UNSW Course Outline

# MATH2111 Higher Several Variable Calculus - 2024

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## General Course Information

**Course Code :** MATH2111
**Year :** 2024
**Term :** Term 1
**Teaching Period :** T1
**Is a multi-term course? :** No
**Faculty :** Faculty of Science
**Academic Unit :** School of Mathematics & Statistics
**Delivery Mode :** In Person
**Delivery Format :** Standard
**Delivery Location :** Kensington
**Campus :** Sydney
**Study Level :** Undergraduate
**Units of Credit :** 6

**Useful Links**

Handbook Class Timetable

## Course Details & Outcomes

### Course Description

This is a core second-year higher mathematics course for students from all disciplines. The course extends the theory of one-variable calculus to functions or mappings with several variables. It forms the foundation for various courses in pure and applied mathematics, as well

as in physics, economics and others. Topics covered include functions of several variables, limits and continuity, differentiability, gradients, surfaces, maxima and minima, Taylor series, Lagrange multipliers, chain rules, inverse function theorem, Jacobian derivatives, double and triple integrals, iterated integrals, Riemann sums, cylindrical and spherical coordinates, change of variables, centre of mass, curves in space, line integrals, parametrised surfaces, surface integrals, divergence and curl, Stokes' theorem, Green's theorem in the plane, applications of integral theorems, Fourier series, convergence of Fourier series, applications of Fourier series. The material will be covered in lectures, problem sheets will be discussed in tutorials.

## Course Aims

The aim of this course is to deepen the 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.

## Relationship to Other Courses

This 6UOC course is the Higher version of the core second year mathematics topic MATH2011 Several Variable Calculus. Either this course or MATH2011 is required for completion of a mathematics or statistics major. MATH2011 and MATH2111 are also compulsory or recommended for several other majors and programs.  MATH2111 is required for all maths or stats majors in advanced science and is required by all students an advanced mathematics or statistics degree.

Formally, entry to MATH2111 requires a mark of 70 in one of the first year course MATH1231 or MATH1241 or MATH1251 or DPST1014. Past experience indicates that students who have not achieved this grade struggle with the course. MATH2111 contains a large amount of extra, theoretical material compared to MATH2011. The marks in MATH2111 are usually adjusted to account for this.

**Exclusions**: MATH2018, MATH2019, MATH2069, MATH2011.

## Course Learning Outcomes

| Course Learning Outcomes |
|---|
| CLO1 : Apply basic theory of several-variable calculus to solve problems. |
| CLO2 : Perform computations for problems arising in higher dimensional calculus. |
| CLO3 : Apply the central concepts of mathematical analysis and of classical applied mathematics to appropriate problems. |
| CLO4 : Prove statements on the theory of several-variable calculus rigorously. |

| Course Learning Outcomes | Assessment Item |
|---|---|
| CLO1 : Apply basic theory of several-variable calculus to solve problems. | • Test 1<br>• Test 2<br>• Test 3<br>• Final Examination |
| CLO2 : Perform computations for problems arising in higher dimensional calculus. | • Test 3<br>• Final Examination |
| CLO3 : Apply the central concepts of mathematical analysis and of classical applied mathematics to appropriate problems. | • Test 1<br>• Test 2<br>• Test 3<br>• Final Examination |
| CLO4 : Prove statements on the theory of several-variable calculus rigorously. | • Test 1<br>• Test 2<br>• Final Examination |

## Learning and Teaching Technologies

Moodle - Learning Management System | Zoom | Echo 360

## Learning and Teaching in this course

Lectures will be conducted face-to-face where you will be introduced to new material, new ideas and new skills. Then students develop these skills by applying them during the tutorials.

Tutorials ("Tutorial 2" on your timetable) begin in week 1 and will be run on an "active classroom" model. This means that you will split up into groups of 3 or 4, and be provided with a short list of problems on the topics covered in the previous week or so of lectures (or the pre-requisite material in week 1). You are expected to go through these problems in small groups, writing the solutions on the whiteboards (we will provide pens). Your tutor will assist you if you get stuck, but the point is to get you used to thinking through the problems and writing them up neatly and coherently. See moodle for more details.

There will also be a set of practice problems for you to cover in your own time as a way of practicing the techniques taught and reinforcing learning. A schedule for these to match up the lecture/video schedule will be included on Moodle.

Additionally, a non-compulsory Q&A session is offered ("Tutorial 1" on your timetable). For this session, you are encouraged to send in questions about past problems from either the active tutorial sheets or the practice problems. A tutor will then demonstrate solutions to these requested problems. See moodle for more details.

## Additional Course Information

Additional information will be made available on Moodle as the term progresses.

# Assessments

## Assessment Structure

| Assessment Item | Weight | Relevant Dates |
|---|---|---|
| Test 1<br>Assessment Format: Individual | 10% | Start Date: Not Applicable<br>Due Date: Week 3: 26 February - 03 March |
| Test 2<br>Assessment Format: Individual | 20% | Start Date: Not Applicable<br>Due Date: Week 7: 25 March - 31 March |
| Test 3<br>Assessment Format: Individual | 20% | Start Date: Friday Week 10<br>Due Date: Friday Week 10 |
| Final Examination<br>Assessment Format: Individual | 50% | Start Date: Exam date<br>Due Date: Exam date |

## Assessment Details

### Test 1

**Assessment Overview**

Test 1 is designed to assess your knowledge of the topics covered in lectures in weeks 1-2 inclusive. Test 1 will be typically scheduled in Week 3. It is comprised of an online quiz and a written assignment question. You will have approximately 1 week to complete the test at a time when is convenient for you, with as many breaks as you need. You will be provided with feedback with comments and/or solutions within two weeks of completing the task.

**Course Learning Outcomes**

- CLO1 : Apply basic theory of several-variable calculus to solve problems.
- CLO3 : Apply the central concepts of mathematical analysis and of classical applied mathematics to appropriate problems.

- CLO4 : Prove statements on the theory of several-variable calculus rigorously.

Detailed Assessment Description

To be provided on Moodle.

Assessment Length

1 week

Submission notes

Mobius and Moodle assignment

Assignment submission Turnitin type

This is not a Turnitin assignment

## Test 2

Assessment Overview

Test 2 is designed to assess your knowledge of the topics covered in lectures in weeks 3-5 inclusive. Test 2 will be typically scheduled in Week 7. It is comprised of an online quiz and a written assignment question. You will have approximately 1 week to complete the test at a time when it is convenient for you, with as many breaks as you need. You will be provided with feedback with comments and/or solutions within two weeks of completing the task.

Course Learning Outcomes

- CLO1 : Apply basic theory of several-variable calculus to solve problems.
- CLO3 : Apply the central concepts of mathematical analysis and of classical applied mathematics to appropriate problems.
- CLO4 : Prove statements on the theory of several-variable calculus rigorously.

Detailed Assessment Description

To be provided on Moodle.

Assessment Length

1 week

Submission notes

Mobius and Moodle Assignment

Assignment submission Turnitin type

This is not a Turnitin assignment

## Test 3

**Assessment Overview**

Test 3 is designed to assess your knowledge of the topics covered in lectures in weeks 5 and 7-9 inclusive. Test 3 will be typically scheduled in Week 10 with a time limit of 40 minutes. You will be provided with feedback with comments and/or solutions within two weeks of completing the task.

**Course Learning Outcomes**

- CLO1 : Apply basic theory of several-variable calculus to solve problems.
- CLO2 : Perform computations for problems arising in higher dimensional calculus.
- CLO3 : Apply the central concepts of mathematical analysis and of classical applied mathematics to appropriate problems.

**Assessment Length**

40 minutes

**Submission notes**

Paper based

**Assignment submission Turnitin type**

Not Applicable

## Final Examination

**Assessment Overview**

The final exam is designed to assess your learning and your problem-solving skills on all topics delivered across the term, including material from lectures and from tutorials. The exam is typically 2 hours long with 10 minutes reading time. Questions will cover all course content, details will be confirmed during the course. You will be expected to write proofs and perform calculations to solve problems. The examination will occur during the official university examination period. Feedback is available through inquiry with the course convenor.

**Course Learning Outcomes**

- CLO1 : Apply basic theory of several-variable calculus to solve problems.
- CLO2 : Perform computations for problems arising in higher dimensional calculus.
- CLO3 : Apply the central concepts of mathematical analysis and of classical applied mathematics to appropriate problems.
- CLO4 : Prove statements on the theory of several-variable calculus rigorously.

**Detailed Assessment Description**

Detailed information will be available on the Moodle course page.

**Assessment Length**

2h

**Submission notes**

Paper-based

**Assignment submission Turnitin type**

Not Applicable

## General Assessment Information

More detail on assessments, including examples of past tests and exams with solutions, will be posted on moodle.

**Grading Basis**

Standard

**Requirements to pass course**

A composite mark of at least 50 (after any recalibration) is required to pass the course. There are no specific hurdle requirements, e.g. it is not compulsory to sit all the tests.

# Course Schedule

| Teaching Week/Module | Activity Type | Content |
|---|---|---|
| Week 1 : 12 February - 18 February | Lecture | Introduction. Curves and surfaces. Introduction to Analysis and Topology (open and closed subsets, limit points, limits of sequences, limits and continuity of a function). |
| Week 2 : 19 February - 25 February | Lecture | Introduction to Analysis and Topology (compact and path-connected sets, Bolzano-Weierstrass Theorem, images of compact and path-connected sets), Differential calculus (differentiability, partial derivatives, Jacobian matrix, Chain Rule) |
| Week 3 : 26 February - 3 March | Lecture | Differential calculus (tangent vectors, tangent planes, Chain Rule, second order partial derivatives, Clairauts's Theorem, directional derivative, gradient, Taylor polynomials, Hessian matrix). |
| | Assessment | Test 1 |
| Week 4 : 4 March - 10 March | Lecture | Differential calculus (Taylor's Theorem, local and global minima and maxima, stationary points, saddle points, classification of stationary points, Sylvester's Criterion, method of Lagrange multipliers, Inverse Function Theorem, Implicit Function Theorem). |
| Week 5 : 11 March - 17 March | Lecture | Integral Calculus (Double and triple integrals, Iterated integrals and Fubini's Theorem, change of variables). Fourier series, piece-wise continuous and piece-wise differentiable functions. |
| Week 6 : 18 March - 24 March | Other | Flex Week: No Classes |
| Week 7 : 25 March - 31 March | Lecture | Convergence of series, application of Fourier series, introduction to vector fields. |
| | Assessment | Test 2 |
| Week 8 : 1 April - 7 April | Lecture | Basic operations of vector fields, path integral, line integral. |
| Week 9 : 8 April - 14 April | Lecture | Application of line integral, fundamental theorems, Green's Theorem, surfaces and parametrization. |
| Week 10 : 15 April - 21 April | Lecture | Surface area and surface integral, Stokes and Divergence Theorems. |
| | Assessment | Class test |

## Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

## General Schedule Information

Lecture recordings will be made available at the end of every week for revision purposes.

# Course Resources

## Prescribed Resources

There is no set textbook. The lectures will comprehensively cover the material and the lectures will define the course.

Lecture notes will be made available through Moodle. The lecturers provide skeleton lecture notes with gaps which will be filled during the lectures. It is probably best to print the lectures notes and bring them to lectures, where you can write on them the solutions to problems etc. The notes may have colours but a black-and-white printout is fine.

Note that some of the assessments are online (using Mobius) and will require internet access and others may require the ability to scan and electronically submit written material. See moodle for more details.

## Recommended Resources

The relevant text book for this course is Vector Calculus (Sixth Edition, 2012) by Marsden and Tromba and published by W. H. Freeman and Company, New York. It is available through the UNSW library, both as a hard copy and as a digital version. There is also an Internet Supplement to the book which is intended for students who wish to gain a deeper understanding of the subject.

Further books that we recommend:

- Morgan, Real Analysis, American Mathematical Society, 2005.
- Williamson, Crowell and Trotter, Calculus of Vector Functions, 1972.
- Spivak, Calculus on Manifolds: A Modern Approach to Classical Theorems of Advanced Calculus (Mathematics Monograph Series), New York: W. A. Benjamin, Inc. (reprinted by Addison-Wesley (Reading, Mass.) and Westview Press (Boulder, Colo.)), (2018) [1965]. [A brief, rigorous, and modern treatment of multivariable calculus, differential forms, and integration on manifolds for advanced undergraduates.]

## Additional Costs

There are no additional costs.

## 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.

This year, we are introducing `active classroom' tutorials in order for students to learn how to approach seemingly difficult problems. We are also offering the additional Q&A session for the first time, following student feedback, to provide space where some solutions can be presented in full detail.

# Staff Details

| Position | Name | Email | Location | Phone | Availability | Equitable Learning Services Contact | Primary Contact |
|---|---|---|---|---|---|---|---|
| Convenor | Anita Liebenau | | H13-E-6105 | 9385 7099 | Mo-Fri | Yes | Yes |
| Lecturer | Guoyin Li | | H13-E-4063 | 9385 7095 | Mo-Fri | No | No |

# Other Useful Information

## Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the UNSW Student Code of Conduct Website.

## Academic Honesty and Plagarism

**Referencing** is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.
Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

**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. 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, plagiarism and the use of AI in assessments can be located at:

- The Current Students site,
- The ELISE training site, and
- The Use of AI for assessments site.

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

## Submission of Assessment Tasks

### Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,
- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

***Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.***

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

### Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://student.unsw.edu.au/special-consideration

**Important note**: UNSW has a "fit to sit/submit" rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant

circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

## Faculty-specific Information

### Additional support for students

- The Current Students Gateway
- Student Support
- Academic Skills and Support
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- UNSW IT Service Centre
- Science EDI Student Initiatives, Offerings and Guidelines

## School-specific Information

### School of Mathematics and Statistics and UNSW 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 web site starting at: The School of Mathematics and Statistics 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.

### Special Consideration - Short Extension Policy

The School of Mathematics and Statistics has carefully reviewed its range of assignments and projects to determine their suitability for automatic short extensions as set out by the UNSW Short Extension Policy. Upon comprehensive examination of our course offerings that

incorporate these types of assessments, we have concluded that our current deadline structures already accommodate the possibility of unexpected circumstances that may lead students to require additional days for submission. Consequently, the School of Mathematics and Statistics has decided to universally opt out of the Short Extension provision for all its courses, having pre-emptively integrated flexibility into our assessment deadlines. The decision is subject to revision in response to the introduction of new course offerings. Students may still apply for Special Consideration via the usual procedures.

**Computing Lab**

The main computing laboratory is room G012 of the Anita B.Lawrence Centre (formerly 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, located on the mezzanine level through the glass door (and along the corridor) opposite the School's entrance.

For more information, including opening hours, see the computing facilities webpage. 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 assessments on time.

## School Contact Information

School Contact Information

Please visit the School of Mathematics and Statistics website for a range of information.

For information on Courses, please go to “Student life & resources” and either Undergraduate and/or Postgraduate and respective "Undergraduate courses" and "Postgraduate courses" for information on all course offerings.

All school policies, forms and help for students can be located by going to the "Student Services" within “Student life & resources” page. We also post notices in "Student noticeboard" for your information. Please familiarise yourself with the information found in these locations. If you cannot find the answer to your queries on the web you are welcome to contact the Student Services Office directly.

**Undergraduate**

E: ug.mathsstats@unsw.edu.au

P: 9385 7011 or 9385 7053

**Postgraduate**

E: pg.mathsstats@unsw.edu.au

P: 9385 7053

Should we need to contact you, we will use your official UNSW email address of in the first instance. **It is your responsibility to regularly check your university email account. Please use your UNSW student email and state your student number in all emails to us.**