UNSW
THE UNIVERSITY OF NEW SOUTH WALES

FACULTY OF SCIENCE
SCHOOL OF MATHEMATICS AND STATISTICS

MATH2111

HIGHER SEVERAL VARIABLE CALCULUS

Semester 1, 2009

MATHEMATICS & STATISTICS
THE UNIVERSITY OF NEW SOUTH WALES

MATH2111 – Course Outline

Information about the course

Course Authority: Dr Jonathan Kress

Lecturers: Dr Jonathan Kress RC–4102, email j.kress@unsw.edu.au
Dr Chris Tisdell RC–4103, email cct@unsw.edu.au.
Dr Kress will lecture weeks 1–6.
Dr Tisdell will lecture weeks 7–12.

Consultation: Please use email to arrange an appointment.

Credit: 6 Units of Credit (6UOC).

Prerequisites: MATH1231 or MATH1241 or MATH1251 each with a mark of at least 70.

Exclusions: MATH2019, MATH2049, MATH2069, MATH2100, MATH2110. MATH2011, MATH2039, MATH2510, MATH2610

Lectures: The scheduling of lectures is to be confirmed, however the following is a guide:

Wednesday	10:00–11:00 am	Macauley Theatre (QUAD-1027),
Wednesday	2:00–3:00 pm	Old Main Building 112 (OMB-112),
Thursday	4:00–5:00 pm	Macauley Theatre (QUAD-1027),
Friday	13:00–14:00 am	Macauley Theatre (QUAD-1027).

Tutorials: There will be one tutorial per week, **including in week 1**. Details of tutorial classes will be given in the first lecture. There may need to be some rearrangement of tutorial times.

About this course

This 6UOC course is the Higher Version of the core second year mathematics topic, Several Variable Calculus. Either this course or its ordinary level version MATH2011 is required for completion of a mathematics major. It also forms a compulsory or recommended component of several other programs. MATH2111 is highly recommended for students intending to proceed to Honours.

Course Aims

The aim of this course is to deepen your understanding of the ideas and techniques of integral and differential calculus for functions of *several* variables. These ideas and techniques are crucial to mechanics, dynamics, electromagnetism, fluid flow and many other areas of pure and applied mathematics. The course combines and extends ideas from one variable calculus and linear algebra to establish the calculus of vector–valued functions: from differentiation through multiple integration to integration over curves and surfaces and the classical Stokes' and Divergence Theorems. The emphasis is on understanding fundamental concepts, developing spatial understanding and acquiring the ability to solve concrete problems.

Higher or Ordinary?

Formally, entry to MATH2111 requires a mark of 70 in first year. Past experience indicates that students who have not achieved this grade struggle with the course. MATH2111 contains a significant amount of extra, theoretical, material compared to MATH2011. Apart from the extra understanding that this brings, the reward for this is that the examination marks are scaled to make sure that the grades are comparable. Many more Distinctions and High Distinctions are awarded in MATH2111 than in MATH2011. The pass rate in MATH2111 is traditionally very high (as it should be with the quality of students in the course). Gaining a high mark in MATH2111 requires that a student understands a reasonable amount of this extra material. Passing requires (as it does in MATH2011) that the student can at least do the most important computational parts of the course.

Student Learning Outcomes

Students taking this course will

- develop an understanding of the main ideas of calculus in higher dimensions,
- develop proficiency in performing computations arising in higher dimensional calculus,
- become acquainted with the central concepts of mathematical analysis, and of classical applied mathematics that will be used in later years.

Through regularly attending lectures and applying themselves in tutorial exercises, students will develop competency in mathematical presentation, written and verbal skills.

Relation to graduate attributes

The above outcomes are related to the development of the Science Faculty Graduate Attributes, in particular: 1.**Research, inquiry and analytical thinking abilities**, 4. **Communication**.

Teaching strategies underpinning the course

New ideas and skills are introduced and demonstrated in lectures, then students develop these skills by applying them to specific tasks in tutorials and assessments.

Rationale for learning and teaching strategies

We believe that effective learning is best supported by a climate of enquiry, in which students are actively engaged in the learning process. To ensure effective learning, students should participate in class as outlined below.

We believe that effective learning is achieved when students attend all classes, have prepared effectively for classes by reading through previous lecture notes, in the case of lectures, and, in the case of tutorials, by having made a serious attempt at doing for themselves the tutorial problems prior to the tutorials.

Furthermore, lectures should be viewed by the student as an opportunity to learn, rather than just copy down lecture notes.

Effective learning is achieved when students have a genuine interest in the subject and make a serious effort to master the basic material.

The art of logically setting out mathematics is best learned by watching an expert and paying particular attention to detail. This skill is best learned by regularly attending classes.

Assessment

Writing Assignment	5%
Class Test 1 (week 5)	15%
Class Test 2 (week 10)	15%
Final Examination	65%

Writing Assignment

The first assessment task will be a writing assignment. The aim of this task is to develop your ability to present your mathematics in a professional way, paying attention to neatness, grammar, clarity of argument, use of notation and so forth. Work that is not up to standard will be returned for resubmission — repeatedly if necessary! You should start work on this assignment as soon as possible, since the mark for this task depends only on the number of weeks that you take to produce an acceptable submission.

Further details of what is expected will be announced in lectures and on My eLearning Vista.

Tests

The class tests are designed to give you a chance to assess your mastery of the course material, including both the theoretical and computational aspects of the course.

Each of the 2 class tests will last about 40 minutes. They will **NOT** take place in tutorials. They will be held in the lecture theatre at the time of the **Thursday lecture** in weeks 5 and 10. Announcements will be made in lectures about the topics that will be covered in each of the tests.

You must bring your **STUDENT ID** card to each test.

Normal exam conditions apply in tests. In particular, you must not bring any kind of written material into the test and you must not try to get assistance from or give assistance to any other person.

You will need to provide your own writing paper for the test.

You will **NOT** be allowed to use a calculator in class tests.

If **illness** (or some other circumstance beyond your control) affects your attendance at or performance in a **class test** do **NOT** make an official application for Special Consideration, just show a medical certificate (or other appropriate documentation) to the lecturer in charge. If this documentation is accepted, your final mark will be calculated using an increased weighting for the remaining assessment tasks.

You should **keep all marked tests** until the end of session in case an error has been made in recording the marks. Your marks will be available online, and you should check these well before the end of session.

Final exam

The final exam is the major assessment task. Its purpose is to determine the level of student mastery of both the theoretical and computational course material. The duration of the final exam will be two hours.

If your attendance at, or preformance in, the final exam is affected by circumcumstances beyond your control, you may be able to apply for special consideration. See the "Administrative Matters" section for further information. You should read this information NOW so that you are aware of the rules and procedures for additional assessment.

Calculator Information

For end of semester UNSW exams student must supply their own calculator. Only calculators on the UNSW list of approved calculators may be used in the end of semester exams. This list is similar to the list of calculators approved for HSC examinations.

BEFORE the exam period calculators must be given a UNSW approved calculator sticker, obtainable 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://my.unsw.edu.au/student/academiclife/assessment/examinations/Calculator.html`

Resources for students

Texts

The text for the course is *Vector Calculus* (Fifth Edition, 2003) by Marsden and Tromba and published by W. H. Freeman and Company, New York. In particular, there is a webpage to complement the book where you will find further resources, `http://bcs.whfreeman.com/marsdenvc5e/` .

For the more abstract material you should consult more widely. Recommended texts are

- Morgan, F., Real Analysis, American Mathematical Society, 2005, P515/91.
- Williamson, Crowell and Trotter, Calculus of Vector Functions, P517.5/23.

The first year text *Calculus* by Salas, Hille and Etgen published by Wiley (any recent edition) has material relevant to much of this course.

Lecture Notes. Lecture notes for the Analysis section will be provided as a PDF on My eLearning Vista. The My eLearning Vista site will also contain a significant amount of additional material that may be of use to students. These web notes should be thought of as an alternative source of information rather than as a description of what will be covered in the lectures this year.

Problem sets. The tutorial exercises will be provided as a PDF on My eLearning Vista.

Sample exams. My eLearning Vista will contain a number of sample exams.

Course Evaluation and Development

The School of Mathematics and Statistics evaluates each course each time it is run. We carefully consider the student responses and their implications for course development. Feedback is very important to us, so please don't leave it to the end of the course to pass on any ideas.

Administrative matters

Additional Assessment. Please carefully read the additional assessment information in handout available on the web at
`http://www.maths.unsw.edu.au/students/current/policies/UG_student_info.pdf`

School Rules and Regulations. Fuller details of the general rules regarding attendance, release of marks, special consideration etc are available via the School of Mathematics and Statistics Web page at
`http://www.maths.unsw.edu.au/students/current/policies/studentpolicy.html`.

Plagiarism and academic honesty. Plagiarism is the presentation of the thoughts or work of another as one's own. Issues you must be aware of regarding plagiarism and the university's policies on academic honesty and plagiarism can be found at
`http://www.lc.unsw.edu.au/plagiarism` and
`http://www.lc.unsw.edu.au/plagiarism/plagiarism_STUDENTBOOK.pdf`.

Syllabus

The references shown against each topic are to the textbook by Marsden and Tromba [MT] and the two addition texts listed above, Morgan [M] and Williamson, Crowell and Trotter [WCT].

These references are not a definition of what is covered in this course — they are just a guide to finding relevant material. Some parts of the course are not covered in the references and many parts of the references (even in the sections mentioned below) are not included in this course.

1. Curves and Surfaces in $\mathbb{R}^n$ [MT, Sections 2.4, 7.3]

   Curves in $\mathbb{R}^n$.
   Surfaces in $\mathbb{R}^n$.

2. Introduction to Analysis and Topology in $\mathbb{R}^n$
   [Web notes; M, Parts I and II; MT, Section 2.2]

   Topology of $\mathbb{R}^n$.
   Limits and continuity for functions $\mathbb{R}^m$ to $\mathbb{R}^n$.
   Compact and connected sets
   Images of compact and connected sets

3. Differential Calculus [MT, Sections 2.3, 2.5, 2.6, 3.2–3.5]

   Partial derivatives.
   Differentiability.
   The Chain Rule
   Scalar fields
   - Directional derivatives and the gradient
   - Normals and tangents
   - Taylor's Theorem, higher order differentials
   - Maxima and minima, Lagrange multipliers

   Solubility of systems of non-linear equations
   - The Inverse and Implicit Function Theorems

4. Integral Calculus [MT, Sections 5.1–5.5, 6.2]

   Double and triple integrals
   Iterated integrals and Fubini's Theorem
   Differentiation under the integral sign
   Change of variables
   Integrals in polar, cylindrical and
   spherical coordinates

5. Fourier Series [WCT, Sections 5.5–5.8; M, Sections 7, 22, 28]

   Inner products of functions
   Function norms and metrics
   Piecewise-continuous functions
   Fourier coefficients
   Piecewise-differentiable functions
   Pointwise convergence
   General periodic functions
   Uniform convergence
   Mean-square convergence
   Applications to partial differential equations

6. Path and Line Integrals [MT, Sections 7.1–7.2]

   The path integral
   The path integral for planar curves
   The line integral
   Reparametrizations
   Line integrals of geometric curves

7. Surface Integrals [MT, Sections 7.3–7.7]

   Parametrized surfaces
   Surface area
   Integrals of scalar functions over surfaces
   Surface integrals of vector fields
   Applications.

8. The Operator ∇ [MT, Section 4.4]

   Divergence and curl
   Interpretation

9. Integral Theorems of Vector Analysis [MT, Sections 8.1–8.5]

   Green's theorem
   Stokes's theorem
   Conservative fields
   Gauss' divergence theorem
   Applications.