

THE UNIVERSITY OF NEW SOUTH WALES  
SCHOOL OF MATHEMATICS AND STATISTICS

**MATH2019**  
**Engineering Mathematics 2CE**  
**Session 2, 2006**

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MATH2019 is a Mathematics Level II course that is only available to students for whom it is specifically required as part of their program.

Units of credit: 6

Prerequisites: MATH1231 or MATH1241.

Exclusions: MATH2011, MATH2111, MATH2510, MATH2610, MATH2120, MATH2130.

### **Course Aims**

In brief, this course is designed to introduce students of Engineering and Surveying to some mathematical tools and analytical reasoning that relate to, and are useful in, the fields of Engineering and Surveying. The course features the mathematical foundations on which some of the world's engineering and surveying advancements have rested or are related to. The course is not designed to be overly-technical in terms of theoretical mathematics, rather it features a range of highly useful concepts that are at the core of applied mathematics.

### **Student Outcomes**

By the end of this course, students are expected to know and understand various ideas, concepts and methods from applied mathematics and how these ideas may be used in, or are connected to, the fields of engineering and surveying. In particular, students will be able to apply various methods to solve a range of problems from applied mathematics and engineering - including: multivariable calculus; differential equations; matrix theory; and Fourier series. The student learning outcomes are related to the UNSW Graduate Attributes via appropriate: course planning and documentation; assessment strategies; and learning and teaching strategies, with specific links given at various points in the remainder of this document.

## Teaching and Student Learning Strategies

There will be:

- 3 x 1-hour lectures per week. They will be held in Webster-A at: 9-10am Tuesdays and 3-5pm Thursdays.
- 1 x 1 hour practice class per week to be held in EE-LG3 at 10-11am Tuesdays.
- 1 x 1 hour tutorial class per week to be held 1pm or 2pm Thursdays.

Tutorials and the practice class begin in week 2. Most students will be assigned to a tutorial at 2pm on Thursdays. During the first lecture, students who cannot make this time will be consulted and alternative times arranged. A list of tutorial room and time for each student will be displayed on the MATH2019 notice board outside room 2060 in the Red Centre before 5pm on Monday, week 2 of session.

The lectures, practice classes and tutorials are designed to incorporate a promotion of the UNSW Graduate Attributes, with a particular focus on:

- (1) the skills involved in scholarly enquiry into mathematics and its applications;
- (2) an in-depth engagement with mathematical knowledge in its engineering context;
- (3) the capacity for critical thinking and for creative problem solving;
- (4) the ability to engage in independent and reflective learning;
- (5) the capacity for enterprise, initiative and creativity;
- (6) an appreciation of, and respect for, diversity.

The above attributes will be encouraged, in part, by the relevant lecturer or tutor following the criteria set out in the Course and Teaching Evaluation And Improvement (CATEI) Process with elements of:

- (1) communicating effectively with students (for example, by emphasizing main points; repetition of important ideas when appropriate; use of clear speech and writing; use of simple language; etc)
- (2) stimulating student interest in the subject matter (eg, through the presentation and discussion of real-world examples and interesting applications; displaying a natural enthusiasm for the subject material themselves; etc)
- (3) fostering students to think critically (eg, by posing interesting questions in classes that demand careful, exact evaluation and judgement)
- (4) providing helpful feedback to help students learn (eg, by providing worked solutions to the Class Tests so that students may reflect on how to improve)
- (5) encouraging student input and participation during classes (eg, through the use of friendly, interactive discussions; by raising open, relevant questions to the class; by encouraging students to raise questions during class)
- (6) being generally helpful to students
- (7) making the topic relevant (eg, by showing the connections between applied mathematics and its role in engineering and surveying through the use of interesting and important examples)
- (8) encouraging the students to learn independently (eg, by asking some open problems during classes but not supplying the answers)
- (9) being well prepared
- (10) acknowledging a variety of solutions to problems, rather than imposing limits to one technique.

Feedback on this course will be gathered through questionnaires from UNSW's CATEI student evaluations. This feedback is taken seriously and continual improvements are made to the course to address these comments.

In engineering, the final product often gives very little hint of the intermediate processes leading to the construction of the product. The same statement is also true of mathematical solutions to (engineering) problems — the final answer may give no indication of how it was obtained. In the engineering context the intermediate steps are obviously crucial and it should also be obvious that the internal solution steps in a mathematical solution process are just as important as the final answer. The teaching methods used in this course attempt to make the solution steps in the appropriate mathematical technique as clear and as logical as possible. Given that a solution step is a logical consequence of the inputs it then does not have to be remembered as a special case, thus reducing the need for learning by memory and leading to a real understanding of the mathematical algorithm.

New ideas and techniques are introduced in lectures and then demonstrated in the problem classes. Students get their chance to develop these skills by applying them to specific tasks in tutorials. It will assist the students enormously if the scheduled problems are attempted before attending the relevant tutorial. Within mathematics it is a fundamental premise that learning a new skill is achieved by doing exercises involving the new technique.

### Assessment Strategies

The assessment consists of two class tests and a final examination. The final mark for MATH2019 will be calculated according to the weightings:

- Class test #1, worth 15%
- Class test #2, worth 15%
- November examination, worth 70%.

The class tests will be of 45 minutes duration. They will be held in Week 6 and in Week 11, during the tutorial normally held at this time. The venue will be your normal tutorial classroom.

The Class Tests and November Examination are designed to incorporate a promotion of the UNSW Graduate Attributes, with a particular focus on:

- (1) the skills involved in scholarly enquiry into mathematics and its applications;
- (2) an in-depth engagement with applied mathematical knowledge in its engineering context;
- (3) the capacity for critical thinking and for creative problem solving;
- (4) the ability to engage in independent and reflective learning;
- (5) the capacity for enterprise, initiative and creativity;
- (6) an appreciation of, and respect for, diversity;
- (7) the skills of effective communication.

The above attributes will be encouraged, in part, by the assessment containing interesting, engaging, challenging and stimulating questions that involve various ideas, concepts and methods from applied mathematics (in particular, from: multivariable calculus; differential equations; matrix theory; and Fourier series) and how these ideas may be used in, or are connected to, the field of engineering. It is obvious that the above are strongly related to the course aims and learning outcomes. The Class Tests are designed to encourage reflective learning so that students may analyse their performance in Class Tests and will be well-prepared for the November Examination.

Assessment in this course will involve demonstrating understanding of the concepts of engineering mathematics that are presented in lectures and will require problem-solving techniques developed in lectures as well as creativity and critical thinking.

At the end of the session, the raw marks for the Class Tests and November Examination may be scaled to produce a student's final mark for the course. The scaling is done so that the final distribution of marks is consistent with UNSW guidelines.

Marks will be awarded for correct working, logical and appropriate reasoning - and not just for a final answer.

## Course Resources

There are two important webpages for MATH2019 that feature the course documentation:

<http://www.maths.unsw.edu.au/students/current/homepages/math2019s2.html>

<http://web.maths.unsw.edu.au/~cct/MATH2019-2006.html>

The first webpage is the official course webpage and features a link to “WebCT Vista”, while the second features a number of things to download, such as:

- course notes
- previous test papers
- problems to be used in tutorials
- table of Laplace transforms.

Students should download these documents, print them out and bring them to classes.

## Misconduct, Plagiarism, Additional Assessment and Conduct of Exams

The School of Mathematics and Statistics has a strict policy on Additional Assessment and Plagiarism. You should view the page

<http://www.maths.unsw.edu.au/students/current/policies/studentpolicy.html>

Students are referred to the section in the 2006 UNSW Student Guide on the matter of Student and Academic Misconduct

<http://www.maths.unsw.edu.au/students/current/policies/misconductpolicy.html>

## Textbooks

- E. Kreyszig, *Advanced Engineering Mathematics* (Wiley, 9th Ed.)
- S.L. Salas & E. Hille, *Calculus: One and Several Variables*

You need not buy these books, however they are recommended. You may be able to find earlier editions at a cheaper second-hand price and they would suffice.

## Additional References

- D. A. McQuarrie, *Mathematical Methods for Scientists and Engineers* (University Science Books).

## Syllabus

### Lectures 1–4: PARTIAL DIFFERENTIATION

- Partial differentiation
- The chain rule
- Multivariable Taylor series
- Linear approximation
- Leibniz's rule for differentiating integrals

### Lectures 5–6: EXTREME VALUES

- Extrema for functions of two variables
- Constrained Extrema and Lagrange multipliers

### Lectures 7–10: VECTOR FIELD THEORY

- Revision of vector algebra
- Scalar and vector fields
- vector calculus
- velocity and acceleration
- gradient of a scalar field, Laplacian operator
- Divergence of a vector field
- Line integrals

### Lectures 11–15: DOUBLE INTEGRALS

- The double integral
- volume under a surface
- calculation of double integrals
- Area,
- reversing the order of integration
- Density, mass and centre of mass
- Moments of Inertia
- Double integrals in polar coordinates
- Jacobian transformation

### Lectures 16–20: ORDINARY DIFFERENTIAL EQUATIONS

- First Order Equations—students must be familiar with the material contained in this chapter
- Separable equations
- Integrating factor method for linear non-homogeneous equations
- Higher Order Equations
- Linear, homogeneous, constant coefficients
- Complex and double roots
- Free oscillations
- Non-Homogeneous Linear Equations
- Method of undetermined coefficients
- Forced oscillations

### Lectures 21–25: MATRICES

- Brief revision, including special matrices
- Matrix multiplication
- Inverse of a matrix

- Eigenvalues and Eigenvectors
- Quadric surfaces
- Quadratic forms
- Orthogonal matrices and diagonalisation
- Systems of linear o.d.e.'s

Lectures 26–31: LAPLACE TRANSFORMS

- The Laplace Transform
- Transform of derivatives
- Shifting theorems and the step function
- Partial fractions
- Solving o.d.e.'s and systems of o.d.e.'s using Laplace transforms

Lectures 32–37: FOURIER SERIES

- Periodic functions, trigonometric series
- Fourier series, Euler formulae
- Functions of arbitrary period
- Even and odd functions
- Half-range expansions
- Forced oscillations

Lectures 38–42: PARTIAL DIFFERENTIAL EQUATIONS

- Basic concepts
- Vibrating string
- D'Alembert's solution
- Wave equation
- Heat equation

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