Department of Mathematics
MATHS 253: Study Guide for Semester 2, 2011.

Welcome to MATHS 253, which is the standard sequel to maths 250, available every semester 1 and 2 on the city campus. It covers topics in linear algebra and multi-variable calculus. It is a foundation for a large number of stage 3 courses in pure and applied mathematics and statistics and also for many advanced courses in physics and various other applied sciences. All students intending to advance in mathematics should take this course.

1. Title:
   Maths 253 is also known as *Advancing Mathematics 3*.

2. Lecturer:
   Alastair McNaughton (course coordinator)
   Office: Room 311, level 3, building 810, Short St, phone extn 85244.
   Office hours: Monday 2pm, Wednesday 10am, Thursdays 11am, and other times by appointment.
   E-mail a.mcnaughton@auckland.ac.nz

3. Times and rooms:

   (a) Lectures:
   Tuesday 9am (Algie/801-209, this is in the law building in Eden Crescent, next down the hill from the Waterloo Quadrant), Wednesday 9am (BLT 204/106-204, this is the Biology lecture theatre), Thursday 12noon (OCH2, the old choral hall lecture theatre).

   (b) Tutorials:
   Tuesday 11 (301-248 in Geology), or Tue 1 pm (303.120), or Tue 2pm (119-G25, ground floor, graduate centre, old stone building behind clocktower) .
   Note that attendance at a Tuesday tutorial is compulsory.

4. Description:

   (a) Points:
   This is a 15-point course.

   (b) Pre-requisites:
   250, or 152 or Physics 112 or Physics 210. *Students wanting to take 253 directly from 208 must have an A+ in 208 and MUST discuss the situation with Alastair.* In general, students from 208 should take 250 before 253.

   (c) Restrictions:
   You cannot include Maths 253 along with Maths 230 (if you took 230 prior to its termination) or Physics 211 in your degree.

(d) Aims:
The main aim is to complete the students preparation prior to commencing the various advanced and more theoretically rigorous level 300 papers. Students will be required to reach a good technical skill level in linear algebra and in calculus. There will be emphasis on combining multi-variable calculus with linear algebra in a way that is suitable for further advanced study.

5. Expectations of students:

(a) Pre-requisite knowledge:
In addition to the pre-requisite papers noted above, it is also essential that students have an ability and a desire to follow reasoning. Mere computational excellence is inadequate.

(b) Recommended preparation:
Maths 250 (or Maths 130 if you took it prior to its termination).
As noted above, in exceptional circumstances this course can also follow on from an A+ in 208 but if you are from 208 you will need to do some extra work to catch up, especially over the first 3 weeks.

(c) Studying mathematics:
All students are expected to do 10 hours per week on this course. This comprises:
3 hours of lectures, 1 hour of tutorial and 6 hours of preparation, revision, assignments and test preparation.

(d) Study expectations:
Students are expected to attend all lectures and tutorials. In addition they are expected to spend about 6 hours per week doing mathematics. This may take the form of preparation for lectures, looking up topics in the textbook, doing assignments, visiting the lecturer during office hours and so on. We expect our students to be interested in their work and keen to understand the concepts and the reasoning which are required.

(e) Attendance:
You are strongly advised to attend all lectures and tutorials. Maths 253 is a challenging course. You are unlikely to pass if you skip lectures. No tutorial credits can be given if you miss a tutorial, even if you have a medical certificate. However, any marks lost through inadvertent absence from tutorials can be recovered by subsequent "bonus" marks, as explained under "assessment (e)" below.

6. Resources:

(a) Texts:
Contemporary Linear Algebra, (Anton and Busby) and
Calculus, 8th edition (Anton, Bivens and Davis). They are available new at both the University Bookshop in the Student Commons area and VOL 1 Bookshop, 33 Symonds St. They are sold as a shrinkwrapped pair at a

special price negotiated with the publisher. There may be a few second hand copies of the Linear Algebra book available as it was first used for another course in 2005. These texts are also the texts for 150/108/250/208/253.

(b) Text Publisher's Web site.
Students using the Anton texts have the publisher's permission to visit and use the following companion Web site: `http://www.wiley.com/college/anton`
The Department of Mathematics encourages you to visit this site and use any material available there.

(c) Lecture Outline Notes:
Lecture notes are supplied for this course. Buy them at the maths student resource centre. In places these notes may include spaces for worked examples which will be filled in during the lectures. **Please do not ask for these missing examples from the lecturer if you do not attend a lecture.** Instead, borrow notes from a fellow student who attended the lectures. For most topics excellent notes and explanations and worked examples will be available directly from the textbook.

(d) Course website:
This semester we expect to have all relevant material available on Cecil. There will be no additional web site.

7. Technology:
The Department of Mathematics is using the software package Matlab for all undergraduate courses. Matlab knowledge will be useful not only for MATHS 253 but also for all subsequent mathematics courses.
Matlab is available for use in the Mathematics/Statistics/Computer Science Basement Computer lab, B91 (9-8, Mon-Thur, and 9-5 Fri). Tutor assistance is available. Matlab is also available in the Student Commons.

A student-version of Matlab is available for purchase ($65) from the SRC for use on your own computer (Windows/Mac/Linux).
Matlab help is available at `http://www.auckland.ac.nz/matlab/`
Familiarity with Matlab is not mandatory this semester.

8. **Lecture topics.**

lecture	topic
1.1	Orthogonal systems of vectors. Orthogonal bases. The projection formula.
1.2	Gram-Schmidt orthogonalisation.
1.3	Inner product as a generalisation of the dot product.
2.1	Orthogonality in inner product spaces and their orthogonal bases.
2.2	Polynomial and Fourier approximations.
2.3	Linear transformations and their matrices. Change of basis matrices.
3.1	Functions of several variables and their limits.
3.2	Partial differentiation and the chain rule.
3.3	Differentiability.
4.1	Taylor series representation.
4.2	Differentials, the tangent plane and the gradient vector.
4.3	Implicit differentiation.
5.1	Matrices of linear operators and change of basis.
5.2	Eigenvectors and eigenvalues revisited. Diagonalisation
5.3	Similar matrices
6.1	Orthogonal matrices. Complex eigenvalues.
6.2	Orthogonal diagonalisability
6.3	Spectral decomposition and Cayley-Hamilton Theorem
	Mid-semester break
7.1	Introduction to double integration.
7.2	Evaluation of iterated integrals by reversing the order.
	Polar coordinates. Applications to finding areas.
7.3	Concepts for triple integrals
8.1	Techniques for triple integrals
8.2	Parametric equations of curves as vector functions.
8.3	Arc length and arc length parametrization. Curvature.
9.1	Quadratic forms, their matrices. Principal axes theorem.
9.2	Conics and Quadrics.
9.3	Positive definite quadratic forms. Sylvester's criterion.
10.1	The second order term in the Taylor formulae: quadric surfaces.
10.2	The Hessian matrix and quadratic forms. Unconstrained optimisation.
10.3	Constrained optimisation using Lagrange methods.
11.1	Vector calculus and the line integral of a scalar function.
11.2	Vector fields and the line integral of a vector function.
11.2	Vector fields and the line integral of a vector function (cont).
12.1	Conservative vector fields and the potential function.
12.2	Non-conservative vector fields and Green's theorem.
12.3	Green's theorem

MATHS 253 Planner Sem 2, 2011.

Mon	Tue	Wed	Thur	Fri
18-7	19-7 lecture 1 **no tutorial**	20-7 lecture 2	21-7 lecture3	22-7
25-7	26-7 lecture 4 **tut 1**	27-7 lecture 5	28-7 lecture6	29-7
1-8	2-8 lecture 7 **tut 2**	3-8 lecture 8	4-8 lecture9 **assignment 1 due**	5-8
8-8	9-8 lecture 10 **tut 3**	10-8 lecture 11	11-8 lecture12	12-8
15-8	16-8 lecture 13 **tut 4**	17-8 lecture 14	18-8 lecture15 **assignment 2 due**	19-8
22-8	23-8 lecture 16 **tut 5**	24-8 lecture 17 **test 6pm**	25-8 lecture 18	26-8
29-8 mid	30-8 sem	31-8 break	1-9 this	2-9 week
5-9 mid	6-9 sem	7-9 break	8-9 this	9-9 week
12-9	13-9 lecture 19 **tut 6**	14-9 lecture 20	15-9 lecture21	16-9
19-9	20-9 lecture 22 **tut 7**	21-9 lecture 23	22-9 lecture24 **assignment 3 due**	23-9
26-9	27-9 lecture 25 **tut 8(double points)**	28-9 lecture 26	29-9 lecture27	30-9
3-10	4-10 lecture 28 **tut 9**	5-10 lecture 29	6-10 lecture30 **assignment 4 due**	7-10
10-10	11-10 lecture 31 **tut 10(double points)**	12-10 lecture 32	13-10 lecture33	14 -10
17-10	18-10 lecture 34 **tut 11(no marks)**	19-10 lecture 35	20-10 lecture36	21-10

9. Assessment:
   To qualify for plussage a student must obtain at least 50 percent for the sum of the tutorial and the assignment marks.
   If a student qualifies for plussage the assessment formula will be either
   10% assignments, 6% tutorials, 30% test, 54% exam, (almost all students)
   or 40% test, 60% exam, (only a very few benefit by this) whichever gives the better result.
   If the student does not qualify for plussage the assessment formula will be
   10% assignments, 6% tutorials, 30% test, 54% exam.

   Note there is no option of just sitting the final exam only.

   (a) Assignments:
   There will be 4 assignments due at 4pm on the following Thursdays:
   4 and 18 August, 22 September and 6 October. No extensions will be allowed.
   Each assignment counts for 2.5 percent of your assessment. Assignment questions are intended to extend your understanding of this course.

   (b) Test:
   The date for the test is **Wednesday, 24 August, 6-7.30pm**, in the old government house lecture theatre(OGH 102-G36). There will be an early sitting at 4pm for those students who have clashes with other tests in BLT100 (building 106). **Please do not e-mail me in a panic if you have a test clash. Just go to the early test.** This test will count for 30 percent of your assessment (or perhaps 40 percent if you obtain plussage). The test will cover the first 5 weeks of the course only, that is lectures 1.1 to 5.3.

   (c) The exam:
   The exam will be for 2 hours only and cover weeks 6 to 12 only. Examination of the topics in weeks 1 to 5 will occur in the test.

   (d) Aegrotates:
   Students who cannot sit either the test or the final examination due to some approved medical or other emergency, should complete an aegrotate application form in the normal manner. However, an aegrotate pass cannot be granted to any student purely on the completion of assignments and tutorials only. You must sit at least one of either the test or the examination to be considered for an aegrotate pass.

   (e) Tutorials:
   The tutorials are the most important part of this course. You will be given a set of interesting problems to do and at the end of each tutorial you will need to hand in your work. It will not be marked in detail, but a mark [1 mark] will be awarded if we consider you have made a fair effort. This mark will not be awarded automatically. It is likely that some of the tutorial time will be spent discussing these problems and related matters. Answers to the tutorial problems will be put on Cecil after the tutorial is

completed. Students who hand in exceptionally good answers to tutorials will be awarded bonus marks which may be exchanged for credits toward any missed tutorials (or ones with 0 marks) or to top up assignments (by up to 20 percent). The details of this scheme will be explained later. The tutorials are not assignments, but rather an opportunity for you to spend an hour a week doing some mathematics and discussing the significance of it. Each tutorial will be worth 0.5 percent of your assessment.

10. Calculators:
    Calculators will be permitted in the mid-term test and the final examination.

11. Formula sheets:
    There will be *no* formulas provided in tests and examinations. Students are expected to memorize all necessary material.

12. Cecil:
    Cecil is the prime means of information about the running of the course. All announcements made in lectures will also be made on Cecil. Students are requested to log on to Cecil on a regular basis, and use it to get information about the course, about assignments, about any matters concerning rooms, resources, or assessments. Access Cecil at `http://www.Cecil.auckland.ac.nz`

13. Class Notices:
    Announcements sent via Cecil are simultaneously sent to your **University Webmail** address. Log onto NetAccount from any university computer using your netlogin and netpassword, to access your University Webmail at
    `https://webmail2.ec.auckland.ac.nz/webmail.html`.
    Alternatively you can redirect your University webmail by logging onto NetAccount and going to the link
    `https://admin.ec.auckland.ac.nz/emailRedirection/`.

    You are advised that many essential notices are sent via Cecil through the semester - it is your responsibility to read these notices either via Cecil or your University Webmail.

    Some material from last semester (old tutorials and assignments etc) is retained on Cecil for your information. Fresh material will be posted for this semester as required.

14. Collaborating & Cheating:
    You are encouraged to discuss problems with one another and to work together on assignments, but you must not copy another person's assignment. Assignment marks contribute to the final mark you receive in this course. We view cheating on assignment work as seriously as cheating in an examination.

    Generally acceptable forms of collaboration:

    - Getting help in understanding from staff and tutors – you are encouraged to ask for help.

- Discussing assignments and methods of solution with other students.

Generally unacceptable forms of collaboration ("cheating"): Copying all or part of another student's assignment, or allowing someone else to do all or part of your assignment for you. Allowing another student to copy all or part of your assignment, or doing all or part of an assignment for somebody else. This is treated as seriously as copying another student's assignment.

If you are in any doubt about the permissible degree of collaboration, then please discuss it with a staff member.

15. Getting Help:
    It is important that you keep up with the pace on a day by day basis. If you find that you are having difficulty keeping up with the lecture material you must seek help immediately. Let your lecturer know you are getting behind. Visit your lecturer in his office hours as soon as you can. Also visit the assistance room. For assistance with the material covered in the course:
    (a) Ask about the material in the Wednesday tutorial.
    (b) Visit the lecturers in their offices during office-hours. Refer page 1.
    (c) Get help and advice from the tutors in the Assistance Room in room G16 in the Sci-space of the Mathematics Building. It will be open on weekdays from 9am to 5pm, starting in week 2.

16. Complaints & Harassment:
    Complaints about assignment or tutorial marks are best taken to your lecturer who is in a position to do something immediately. More general complaints can be taken up by your class representative who should be elected or appointed in the first couple of lectures. You may also approach the Head of Department. Harassment on any grounds, such as racial, sexual, religious and academic is totally unacceptable. Complaints about harassment are best taken to the University Mediator (extension 87478) or to any member of the Resolve Network whose names are displayed on posters around the campus.

17. On-going course development:
    Following student course evaluations and staff course review at the end of 2010 the course study outline notes have been slightly improved. The order of some topics has been altered to give a more satisfactory sequence. Improvements will also be made to the delivery of the course.

I wish you all a profitable time and due success in this course.

Alastair McNaughton