriate Algebra and Calculus.

Aim

The aim of the Computing component is twofold.

- The primary aim of the computing component of MATH1251 is to develop your skills in using MATLAB. The name of this software package derives from MATrix LABoratory, reflecting its origins in the early 1980s as an interactive interface to a library of Fortran routines for matrix computations. A company called *The MathWorks Inc.* produces MATLAB, and has progressively expanded the package to cover many areas of mathematics besides linear algebra, Also, MATLAB now has a highly developed programming language, a sophisticated graphics system, and software tools including a debugger, a profiler and support for developing graphical user interfaces. Another feature of MATLAB is its ability to work with Fortran or C/C++ codes, as well as with Microsoft Excel. These advanced features of MATLAB are essential for many commercial applications, but in MATH1251 you will only be expected to use a

restricted number of the basic mathematical and graphical functions in MATLAB, and do some simple programming.

- Secondly, you will gain some experience in teaching yourself how to use a complicated computing package. This is a skill that will be needed in other courses at UNSW and in the workforce.

Computing lab

The main computing laboratory is in room G012 in the Red Centre. You can get to this lab by entering the building through the main entrance to the School of Mathematics (on the Mezzanine Level) and then going down the stairs to the Ground Level. A second smaller lab is room M020, on the mezzanine level in the Red Centre.

For the computers in the school laboratories, your login ID is "z" followed immediately by your seven-digit student number and your password is your zPass, issued to you at enrolment. If you have difficulties logging in, the computers will allow a five minute login with ID "new user" and password "new user" where you can access https://idm.unsw.edu.au and reset or unlock your zPass. Be aware that two consecutive failed login attempts will lock you out of the computing system for 30 minutes, or until you reset or unlock your zPass.

The laboratories will normally be open as follows:

	Days	**M020**	**G012**
During Semester	Monday to Friday	9am to 9pm	9am to 9pm
Week 10 and Monday of week 11		9am to 9pm	**Closed**
	Saturdays & Sundays	Closed	Closed
Public holidays & Weekends		Closed	Closed

Any changes to these times will be posted on the door of Room M020.

Remember that there will always be unscheduled periods when the computers are not working because of equipment problems and that this is not a valid excuse for not completing tests on time.

Remote Access

All of the software that you need for this course is installed on the computers in the Red Centre labs. This software can also be accessed from your own computer. For information on accessing Mathematical and Statistical software from outside the Red Centre labs, please see the information provided on this course's page in UNSW Moodle. You can also use a remote access version of Matlab via the myAccess service http://myaccess.unsw.edu.au .

Account and passwords

If you had an account for computers in the Mathematics Labs in semester 1, you will continue to use the same account with the same password in semester 2.

Remember that for the computers in the school laboratories, login ID is "z" followed immediately by your seven digit student number and your password is your zPass. If you have difficulties logging in, the computers will allow a five-minute login with ID "new user" and password "new user" where you can access https://idm.unsw.edu.au and reset or unlock your zPass. Be aware that two consecutive failed login attempts will lock you out of the computing system for 30 minutes, or until you reset or unlock your zPass. If you have forgotten how to log in and use the lab computers, help can be found in chapters 1-4 of the Computing Laboratories Information booklet and the School web site.

If you have problems with your account, you should go to Room M022 on the Mezzanine Level of the Red Centre between 1pm and 2pm on any week day from Thursday of Week 1. You will need to show your student card.

Learning Matlab

As a rough guide, you should spend around one hour per week on computing in MATH1251. This is an average figure, and we recommend that you make a special effort in the first few weeks to master the basics. In lectures, you will see numerous examples of how MATLAB is used to solve a variety of mathematical problems, but there is not sufficient class time for a systematics treatment of MATLAB.

When you come to write M-files (scripts or functions) you will need to use an editor. We recommend the built-in MATLAB editor (type **help edit**) because it has several features specifically tailored to writing MATLAB programs. Nevertheless, you can use any of the other available editors, such as kwrite, kate etc.

Limited help will be available from the consultants who will be available in Room G012 from 12noon to 4pm each day.

If you have any constructive criticism or comment about the Computing component then please let us know.

Maple

Other first-year mathematics courses use a different software package called Maple. However, the Actuarial Studies Unit advised us that MATLAB was more suitable for their purposes and would be introduced into their second and third year courses. Many later year applied mathematics courses, including those taken by students in Finance/Mathematics programs, already use MATLAB. Some later year pure mathematics courses use Maple.

The main distinction between the two software packages is MATLAB works primarily with an array of numeric data, Maple works primarily with symbolic expressions. We do not expect you to learn Maple in MATH1251, but it is available on the PCs in the Mathematics computing labs and you are free to use it.

Matlab Toolboxes

As well as its kernel routines, MATLAB has a collection of specialised software libraries called toolboxes. We will not use any of them in MATH1151 or MATH1251, but in later year courses many of you will see the financial, statistics and the optimization toolboxes. Use the MATLAB **help** command to see a complete list of the toolboxes available on the computing laboratory PCs.

One toolbox not available is the Symbolic Math Toolbox, which essentially allows you to use certain Maple commands within MATLAB.

Special consideration for the laboratory test

It is because the computing tests can be sat at many different times, medical, or other reasons for missing the test will generally not be accepted. For this reason, you are advised to choose an early time to sit the test.

If you consider that you have an exceptional reason for missing the test then you must speak to Dr Thong Quoc Le Gia, Lecturer in Charge of MATH1251 Computing, as soon as possible after the tests have been completed.

If you are unable to attend your Maple laboratory test session because of illness or other circumstances outside of your control, you should contact the Student Services Office (room 3072) as soon as possible and on submission of a suitable medical certificate or appropriate documentation, another test time will be arranged.

Tutors do not have permission to accept medical certificates for the computing test.

If possible, special arrangements for the computing laboratory test will be made for students with supporting documentation from SEADU (Disability Unit). If you wish to exercise this option, you must contact Dr Le Gia before the laboratory tests have commenced so that any needed special facilities can be implemented.

Dr Thong Quoc Le Gia
Lecturer in Charge
MATH1251 Computing

Some Greek Characters

Listed below are the Greek characters most commonly used in mathematics.

Name	Lower case	Upper case	Name	Lower case	Upper case
Alpha	α		Nu	ν	
Beta	β		Xi	ξ	
Gamma	γ	Γ	Pi	π	Π
Delta	δ	Δ	Rho	ρ	
Epsilon	ϵ		Sigma	σ	Σ
Zeta	ζ		Tau	τ	
Eta	η		Phi	ϕ or φ	Φ
Theta	θ	Θ	Chi	χ	
Kappa	κ		Psi	ψ	Ψ
Lambda	λ	Λ	Omega	ω	Ω
Mu	μ				