UC

UNIVERSITY OF CANTERBURY

Te Whare Wānanga o Waitaha

CHRISTCHURCH NEW ZEALAND

College of Engineering

Mathematics and Statistics

Course Outlines

07

Mathematics

MATH101 **Introductory Mathematics with Applications** **18 points**

MATH101-07W (C) Whole Year (S1 and S2)

If you have not studied mathematics for some time, or lack confidence in your mathematical skills, then MATH101 may be the course for you. It is particularly suitable if your interests are in subject areas such as the earth and life sciences, which are not traditionally mathematical, but where mathematics is becoming increasingly important.

We recognise that to become confident in basic mathematics, you need a supportive teaching and learning environment. Accordingly, you will be given constant feedback on your progress, and time and care will be taken with fundamental concepts.

A strong application/modelling theme will overlay the basic techniques, and regular assignments will be set to give you practice at translating real problems into mathematical terms, solving them, and interpreting their solutions.

Topics
Applications of equations and inequalities. Functions and mathematical models. Linear systems of equations and matrices. Trigonometry. Mathematical models in calculus.

Text
Haeussler and Paul, *Introductory Mathematical Analysis*, Prentice-Hall, 10th or 11th ed.

Restrictions
MATH104, MATH105, MATH106, MATH107, MATH108, MATH109, MATH171, EMTH171.

Note
If you pass this course and wish to include more mathematics in your programme, then we will encourage you to take MATH108. If your grades are sufficiently high, and with the permission of the Head of Department, you may enrol in MATH109.

Enquiries
Pamela Hurst

MATH108 **Mathematics 1C** **18 points**

MATH108-07W (C) Whole Year (S1 and S2)
MATH108-07S1 (C) Semester One
MATH108-07S2 (C) Semester Two

This course aims to increase students' confidence in using mathematics by giving them the experience of success. Students' skills in analysing and solving problems, and their ability to write mathematics, will be developed. The course will provide you with a solid foundation in linear algebra and calculus.

Topics

Calculus: Functions. Limits and continuity. Differentiation. Maxima and minima. Concavity. Curve sketching. Implicit differentiation. Integration. Differential equations. Functions of several variables.

Linear Algebra: Systems of linear equations. Matrix algebra.

Text

Semester one and two courses:
Anton, *Calculus*, Wiley, 8th edition (early transcendentals).

Whole year course:
Haeussler and Paul, *Introductory Mathematical Analysis*, Prentice-Hall, 10th or 11th ed.

Restrictions

MATH104, MATH105, MATH106.

Enquiries

Department of Mathematics and Statistics reception

MATH109 **Mathematics 1D** **18 points**

MATH109-06SU2 (U) Summer (November 2006)
MATH109-07S1 (C) Semester One
MATH109-07S2 (C) Semester Two

So, you have successfully passed MATH108 and are keen to tackle the more advanced topics, calculus and linear algebra! Here we extend the ideas you met in MATH108 to complete your level 100 study of core mathematics.

You will discover more about the underlying geometrical ideas in linear algebra, using it to find areas and volumes and to solve problems about lines and planes. The algebraic aspect of calculus will be complemented by problems dealing with applications, where you will need to understand what your answers mean in practical terms.

Topics
Vector geometry. Matrices and determinants. Complex numbers. Trigonometric functions and further integration. Differential equation. L'Hôpital's rule and improper integrals. Sequences and series.

Text
Anton, *Calculus*, Wiley, 8th edition (early transcendentals).

Prerequisite
MATH106 or MATH108.

Restrictions
MATH104, MATH105, MATH107.

Note
If you have a high level of achievement in MATH101 you may enrol in MATH109 with the approval of the Head of Department.

Enquiries
Bill Taylor (Semester One), Günter Steinke (Semester Two) or Irene David (Summer)

MATH115 **Discrete Mathematics 1** **18 points**

MATH115-07W (C) Whole Year (S1 and S2)

Discrete mathematics is that part of mathematics in which limit processes are not of interest. MATH115 explores the integers, set algebra and various finite mathematical structures. This course aims to give students a good grounding in these topics, with special emphasis on understanding both computational techniques and proof methods. Algorithms play an important part in the course, which is designed for students majoring in mathematics or computer science. Computing is not directly involved.

Topics
Logic. Integers, induction and divisibility. Modular arithmetic. Sets, countability and functions. Graphs and trees.

Recommended Reading
Biggs, *Discrete Mathematics*, Clarendon Press, 1st or 2nd ed.
Epp, *Discrete Mathematics with Applications*, Brooks/Cole, 1995 or latest ed.
Grossman, *Discrete Mathematics for Computing*, Macmillan, 1995 or latest ed.
Ross and Wright, *Discrete Mathematics*, Prentice-Hall, 5th ed.

Note
Do not purchase any books before the start of term. You will be notified of the required books in the first few lectures.

Enquiries
Bill Taylor

MATH134 | **Logic and Computability** | **18 points**

MATH134-07SU1 (C) Summer (Jan 07)
MATH134-07S1 (C) Semester One

This course introduces you to reasoning with utmost clarity and rigour about what it is to reason carefully and well. In particular, we ask: what is it to deduce a conclusion validly from some premises? One purpose of the course is to articulate a precise and cogent answer to this question. Another purpose is to descry a way in which valid deduction is demonstrably limited, and so seems not a complete view of what reason or rationality is.

In brief, we will study formal logic, its scope and limits. Logic as an inquiry has changed profoundly in the last 150 years, very much because of investigations where philosophy and mathematics intersect. These changes are intellectually rich and exciting. They are also hugely consequential culturally. For without formal logic there would be no computers. And without computers, our social forms and ways of getting on in the world would be very different.

The present course surveys the discoveries about reason, which made the computer revolution possible. In so doing it also surveys some fundamental insights regarding the limits of symbolical reasoning, and thus of logic itself. It introduces you to propositional and predicate logic, soundness and completeness notions and results, the Gödel incompleteness theorem and its philosophical significance, and the relations between formal logic and the theory of computation

Text
Jeffery, *Richard. Formal Logic: Its Scope and Limits*, 3rd ed. McGraw-Hill, 1991. Republished by Hackett 2004.

Restrictions
MATH144, PHIL134, PHIL144.

Note
MATH134, MATH144, PHIL134 and PHIL144 are equivalent courses.

Enquiries
Philip Catton (Philosophy) or Douglas Bridges (Mathematics and Statistics)

MATH171 **Mathematical Modelling and Computation** **18 points**

MATH171-07S2 (C) Semester Two

In this mathematical modelling course, you will be introduced to the use of computational methods in an applications context. The case studies considered will be chosen from a range of engineering and scientific applications. The course complements existing level 100 ones in the mathematical sciences, and is in particular recommended for engineering students and those of you who wish to major in applied mathematics.

You will have a three hour computer lab each week during the course, which will contribute to your final grade.

Topics
Structured computer programming in application context. The MATLAB package. Case studies from engineering and scientific problems, showing the process of modelling through formulation, solution and interpretation.

Recommended Reading
Pratap, *Getting Started with MATLAB 6: A Quick Introduction for Scientists and Engineers*, Oxford University Press.

Restrictions
EMTH171.

Recommended Preparation
MATH108 Currently enrolled in or have completed MATH105 or MATH109.

Note
EMTH171 is available to students enrolled in an Engineering degree.

Enquiries
Alex James

MATH208 **Logic A** **22 points**

MATH208-07S1 (C) Semester One

Students taking MATH208 take all the 36 lectures given by Professor Copeland to PHIL208, together with 12 extra lectures from Professor Bridges. Professor Copeland's lecture topics will be: on derivation rules for the propositional calculus; modal logic and applications; tense logic and the logic of time. Professor Bridges' lectures will cover intuitionistic logic and its motivation, formal intuitionistic logic, and Kripke models.

Text
For Professor Copeland's lectures: E.J. Lemmon, *Beginning Logic*, Hackett Publ. Co., 1998.
There is no text for Professor Bridges' lectures, for which notes will be published on the web.

Prerequisite
18 points from Mathematics, Philosophy or Computer Science.

Restrictions
MATH308, PHIL208, PHIL225, PHIL246, PHIL308, PHIL346.

Enquiries
Douglas Bridges (Mathematics and Statistics) or Jack Copeland (Philosophy)

MATH221 **Algebra and Cryptography** **11 points**

MATH221-07S1 (C) Semester One

Cryptography (the construction and analysis of ciphers) has become of vital importance over the past years since it is the only practical way of keeping confidential information secret. It is based largely on modern algebraic ideas, as well as classical number theory. We will look at a number of cipher schemes, building up the algebra required to understand them. This will give you a good introduction to many areas of modern algebra. The course should be of particular interest to computer science students. This course is recommended for students intending to enrol in the Postgraduate Diploma in Security and Forensics, offered in the Department of Computer Science and Software Engineering.

Topics
Basic ideas of cryptography. Introductory number theory. Simple ciphers based on modular arithmetic. The RSA cipher and public key ciphers. Diffie Hellman key exchange. Groups. Cyclic groups and generators. Rings and fields. Boolean algebras. Polynomial rings. Constructing finite fields. Linear shift registers. One time pads and pseudo random number generators.

Text
J. Buchmann, *Introduction to Cryptography*, Springer-Verlag, 2nd edition.

Prerequisite
MATH104, MATH105, MATH106, MATH107, MATH108, MATH109, MATH115.

Restrictions
MATH211 or MATH315.

Enquiries
Peter Renaud

MATH222 | **Groups and Symmetry** | **11 points**

MATH222-07S2 (C) Semester Two

How can we classify or measure the symmetry of objects in the world around us? In this course you will see how various mathematical objects (like matrices or permutations) can be used to represent symmetries. This leads to the idea of a group, a new type of mathematical object which can be used to measure symmetry in crystals, but which has applications in other areas, such as number theory and solving equations.

Recommended Reading
J.A. Gallian, *Contemporary Abstract Algebra* (4th or later edition), Houghton Mifflin, 1998.

Prerequisite
MATH104, MATH105, MATH106, MATH107, MATH108, MATH109 or MATH115.

Restrictions
MATH211.

Enquiries
Ben Martin

MATH231 | **Discrete Methods** | **11 points**

MATH231-07S2 (C) Semester Two

Many real-world problems can be interpreted and solved in terms of graphs (networks). These problems arise in diverse areas including operations research and evolutionary biology. Very often, such problems require an algorithmic solution. This course is an introduction to graph theory. One of its objectives is to show how results in graph theory lead to such solutions.

Topics
Digraphs (directed graphs), critical path analysis, rooted trees. Graphs, connectedness, trees, planarity. Shortest paths, greedy algorithms, travelling salesman problem.

Text
A course reader will be available.

Prerequisite
MATH104, MATH105, MATH106, MATH107, MATH108, MATH109 or MATH115.

Restrictions
MATH215.

Enquiries
David Robinson

MATH243 **Analysis 2** **11 points**

MATH243-07S1 (C) Semester One

If you want to understand calculus properly, and want to be well-prepared for the future pure or applied mathematics courses that use notations of convergence and continuity, then you should take MATH243. This course is also the ideal preparation for MATH343 (Metric, Normed and Hilbert Spaces), which in turn will provide you with a modern framework for numerical analysis, approximation theory, quantum physics, theoretical economics and finance, and, of course, large parts of pure mathematics.

Topics
The real numbers as a complete ordered field. Limits, and continuity. Sequences and series. Differentiation.

Text
No set text.

Prerequisite
MATH104, MATH105, MATH107, MATH109.

Restrictions
MATH212.

Enquiries
Arno Berger or Qui Bui

MATH251 **Linear Systems** **11 points**

MATH251-07S1 (C) Semester One

Linear algebra is an essential part of the mathematical toolkit required in the modern study of many areas in the behavioural, natural, physical and social sciences, in engineering, in business, in computer science, and in pure and applied mathematics and statistics. This course begins to develop the fundamental concepts of linear algebra, emphasizing practical applications. The computer package MATLAB will be used to do some numerical calculations and graphing.

Students should continue with MATH252 after finishing MATH251.

Topics
Systems of linear equations. Iterative methods. Efficiency of algorithms. Matrix algebra. LU decomposition. Subspaces, linear dependence, basis, dimension, rank and nullity. Matrices and linear transformations. Orthogonality. Projections. Gram-Schmidt process. QR decomposition.

Text
Poole, *Linear Algebra: A Modern Introduction*, Brookes/Cole.

Prerequisite
MATH104, MATH105, MATH107 or MATH109.

Restrictions
EMTH203, EMTH204, MATH204, MATH217, MATH254.

Enquiries
Department of Mathematics and Statistics reception

MATH252 **Matrix Algebra 2** **11 points**

MATH252-07S2 (C) Semester Two

The eigenvalue problem for linear operators is of fundamental importance for the application of linear algebra in science. This course provides a basic understanding of eigenvalues and eigenvectors. Both the mathematical background and (some of) the multifarious applications, e.g. recursive sequences, differential equations, stability and resonances, are discussed at length. Also, computing eigenvalues and eigenvectors is a central topic in numerical linear algebra. Accordingly, state-of-the-art algorithms for this purpose are presented. The computer package MATLAB may be used at times.

This course gives a sound and hands-on introduction to an all-important topic in applied linear algebra. It is the ideal continuation of MATH251.

Text
Poole, *Linear Algebra: A Modern Introduction*, Brooks/Cole.

Prerequisite
MATH104, MATH105, MATH107 or MATH109.

Restrictions
EMTH203, EMTH204, MATH204, MATH217, MATH254.

Enquiries
Arno Berger

MATH254 **Linear Algebra 2** **22 points**

MATH254-07S2 (C) Semester Two

Linear Algebra is the study of matrices and vectors. It is elegant mathematics (and also the key to Calculus!). As well, it is a powerful tool for applications in electronics, physics, chemistry, engineering, probability and statistics, economics and biology. The course covers the main concepts and underlying ideas, important techniques, and examples using the MATLAB package.

Topics
Background connections to Calculus and complex numbers, Linear systems, Vector spaces, Norms, Projection and Inner-product spaces, Eigenvalues and Eigenvectors, Linear Transformations, Special Matrices.

Recommended Reading
Anton, Elementary *Linear Algebra*, Wiley, 6th or 7th ed.
Fraleigh and Beauregard, *Linear Algebra*, Addison-Wesley, 3rd ed.
Poole, Linear Algebra: *A Modern Introduction*, Brooks/Cole.

Prerequisite
(MATH104, MATH105, MATH107 or MATH109) and Head of Department approval.

Restrictions
EMTH203, EMTH204, MATH204, MATH217, MATH251, MATH252.

Enquiries
Peter Renaud

MATH261 **Multivariate Calculus** **11 points**

MATH261-07S1 (C) Semester One

This course extends the ideas of differentiation and integration to functions of several variables. As well as being essential for the study of mathematics in its own right, the material covered will be useful to students in physics, chemistry and engineering.

Topics
Multivariate differentiation, extreme values, optimisation for functions of two variables, Taylor's theorem for two variables. Line integrals, conservative fields, potential functions, curl. Surface integrals, double and triple integrals. Vector calculus.

Text
Anton, *Calculus*, Wiley, 7th ed.

Recommended Reading
Adams, *Calculus of Several Variables*, Addison-Wesley.

Prerequisite
MATH104, MATH105, MATH107 or MATH109.

Restrictions
EMTH201, EMTH202, EMTH204, EMTH210, MATH204, MATH218, MATH219, MATH264.

Enquiries
Mike Plank

MATH262 **Differential Equations and Transforms** **11 points**

MATH262-07S2 (C) Semester Two

One of the standard techniques of problem solving is converting the given problem to a different (hopefully simpler) one. This course covers various methods for solving ordinary differential equations. Essentially all of these methods employ this technique. As well as being essential for the study of mathematics in its own right the material covered will be useful to students in physics, chemistry and engineering.

Topics
Variation of parameters, reduction of order, Laplace Transform; Fourier Series; an introduction to the Fourier Transform.

Recommended Reading
Boyce and DiPrima, *Elementary Differential Equations and Boundary Value Problems*, Wiley, 8th Ed.

Prerequisite
MATH104, MATH105, MATH107 or MATH109.

Restrictions
EMTH201, EMTH202, EMTH204, EMTH210, MATH204, MATH218, MATH219, MATH264.

Enquiries
Mark Hickman

MATH264 **Multivariate Calculus and Differential Equations** **22 points**

MATH264-07S1 (C) Semester One

Calculus is a way of modelling and understanding any system where changes occur smoothly. Such systems arise in engineering, physics, chemistry, biology and economics. The aim of this course is to give you the tools to analyse such systems.

In the first part of this course we look at the differentiation and integration of functions of several variables, while in the second part we look at various ways of solving the types of differential equations which arise in science and engineering.

Much of the course is concerned with how to calculate various quantities (rates of change, maxima and minima, lengths, area, volumes and flows). We use the computer package Maple to take the tedium out of these calculations, and to provide a visual interpretation of them. We also use Maple to solve differential equations, and to examine the behaviour of the resulting solutions.

Recommended Reading
Anton, *Calculus* (5th edition or later), Wiley
Boyce and DiPrima, *Elementary Differential Equations and Boundary Value Problems*, Wiley, 6th ed.

Prerequisite
(MATH104, MATH105, MATH107 or MATH109) and Head of Department approval.

Restrictions
EMTH201, EMTH202, EMTH204, EMTH210, EMTH264, MATH204, MATH218, MATH219, MATH261, MATH262.

Enquiries
John Hannah

MATH271 **Mathematical Modelling and Computation 2** **11 points**

MATH271-07S2 (C) Semester Two

An application-oriented course in scientific computation. Numerical methods and approximations underlie much of modern science, engineering and technology, such as modelling structures, aircraft, geophysical situations, the spread of viruses, design of integrated circuits, and for image processing problems such as creating special effects for movies. The blend of theory, numerical methods, modelling and applications forms the basis for scientific computation.

The emphasis will be to survey a number of different numerical techniques rather than discuss any single topic in great detail. It will involve a mix of techniques from calculus and linear algebra, together with algorithmic and programming considerations. Programming exercises will be conducted using MATLAB. The interplay between mathematics, algorithmic concepts, the coding and numerical experiments is what makes scientific computation such a fascinating subject.

Topics
Iterative methods for nonlinear equations; numerical solution of linear and nonlinear systems; interpolation and approximation; numerical solution of ordinary differential equations. MATLAB: matrix algebra; structured programming; writing M-files; user-define functions; visualisation techniques.

Prerequisite
(MATH171 or MATH280 or MATH281 or MATH282) and (EMTH201 or EMTH202 or EMTH204 or EMTH210 or MATH261 or MATH264). Or high grade in MATH104, MATH105, MATH107 or MATH109 and Head of Department approval.

Restrictions
MATH266, EMTH271.

Enquiries
John Hannah

MATH282 **Introduction to Scientific Computation** **11 points**

MATH282-07SU1 (C) Summer (January 2007)

Introduction to the mathematical software package, MATLAB, that integrates technical computation, graphics, visualisation, and programming.

Topics
Getting started; basic features; IEEE floating point arithmetic; arrays; M-files; flow control; functions; graphics; programming principles.

This course is run as a series of computer lab sessions, incorporating introductory lectures.

Text
Chapman, SJ,*MATLAB Programming for Engineers*, 2nd ed, Brooks/Cole, pbk, 2001.
This course is heavily dependant on the textbook.

Prerequisite
MATH104, MATH105, MATH107 or MATH109.

Restrictions
MATH280, MATH281.

Enquiries
Bob Broughton

MATH301 **Mathematics in Perspective** **14 points**

MATH301-07S1 (C) Semester One

What is mathematics? What are some of the key moments in the history of mathematics? What kinds of mathematical result are considered important, and why?

This course is about the history, philosophy, people and major results of mathematics over the centuries. Since we will minimise the attention paid to technical details, the course should be accessible not only to those with a 200 level mathematics background, but also to intellectually mature students in philosophy and related subjects. In particular, it is strongly recommended for anyone who intends teaching mathematics at any level from primary school onwards.

Topics
Mathematics in ancient times. The development of algebra and calculus. Euclidean and other geometries. Major mathematical themes of the twentieth century. The foundational crisis: Hilbert, Brouwer, and Godel.

Prerequisite
36 points in Mathematics or Statistics or Engineering Mathematics at 100 level and 44 points from the BA or BSc Schedule at 200 level in Mathematics, Statistics, Engineering Mathematics, related subjects, or other subjects with good grades, as approved by the Head of Department.

Note
MATH301 may be studied at the 400 level as MATH433.

Enquiries
John Hannah

MATH305 **Mathematics Project** **14 points**

MATH305-06SU2 (C) Summer (November 2006)

This 150 hour course provides students with an opportunity to develop mathematical research skills and to extend and strengthen their understanding of an area of mathematics.

Prerequisite
44 points from MATH210-299 and with the approval of the Head of Department.

Restrictions
STAT305.

Enquiries
Alex James or Ben Martin

MATH321 **Fields and Commutative Rings** **14 points**

MATH321-07S1 (C) Semester One

This course further investigates the algebraic structure of rings and fields which were introduced at 200-level and gives a deeper understanding of these algebraic concepts. If you are interested in a thorough grounding in the algebraic theory which underpins modern applications like cryptography and error-correcting codes, or the work of Andrew Wiles in his solution of Fermat's Last Theorem, then this is the course to take.

Topics
These include the construction of finite fields; some fundamentals of commutative ring theory, including Euclidean domains, Gaussian integers, and other rings of "algebraic integers"; the impossibility of certain geometric constructions such as trisecting an angle. An introduction to fields and rings, including applications to coding theory and the impossibility of constructions such as 'squaring the circle'.

Text
J. A. Gallian, *Contemporary Abstract Algebra*, Houghtom Mifflin, 6th ed.

Prerequisite
MATH221 or MATH222 or (EMTH204 or MATH254 with the approval of the Head of Department).

Restrictions
MATH311.

Note
MATH321 may be studied at the 400 level as MATH439.

Enquiries
Günter Steinke

MATH333 **Coding Theory** **14 points**

MATH333-07S1 (C) Semester One

In attempting to communicate, information can get lost or altered so that the message received is different from the message transmitted. The reasons for this could be atmospheric conditions in satellite communications, poor handwriting, or scratches on a compact disc. The task of coding theory is to design ways of organising information so that, even though information may be lost or damaged, the original message can be recovered. Coding theory highlights a beautiful application of vector spaces over finite fields.

This course should be of interest to students in Mathematics, Computer Science and Electrical Engineering.

Text
A course reader will be available.

Prerequisite
(22 points from MATH221, MATH222, MATH231, MATH251, MATH252, MATH254, EMTH203, EMTH204) or (22 points of 200-level maths papers with the approval of the Head of Department).

Restrictions
MATH315.

Enquiries
Charles Semple

MATH334 **Combinatorics** **14 points**

MATH334-07S2 (C) Semester Two

Combinatorics covers a broad range of topics and abounds in problems that are easy to state but hard to solve. It generally deals with enumeration problems, the analysis and construction of regular finite configurations and devising practical and efficient algorithms. The course gives an introduction to some of the many branches of combinatorics, their cross-linkages and their applications in experimental designs, access schemes, codes and encryption.

Topics
These may include; Latin squares, magic squares, Hadamard matrices, block designs, Steiner triple systems, finite geometries, configurations, games, counting methods.

Recommended Reading
D.R. Stinson, *Combinatorial Designs. Constructions and Analysis*, Springer.

Prerequisite
(22 points from MATH221, MATH222, MATH231, MATH251, MATH252, MATH254, EMTH203, EMTH204) or (22 points of 200-level maths papers with the approval of the Head of Department).

Restrictions
MATH315.

Enquiries
Günter Steinke

MATH336 **Foundations of Mathematics** **14 points**

MATH336-07S2 (C) Semester Two

What is mathematics? What is the connection between truth and provability? What are the limitations of mathematics? Is every mathematical truth provable, at least in principle? “Foundations of mathematics” is the name given to the examination of such questions, using mathematical methods wherever applicable. The technical mathematical background required for this course is fairly minimal (for example, you don’t need to have done a course on analysis), so the course should be accessible to some philosophers and computer scientists; nevertheless, a measure of mathematical/intellectual maturity is an essential prerequisite.

Topics

Topics will include some from the following list, which should not be regarded as exhaustive or exclusive:

- Philosophies of Mathematics in the 20th century; the great foundational debate – Hilbert vs. Brouwer.
- Classical propositional and predicate logic; valuations, tableaux, and derivations; soundness and completeness; the compactness theorem and its applications.
- Computability: models of computation; the Church–Markov–Turing thesis; undecidability; recursive and recursively enumerable sets; Rice's theorem and the recursion theorem.
- Intuitionistic proof theory and model theory; translations from classical to intuitionistic logic; varieties of constructive mathematics; an introduction to constructive mathematics in practice.
- Axiomatic Zermelo-Fraenkel set theory; ordinals; independence of the axiom of choice and the continuum hypothesis.
- Gödel’s incompleteness theorems

Since there is not the slightest chance of covering all this material in 24 lectures, the actual direction of the course may be decided by the interests of its participants, including the lecturer.

Text

There is no textbook for the course. Full lecture notes will be available on the web.

Prerequisite

22 points from MATH221-282 or EMTH200-204 or EMTH210-271 or with the approval of the Head of Department.

Note

MATH336 may be studied at the 400 level as MATH432.

Enquiries

Douglas Bridges

MATH342 **Applications of Complex Variables** **14 points**

MATH342-07S2 (C) Semester Two

Complex functions have a variety of applications in engineering and science, and of course in mathematics itself. This course will cover the basic theory with an emphasis on some of these applications. It is strongly recommended for students in mathematics, engineering and physics.

Topics
Complex numbers. Analytic functions. Cauchy's theorem. Taylor and Laurent series. Singularities. Residue theorem and evaluation of definite integrals. Conformal mappings. Schwarz-Christoffel transformation. Bilinear functions.

Recommended Reading
Marsden and Hoffman, *Basic Complex Analysis*, Freeman, 2nd ed.

Prerequisite
(22 points from MATH219, MATH264, EMTH204) or (MATH261 and MATH262) or MATH243 or EMTH202.

Restrictions
MATH319.

Enquiries
Chris Price

MATH343 **Metric, Normed and Hilbert Spaces** **14 points**

MATH343-07S1 (C) Semester One

This course introduces those parts of modern analysis that are essential for many aspects of pure and applied mathematics, physics, economics, finance, and so on. For example, if you want to understand the convergence of numerical algorithms, approximation theory, quantum mechanics, or the economic theory of competitive equilibrium, then you will need to know something about metric, normed and Hilbert spaces.

Topics
Convergence, continuity, compactness and completeness, initially for the real number system and then generalized to metric spaces. Normed vector spaces and Hilbert spaces.

Recommended Reading
Graeme Cohen, *A Course in Modern Analysis and its Applications*, C.U.P., 2003.

Prerequisite
MATH243 or MATH264 or EMTH202 or (22 points from MATH200 or EMTH200 as approved by the Head of Department).

Restrictions
MATH312.

Note
All Honours mathematics students are encouraged to take MATH343.

Enquiries
Qui Bui

MATH352 **Applied Matrix Algebra A** **14 points**

MATH352-07S1 (C) Semester One

This course provides a practical outline of the algebra of matrices and the associated computational methods. These topics lay the foundation of much of modelling with discrete methods, especially in optimisation.

Topics
Problems in parameter estimation by linear, nonlinear and total least squares, together with the relevant matrix factorisations. Newton's method for systems of non-linear equations. Introduction to non-linear optimisation.

Recommended Reading
Noble and Daniel, *Applied Linear Algebra*, Prentice-Hall, 3rd ed.
Strang, *Linear Algebra and its Applications*, Thomson Brooks-Cole, 4th ed.
Golub and Van Loan, *Matrix Computations*, North Oxford Academic, 3rd ed.
Fletcher, *Practical Methods of Optimisation*, Wiley, 1st or 2nd ed.

Prerequisite
MATH251, MATH252, MATH254, EMTH203 or EMTH204.

Restrictions
MATH317.

Recommended Preparation
MATH271, MATH280, MATH281 or MATH282.

Enquiries
Department of Mathematics and Statistics reception

MATH353 | **Applied Matrix Algebra B** | **14 points**

MATH353-07S2 (C)   Semester Two

This course considers the theory and computation of eigensystems of matrices. The work provides a background for problems in vibrating systems, dynamical systems and statistics. Modern applied matrix algebra is used throughout and the techniques common to the major algorithms are developed. MATLAB is used in implementing the algorithms to reinforce the theory.

Topics
Eigensystems and advanced computational algorithms. Linear algebra and applications of the Fast Fourier Transform.

Recommended Reading
Watkins, *Fundamental of Matrix Computations*, Wiley, 2nd ed.
Noble and Daniel, *Applied Linear Algebra*, Prentice-Hall, 3rd ed.
Strang, Linear *Algebra and its Applications*, Thomson Brooke-Cole, 4th ed.
Golub and Van Loan, *Matrix Computations*, North Oxford Academic, 3rd ed.

Prerequisite
MATH252, MATH254, EMTH203 or EMTH204.

Restrictions
MATH317.

Recommended Preparation
(MATH251 or MATH352) and (MATH271, MATH280, MATH281 or MATH282).

Enquiries
Bob Broughton

MATH361 **Partial Differential Equations** **14 points**

MATH361-07S1 (C) Semester One

Partial differential equations (pdes) are a cornerstone of modern applied mathematics, since they are used to describe the behaviour of systems varying in space and time. For example, the propagation of sound waves through the air, or the flow of heat from a furnace. This introductory course on pdes is particularly relevant to physics and engineering majors.

Topics
Boundary value problems, questions of well-posedness. Linear second order pdes, classification. Solutions of pdes by separation of variables. Sturm-Liouville problems. Transform methods. First order equations, solution by the methods of characteristics. Quasi-linear first order pdes. Applications will be discussed throughout.

Text
Logan, J. David, *Applied Partial Differential Equations*, Springer-Verlag, New York 2nd ed. (paperback). Available on 3 day loan from the PSL library

Prerequisite
22 points from MATH219, MATH261, MATH262, MATH264, EMTH202, EMTH204.

Restrictions
MATH314, MATH318, MATH319.

Enquiries
Mark Hickman

MATH363 **Dynamical Systems** **14 points**

MATH363-07S2 (C) Semester Two

Systems of nonlinear ordinary differential equations are used in economics, biology and other sciences, and engineering. This course provides an introductory treatment of nonlinear differential equations through the methods of bifurcation theory.

Topics
Existence and uniqueness theory. Introduction to nonlinear systems; linearisation and bifurcation, periodic solutions.

Text
Strogatz, *Nonlinear Dynamics and Chaos with applications to Physics, Chemistry and Engineering*, Addison-Wesley, 1st ed.

Prerequisite
22 points from MATH219, MATH261, MATH262, MATH264, EMTH202, EMTH204.

Restrictions
MATH318.

Recommended Preparation
MATH252, MATH254 or EMTH203.

Enquiries
Department of Mathematics and Statistics reception

MATH371 **Vector Calculus and Modelling** **14 points**

MATH371-07S1 (C) Semester One

The emphasis here is on the physical application of mathematics to continuous processes.

Topics
Vector calculus; Cartesian tensor; applications of the divergence theorem and Stoke's theorem to the derivation of differential equations; properties of their solutions. Modelling techniques for evolutionary and equilibrium pdes.

Text
No set text.

Prerequisite
MATH219, MATH264, MATH261 or MATH262, EMTH202 or EMTH204.

Restrictions
MATH318.

Enquiries
David Wall

MATH376 **Applied Stochastic Modelling** **14 points**

MATH376-07S2 (C) Semester Two

See STAT316

MATH381 **Advanced Scientific Computing** **14 points**

MATH381-07S2 (C) Semester Two

This course continues the work of MATH171 and MATH271 in the area of scientific computation. Many problems from the biological and physical sciences, engineering, and economics give rise to nonlinear models in a variety of forms. This course looks at advanced techniques for solving such models. The fundamental concepts are introduced, along with practical considerations. The intention is to use advanced MATLAB functions and toolboxes in the solution of problems thus familiarizing the student with the requirements of advanced numerical algorithms as well as providing a sufficient background in advanced numerical mathematics.

Prerequisite
(EMTH202, EMTH204, MATH261, MATH262 or MATH264) and (MATH266, MATH271, MATH280, MATH282).

Restrictions
MATH366, MATH367.

Enquiries
David Wall

MATH391 **Special Topic: Cryptography** **14 points**

MATH391-07S2 (C) Semester Two

Cryptography is the science of making and breaking secret codes: encryption is what keeps our credit card details safe when we send them over the internet. In this course we will study the mathematics behind some of the main encryption systems in current use. These systems draw on ideas from algebra, geometry, number theory and probability theory. The course is aimed at students majoring in computer science or mathematics.

Recommended Reading
P. Garrett, *Making and Breaking Codes: An Introduction to Cryptology*, Prentice Hall, 2001.

Note
MATH391 may be studied at the 400 level as MATH409.

Enquiries
Ben Martin

MATH401 **Dynamical Systems 1**

MATH401-07S2 (C) Semester Two

Dynamical systems is a rapidly developing branch of mathematics with growing applications in diverse fields from traditional areas of applied mathematics to numerical analysis, biological systems, economic models and medicine.

It is often difficult or impossible to write down an exact solution to systems of nonlinear equations. The emphasis in this course will be on qualitative techniques for classifying the behaviour of nonlinear systems, without necessarily solving them exactly. Both main types of dynamical system will be studied: discrete systems, consisting of an iterated map; and continuous systems, consisting of nonlinear differential equations. Topics covered will include: chaotic behaviour of simple 1D maps; period-doubling bifurcations; phase portrait analysis; methods for determining stability of fixed points and limit cycles.

The course will not involve numerical techniques, though some knowledge of computer packages such as MATLAB may be helpful.

Enquiries
Michael Plank

MATH405 **Bioinformatics I (Phylogenetics)**

MATH405-07S1 (C) Semester One

Bioinformatics is currently a fast-growing field of research. This course will address one general question in this area, namely, what can genetic sequences tell us about the evolution of species? Topics covered will include phylogenetic trees and networks, distance and character based approaches to tree reconstruction, Markov models of sequence evolution and population genetics. The course will mainly use discrete mathematical techniques (particularly algorithms, graph theory and probability theory) and will be mostly self-contained, and suitable for a mathematically mature student from other related disciplines (e.g. computer science, biological sciences, physics).

Enquiries
Mike Steel

MATH406 **Mathematical Models in Biology**

MATH406-07S1 (C) Semester One

How did the leopard get its spots? Why should children be vaccinated against measles? This course will try to answer these (and other) questions by using mathematical models to examine biological phenomena.

Some knowledge of dynamical systems and a familiarity with Maple (or MATLAB) are useful prerequisites to this course.

Enquiries
Alex James

MATH407 Special Topic: Moving Frames & Exterior Differential Systems

MATH407-07S1 (C) Semester One

Moving frames and exterior differential systems form a natural backdrop for the study of problems in geometry and partial differential equations. In particular, most (if not all) physical systems exhibit symmetry and so embody geometric content in the differential equations that describe the physics. These systems are naturally described in the coordinate free approach of moving frames. Integrability conditions, the "size" of the solution space and the existence of "singular" branches of the solution space for systems of partial differential equations can be readily found in the moving frame approach.

This course will introduce moving frames and exterior differential systems with an emphasis of the conceptual and operational issues. The "standard" vector calculus will be revisited with the aid of differential forms. Their application to simple geometric problems and the reformulation of Maxwell's equations as an exterior differential system will be considered. If time permits (and depending on student interest) either the exterior differential system formulation of Einstein's field equations or application of moving frames to computer recognition of objects will be considered.

Prospective students should have familiarity with partial differential equations and vector calculus.

Enquiries
Mark Hickman

MATH409 Special Topic: Cryptography

MATH409-07S2 (C) Semester Two

Cryptography is the science of making and breaking secret codes: encryption is what keeps our credit card details safe when we send them over the internet. In this course we will study the mathematics behind some of the main encryption systems in current use. These systems draw on ideas from algebra, geometry, number theory and probability theory. The course is aimed at students majoring in computer science or mathematics.

See MATH391.

Enquiries
Ben Martin

MATH410 / EMTH605 **Approximation Theory 1**

MATH410/EMTH605-07S2 (C) Semester Two

The first part of this course will concentrate on the fundamentals of approximation of functions of one variable. Central topics will be approximation by algebraic and trigonometric polynomials, and the existence, characterisation and uniqueness of best approximations from finite dimensional normed linear spaces.

In the latter part of the course we will develop some more recent topic such as scattered data interpolation in several variables.

Approximation theory lies at the interface of many specialties. As such its study involves an interesting mix of pure and applied mathematics.

Recent applications of Approximation Theory here at Canterbury include fitting surfaces to noisy point clouds, applied for example in the movie industry, and fitting geophysical data sets such as grade measurements from drill holes in mines.

Enquiries
Rick Beatson

MATH412 / EMTH604 **Unconstrained Optimization**

MATH412/EMTH604-07S1 (C) Semester One

This course looks at theoretical and practical aspects of unconstrained optimization of smooth functions. The main focus is on line search algorithms, with steepest descent, Newton and quasi-Newton methods, conjugate gradients, and the Gauss-Newton method for nonlinear least squares being covered. Trust region methods are also covered. An introduction to constrained optimization, and/or derivative free methods will be done, as time permits. Experience with MATLAB useful, but not essential.

Enquiries
Chris Price or Ian Coope

MATH420 **Hilbert Spaces**

MATH420-07S2 (C) Semester Two

The theory of Hilbert spaces is fundamental in many areas of modern mathematical analysis. Historically, the theory grew out of the necessity to better understand (and answer) the deep mathematical questions brought about by mathematical physics, concerning for instance the dynamics of vibrating shells and plates, the theory of heat, and - later on - quantum dynamics. So it is hardly surprising that a sound knowledge of Hilbert space theory is indispensable nowadays for anyone seriously interested in fields as diverse as econometrics, quantum mechanics or fluid dynamics. Within mathematics, Hilbert spaces have to be regarded as the most natural generalisations of Euclidean spaces with which they have in common a clear and easy-to-grasp geometric structure. Unlike Euclidean spaces, however, Hilbert spaces may be infinite dimensional. From the implications of this seemingly innocent alteration the theory gets its characteristic flavour, and also its great applicability since most spaces encountered in mathematical physics are infinite dimensional.

This course provides a friendly introduction to Hilbert spaces and to the theory of operators on such spaces, notably to some elementary spectral theory. Although mathematically rigorous, the course does not put undue emphasis on analytical and topological ideas, but instead looks at these concepts to the extent they are required to give a clear understanding of the basic aspects of Hilbert space theory. Applications are drawn from classical and quantum mechanics. They are, however, presented rather informally as a rigorous discussion lies well beyond the scope of this course. Studying Hilbert spaces is the best way that you can tip your toes into the waters of functional analysis without getting sucked immediately into the depths of more demanding (and perhaps pathological) spaces and operators. To make this experience fully enjoyable a background in calculus and linear algebra at MATH 200 level will be assumed. Prior exposure to MATH 343 would be an asset, but is not mandatory. A comprehensive course reader will be available from UC print and copy.

Enquiries
Arno Berger

MATH425 **Fourier Transforms and Distribution Theory**

MATH425-07S2 (C) Semester Two

Operational calculus (Distribution theory) had been used by engineers (Heaviside) and physicists (Dirac) long before it was developed by L. Schwartz into a rigorous and coherent theory. Before Schwartz it was already used successfully by S.L. Sobolev in the study of partial differential equations. Since the early 1950's distribution theory has become an indispensable tool in many branches of mathematical analysis.

This course is an introduction to Fourier analysis and distribution theory. Amongst the topics covered are: The Fourier transforms, Poisson summation formula, Sampling theorems, Fourier transform of distributions, the continuous wavelet transform.

Fourier analysis is a fertile meeting ground of real, complex and functional analysis. In this course this aspect will be highlighted. To make the course self-contained, background material from other fields will be given (and explained).

Enquiries
Qui Bui

MATH426 **Differential Geometry**

MATH426-07S1 (C) Semester One

Have you ever wondered why you can roll a piece of paper into a tube but cannot bend the paper tube to form a torus without wrinkling or breaking the paper? There are physical reasons but differential geometry also provides a mathematical answer. Differential geometry studies differentiable manifolds that are equipped with additional structures like a metric (as in Riemannian geometry) and investigates their intrinsic properties and invariants. In so doing one encounters many ideas which are not only beautiful in themselves but are basic for both advanced mathematics and theoretical physics.

The course gives an introduction to classical differential geometry including the basic theory of manifolds, vector fields, geodesics and intrinsic invariants like curvature.

Enquiries
Gunter Steinke

MATH427 **Lie Groups and Lie Algebras**

MATH427-07S1 (C) Semester One

Lie groups are an essential tool in many areas of mathematics and physics. They are groups that also carry an analytical structure and are often found as groups of symmetries of `nice' mathematical objects like diffferentable geometries. The most important Lie groups are finite-dimensional and occur as groups of matrices over real or complex numbers. For example, the group of all rotations of Euclidean 3-space is a 3-dimensional Lie group. Every Lie group has an associated Lie algebra which is a very good linear approximation of the group. Many properties of the Lie group can be deduced from its algebra.

The course gives an introduction into the theory of finite-dimensional Lie groups and their associated Lie algebras. Linear representations of Lie groups may be covered in MATH437.

Enquiries
Gunter Steinke

MATH429 **Combinatorics**

MATH429-07S1 (C) Semester One

Matroids (also called combinatorial geometries) are precisely the structures that underlie the solution of many combinatorial optimization problems. These problems include scheduling and timetabling, and finding the minimum cost of a communications network between cities. Given this, it is perhaps surprising that matroid theory unifies the notions of linear independence in linear algebra and forests in graph theory as well as the notions of duality for graphs and codes.

This self-contained course is an introduction to matroid theory, a branch of discrete mathematics that has basic connections with graphs, codes, projective geometries, and combinatorial optimisation. The course is intended for students majoring in mathematics or computer science.

Enquiries
Charles Semple

MATH431 **Special Topic: Algebra and Symbolic Computation**

MATH431-07S2 (C) Semester Two

Have you ever wondered why exp($-x^2$) can't be integrated?

Polynomials in several variables arise in many settings, ranging from robot control problems to the above symbolic calculus problem. The first part of this course will look at the construction of Grobner bases, and their use to solve simultaneous polynomial equations, such as those which arise in robotics.

The second part will discuss algorithms, used by packages such as Maple and Mathematica, to perform symbolic integration. The theme linking the two parts is the idea of generalizing one-variable polynomial algebra (greatest common divisors, division algorithm and so on) to polynomials of several variables.

What you need to know about already...

The division algorithm (or long division) for polynomials. Basic calculus: integration and differentiation.

... and what would be nice, but you'll survive without it

How to find the greatest common divisor of two polynomials (or two integers) using Euclid's algorithm.

What is meant by fields, rings and ideals (in the abstract algebra sense).

Enquiries
John Hannah

MATH432 **Foundations of Mathematics**

MATH432-07S2 (C) Semester Two

What is mathematics? What is the connection between truth and provability? What are the limitations of mathematics? Is every mathematical truth provable, at least in principle? "Foundations of mathematics" is the name given to the examination of such questions, using mathematical methods wherever applicable. The technical mathematical background required for this course is fairly minimal (for example, you don't need to have done a course on analysis), so the course should be accessible to some philosophers and computer scientists; nevertheless, a measure of mathematical/intellectual maturity is an essential prerequisite.

See MATH336.

Enquiries
Douglas Bridges

MATH433 **Special Topic: Mathematics in Perspective**

MATH433-07S1 (C) Semester One

What is mathematics? What are some of the key moments in the history of mathematics? What kinds of mathematical result are considered important, and why?

This course is about the history, philosophy, people and major results of mathematics over the centuries. Since we will minimise the attention paid to technical details, the course should be accessible not only to those with a 200 level mathematics background, but also to intellectually mature students in philosophy and related subjects. In particular, it is strongly recommended for anyone who intends teaching mathematics at any level from primary school onwards.

See MATH301.

Enquiries
John Hannah

MATH437 **Special Topic: Representation Theory**

MATH427-07S1 (C) Semester One

The set GL(n,C) of invertible complex n x n matrices forms a group under multiplication. Given n, a representation of a group G is a homomorphism (structure-preserving map) from G to GL(n,C). The idea of representation theory is to study abstract groups by studying their representations. Representation theory has applications in theoretical physics: whenever there is symmetry in a physical problem, there is usually a representation of the associated symmetry group. This course will give an introduction to representation theory, first for finite groups, then for compact Lie groups (such as the special orthogonal group SO(3) of rotations in 3-space).

Preparation: Some familiarity with groups will be assumed (the definition of a group, subgroups, homomorphisms, quotient groups, etc.). If your background in group theory is weak, you will probably need to do some preparatory work at the beginning to catch up. Notes summarising the necessary background material will be available from the course website before the semester begins.

Enquiries
Ben Martin

MATH438 **Special Topic: Measure and Integration**

MATH438-07S2 (C) Semester Two

A measure is a function whose domain is a collection of sets (rather than a collection of points), and which has the essential properties of length, area, and volume. One of its uses is in the definition of the Lebesgue integral, which is far more widely applicable and easy to use than the Riemann integral (familiar from calculus). This course will give an introduction to both measure theory and the Lebesgue integral.

Enquiries
Department of Mathematics and Statistics reception

MATH439 **Special Topic: Fields and Commutative Rings**

MATH439-07S1 (C) Semester One

This course further investigates the algebraic structure of rings and fields which were introduced at 200-level and gives a deeper understanding of these algebraic concepts. If you are interested in a thorough grounding in the algebraic theory which underpins modern applications like cryptography and error-correcting codes, or the work of Andrew Wiles in his solution of Fermat's Last Theorem, then this is the course to take.

Topics
These include the construction of finite fields; some fundamentals of commutative ring theory, including Euclidean domains, Gaussian integers, and other rings of "algebraic integers"; the impossibility of certain geometric constructions such as trisecting an angle. An introduction to fields and rings, including applications to coding theory and the impossibility of constructions such as 'squaring the circle'.

See MATH321.

Enquiries
Günter Steinke

MATH441 **Special Topic: Mathematical Economics**

MATH441-07S2 (C) Semester Two

Topics

Mathematical economics came of age only in 1959, with the publication of the brief monograph Theory of Value by Gerard Debreu (who subsequently became a Professor of Mathematics at UC Berkeley and a Nobel Prizewinner in

economics). In his book, Debreu presented the first systematic, rigorous development of major topics in microeconomics using tools from topology and functional analysis. We will describe a number of topics found in Theory of Value, but with the benefit of the large amount of research in mathematical economics that has taken place over the past half-century. Concepts and results from, for example, functional analysis, will be introduced and explained as they are needed for application to the economic theory. Topics will include some from the following list, which should not be regarded as exclusive or exhaustive:

- Preference orderings and their representation by utility functions; intransitivity of indifference: representing interval orders by pairs of functions.
- Consumption and production bundles; Pareto optima and competitive equilibria.
- Demand; the existence of the demand function in the presence of strong convexity.
- The Brouwer and Kakutani fixed-point theorems.
- The existence of a competitive equilibrium, and its equivalence to Brouwer's fixed-point theorem.
- Games and equilibria.

Prerequisite

MATH343 or permission of Head of Department.

Text

There is no textbook for the course, but the following references may be helpful from time to time:

K.J. Arrow and F.H. Hahn, *General Competitive Analysis*, Oliver & Boyd, 1971.
D.S. Bridges and G.B. Mehta, *Representations of Preference Orderings*, Lecture Notes in Economics and Mathematical Systems 422, Springer–Verlag, 1996.
G. Debreu, *Theory of Value*, Cowles Foundation Monographs, 1959.
W. Hildenbrand and A.P. Kirwan, *Introduction to Equilibrium Analysis*, North-Holland, Amsterdam, 1976.
J. Quirk and R. Saposnik, *Introduction to General Equilibrium Theory and Welfare Economics*, McGraw-Hill, 1968.
A. Takayama, *Mathematical Economics*, Dryden Press, 1974.

Enquiries

Douglas Bridges

MATH442 **Special Topic: Wavelets and Data Compression**

MATH442-07S2 (C) Semester Two

What are wavelets? Wavelets and orthogonal decompositions. Wavelet transforms. Applications to signal analysis and data compressions. The point of view will be very much an applied one.

Recommend Preparation
Linear algebra (at about 200 level) and an appreciation for Fourier series and transforms.

Enquiries
Peter Renaud

MATH443 **Special Topic: Metric, Normed and Hilbert Spaces**

MATH443-07S1 (C) Semester One

This course introduces those parts of modern analysis that are essential for many aspects of pure and applied mathematics, physics, economics, finance, and so on. For example, if you want to understand the convergence of numerical algorithms, approximation theory, quantum mechanics, or the economic theory of competitive equilibrium, then you will need to know something about metric, normed and Hilbert spaces.

See MATH343.

Enquiries
Qui Bui

MATH449 **Project**

MATH449-07W (C)

Enquiries
Department of Mathematics and Statistics reception

MATH491 **Summer Research Project**

MATH491-06SU2 (C) Summer (November 2006)

This 150 hour course provides students with an opportunity to develop mathematical research skills and to extend and strengthen their understanding of an area of mathematics.

Enquiries
Alex James or Ben Martin

Statistics

STAT111 | **Statistics 1** | **18 points**

STAT111-07W (C) Whole Year (S1 and S2)

The course is designed for students seeking a good grounding in how statistics is applied to tackle genuine problems. You will use real data sets, and carry out some statistical computations using Excel.

Topics
Introductory statistics and exploratory data analysis. Sampling and design schemes. Probability concepts. Sampling distributions and estimation. Hypothesis tests. Analysis of variance. Regression and correlation. Categorical data analysis. Price indices.

Text
Wild and Seber, *Chance Encounters* (1999), Wiley.

Restrictions
STAT112, STAT131.

Enquiries
Carl Scarrott

STAT112 | **Statistics 1** | **18 points**

STAT112-07S2 (C) Semester Two

This course covers the same statistics topics as STAT111 but runs at a faster pace in the 2nd semester. The course is designed for commerce students, but anyone with an interest in statistics will find STAT112 useful.

STAT112 is equivalent to STAT111 as a prerequisite for higher level courses.

Restrictions
STAT111, STAT131.

Enquiries
Marco Reale

STAT212 **Statistical Distribution** **11 points**

STAT212-07S1 (C) Semester One

This course explains the genesis of the most commonly used statistical distributions and analysis of their properties. Understanding distributions is an essential step for statistical inference and more advanced probability theory, and thus for the study of any statistical methods.

Topics
Distributions and densities, expectations, moments and moment-generating functions, discrete distributions, continuous distributions, sampling distributions.

Text
To be advised.

Prerequisite
(MATH105, MATH106, MATH107, MATH108 or MATH109) and (STAT111, STAT112 or STAT131).

Restrictions
STAT221, STAT223, STAT231.

Enquiries
Mike Steel

STAT214 **Statistical Inference** **11 points**

STAT214-07S2 (C) Semester Two

This course provides the theoretical foundations for statistical estimation and testing at an introductory level. Both the classical and Bayesian paradigms will be studied.

Topics
Overview of estimation and hypothesis testing.
Estimation and confidence intervals.
Law of large numbers and estimation of expectations.
Maximum likelihood estimation.
Statistical tests.
The hypothesis testing framework.
Statistical testing using confidence intervals.
One-sided tests and confidence intervals.
Goodness of fit tests.
Introduction to Bayesian Statistics.
Bayesian estimation and credible intervals.
Bayesian tests.

Prerequisite
(STAT111 or STAT112) and MATH108.

Recommended Preparation
STAT212.

Restrictions
STAT221.

Enquiries
Dominic Lee

STAT216	Probability 2	11 points

STAT216-07S1 (C) Semester One

Probability theory is the foundation on which much of statistics is based. It has become central to every field of science and business during the past half century. This course follows the probability theme, with distribution theory and Markov chains.

Topics
Probability. Univariate probability distributions. Expectation. Multivariate distributions. Sequences of random variables. Random walks. Markov Chains.

Text
To be advised.

Prerequisite
STAT111 or STAT112 or MATH108.

Restrictions
MATH223, STAT231.

Enquiries
Bill Taylor

STAT218	Computational Methods in Statistics	11 points

STAT218-07S2 (C) Semester Two

The power of modern computers has unleashed new ways of thinking about statistics and implementing statistical solutions. This course introduces the student to computational techniques with uses ranging from exploratory data analysis to statistical inference. These techniques are now widely used and are fast becoming indispensable in the modern statistical toolkit. The course will provide the student with a sound understanding of the computational methods and hands-on experience in implementing and using them.

Topics
Generation of random variables, Monte Carlo integration and importance sampling, bootstrap methods, Markov chain Monte Carlo, kernel density estimation and regression, classification and regression trees.

Prerequisite
STAT111 or STAT112 or MATH108 or MATH115 or MATH171.

Enquiries
Department of Mathematics and Statistics reception

STAT222 **Applied Statistics** **11 points**

STAT222-07S1 (C) Semester One

The aim of this course is to provide a practical introduction to some of the most common statistical techniques, with emphasis on application to real data and problems. The course is of interest to students majoring in statistics, as well as students from other disciplines (e.g. biology, commerce, etc.) who want to increase the breadth of their statistical knowledgebase.

The computer package SAS is used, an industry standard for many of the key employers of statisticians, but no prior knowledge is assumed.

This course is equivalent to the first semester of STAT220. Students on this course may also be interested in STAT224 Regression Modelling.

Topics
Sample surveys, experimental design, hypothesis testing and analysis of variance.

Recommended Reading
Schaeffer, Mendenhall and Ott, *Elementary Survey Sampling*, Duxbury.
J. H. Zar, *Biostatistical Analysis*, Prentice-Hall.

Prerequisite
STAT111, STAT112 or STAT131.

Restrictions
FORE210, FORE222, STAT220.

Enquiries
Marco Reale

STAT224 **Regression Modelling** **11 points**

STAT224-07S2 (C) Semester Two

The aim of this course is to provide a practical introduction to the fundamentals of linear regression modelling, with emphasis on application to real data and problems. Regression models are the most widely used statistical tools for examining the relationships among variables. The course is of interest to students majoring in statistics, as well as students from other disciplines (e.g. biology, commerce, etc.) who want to increase the breadth of their statistical knowledgebase.

The computer package SAS is used, an industry standard for many of the key employers of statisticians, but no prior knowledge is assumed.

This course is equivalent to the second semester of STAT220. Students on this course may also be interested in STAT222 Applied Statistics, although it is not a pre-requisite.

Topics
Linear regression models, model building and evaluation.

Recommended Reading
Mendenhall and Sincich, *A Second Course in Statistics: Regression analysis*.
J. H. Zar, *Biostatistical Analysis*, Prentice-Hall.

Prerequisite
STAT111, STAT112 or STAT131.

Restrictions
FORE210, FORE224, STAT220.

Enquiries
Carl Scarrott

STAT305 **Statistics Project** **14 points**

STAT305-06SU2 (C) Summer (November 2006)

This 150 hour course provides students with an opportunity to develop statistical research skills and to extend and strengthen their understanding of an area of statistics.

Prerequisite
33 points from STAT210-299 and with the approval of the Head of Department.

Restrictions
MATH305.

Enquiries
Alex James or Ben Martin

STAT312 **Sampling Methods** **14 points**

STAT312-07S1 (C) Semester One

This course looks at practical methods for gathering new data, the raw material of statistics.

Topics
Sampling techniques and designs, including adaptive sampling, regression estimators, multistage sampling and line transect sampling. Other topics include dealing with missing sample values, and special designs for sampling animal populations.

Text
Lohr, *Sampling: Design and Analysis*, Duxbury, 1999

Prerequisite
(i) 11 points from STAT212, STAT214, STAT222 or STAT224 and (ii) a further 11 points from STAT210-299.

Note
STAT312 may be studied at the 400 level as STAT455.

Enquiries
Easaw Chacko

STAT313 | **Computational Statistics** | **14 points**

STAT313-07S2 (C) Semester Two

Data analysis and statistical inference based on permutation methods, EDF methods, boostrap and resampling methods, kernel methods, and Markov chain methods.

Prerequisites
(i) 11 points from STAT212, STAT214, STAT222, STAT224 and a further 11 points from STAT210-299. and (ii) MATH108.

Recommended Preparation
STAT218, and either MATH109 or MATH199.

Enquiries
Easaw Chacko

STAT314 | **Statistical Inference** | **14 points**

STAT314-07S1 (C) Semester One

This course looks at the foundations of statistical inference. It covers estimation and test of hypotheses from the classical viewpoint and includes the introduction to the Bayesian approach.

Topics
Sufficiency and reduction of data. Maximum likelihood and methods of moments estimators and their properties. Point and interval estimates. Hypothesis tests. Introduction to Bayesian methods.

Recommended Reading
Mood et al., *Introduction to the Theory of Statistics*, McGraw-Hill, 3rd ed.

Prerequisite
(i) 11 points from STAT212, STAT214 and a further 11 points from STAT210-299 and (ii) MATH109 or MATH199.

Recommended Preparation
STAT212 and STAT214.

Note
STAT314 may be studied at the 400 level as STAT464.

Enquiries
Marco Reale

STAT315 **Multivariate Statistical Methods** **14 points**

STAT315-07S2 (C) Semester Two

Multivariate statistical methods extract information from datasets which consist of variables measured on a number of experimental units. The application of these methods is blooming with the availability of large datasets from a wide range of scientific fields, combined with the advent of computing power to implement them. Examples abound in fields as diverse as bioinformatics, internet traffic analysis, clinical trials, finance and marketing. This course will cover the theory and applications of various multivariate statistical methods.

Topics
Multivariate Regression, Principal component analysis; factor analysis; discriminant analysis; clustering methods.

Text
Johnson, R.A. and Wichern, D.W. (2002). *Applied Multivariate Statistical Analysis*. Fifth Edition. Prentice Hall.
Everitt, B. and Dunn, G. (2001). *Applied Multivariate Data Analysis*. Second Edition. Hodder Arnold.

Prerequisite
11 points from STAT212, STAT214, STAT222, STAT224 and a further 11 points from STAT210-299.

Recommended Preparation
MATH252 or MATH254.

Note
STAT315 may be studied at the 400 level as STAT463.

Enquiries
Carl Scarrott

STAT316 | **Applied Stochastic Modelling** | **14 points**

STAT316-07S2 (C)　Semester Two

This course develops some of the theory of Poisson and Markov processes and applies it to a range of discrete problems such as random walks on graphs, population dynamics in biology, urn models, and simple processes in physics and genetics.

Topics

Limit theorems in probability, conditional expectation, Poisson processes, discrete Markov chains, random walks on graphs, branching processes and martingales. The course is based around numerous applications of the theory to problems of interest.

Prerequisites

(i) 11 points from STAT212, STAT214, STAT216 and a further 11 points from STAT210-299 and (ii) MATH109 or MATH199

Restrictions

MATH376.

Recommended Preparation

STAT212, STAT216 and 11 points from MATH252, MATH254, MATH261, MATH262, MATH264, EMTH202-204.

Note

STAT316 may be studied at the 400 level as STAT458.

Enquiries

Department of Mathematics and Statistics reception

STAT317 **Time Series Methods** **14 points**

STAT317-07S1 (C) Semester One

Here we explain some techniques to model observations taken sequentially over time. This kind of data is very common in biology, environmental sciences, economics and finance. Time series methods are widely used for forecasting. This course is application oriented, and computers are used to analyse real time series data.

Topics
Smoothing, Transformations, ARIMA models, Forecasting. Use of a computer package to analyse time series data.

Text
Chatfield, C. *The Analysis of Time Series*. Chapman and Hall.

Recommended Reading
Diggle, P.J. *Time Series, A Biostatistical Introduction*. Oxford Science Publications.

Prerequisite
(i) 11 points from STAT212, STAT214, STAT222, STAT224 and a further 11 points from STAT210-299, ECON211 and MSCI210 and (ii) MATH109 or MATH199.

Recommended Preparation
11 points from MATH251, 252, 254 and 11 points from MATH271, 282, STAT216.

Note
STAT317 may be studied at the 400 level as STAT456.

Enquiries
Easaw Chacko

STAT391 **Bayesian Statisitcs** **14 points**

STAT391-07S2 (C) Semester Two

This course explores the Bayesian approach to Statistics by considering the theory, methods for computing Bayesian solutions, and examples of applications. Applications that will be discussed include normal models, regression and variable selection, generalized linear models and mixture models. Students should have a sound mathematical background and a good foundation in Statistics and Probability.

Topics
Theoretical foundations of Bayesian Statistics.
Choice of prior distribution.
Bayesian estimation and credible regions.
Bayesian tests and model selection.
Methods for computing Bayesian solutions.
Hierarchical models.

Prerequisite
(i) 11 points from STAT212, STAT214 and a further 11 points from STAT210-299 and (ii) MATH109 or MATH199.

Recommended preparation
STAT218.

Enquiries
Dominic Lee

STAT392 **Data Mining** **14 points**

STAT392-07S2 (C) Semester Two

Data mining refers to a collection of tools to discover patterns and relationships in data, especially for large data bases. It involves several fields including data base management, statistics, artificial intelligence, and machine learning, and it has had a considerable impact in business, industry and science.

This course provides an introduction to the principal methods in data mining: data preparation and warehousing, supervised learning (tree classifiers, neural networks), unsupervised learning (clustering methods), association rules, and the dealing with high-dimensional data (PCA, ICA, multidimensional scaling). Students will see applications from various fields, such as commerce (fraud detection, product placement, targeted marketing, assessing credit risk) and medicine (diagnostics). We will use data mining software to illustrate methods with data sets from these fields.

Students must (i) do problems that are assigned throughout the term and (ii) research an area and write an account of it; the instructor will give suggestions for topics in class.

Text
There is no text. Some readings will be placed in the Physical Sciences Library; others will be from some of the many web resources on data mining.

Prerequisite
STAT111, STAT112 or STAT131 and 22 points at the 200 level in a relevant area.

Note
A fortnightly tutorial session will be scheduled at the start of the course.

STAT392 may be studied at the 400 level as STAT462.

Enquiries
Marco Reale

STAT405 **Bioinformatics I (Phylogenetics)**

STAT405-07S1 (C) Semester One

Bioinformatics is currently a fast-growing field of research. This course will address one general question in this area, namely, what can genetic sequences tell us about the evolution of species? Topics covered will include phylogenetic trees and networks, distance and character based approaches to tree reconstruction, Markov models of sequence evolution and population genetics. The course will mainly use discrete mathematical techniques (particularly algorithms, graph theory and probability theory) and will be mostly self-contained, and suitable for a mathematically mature student from other related disciplines (e.g. computer science, biological sciences, physics).

Enquiries
Mike Steel

STAT440 **Probability Theory**

STAT440-07S1 (C) Semester One

This is an advanced course in Probability Theory that equips students with the foundation for further studies in probability, statistics and stochastic processes. Concepts and results from measure theory are introduced and used so that students become aware that probability fits into the broader context of measure theory. Students should have a reasonable background in mathematics or statistics, at least up to the level of MATH243 or STAT214.

Topics

1. Sample spaces, outcomes and events. Probabilities and probability spaces. Conditional probability.
2. Random variables. Combining random variables. Distributions and distribution functions. Transformation theory. Constructing random variables with prescribed distributions.
3. Independent random variables. Functions of independent random variables. Independent events.
4. Expectation. Fundamental properties. Computing expectations. Moments.
5. Convergence of sequences of random variables. Modes of convergence. Convergence under transformations.
6. Characteristic functions. Application to limit theorems. Other transforms.

Enquiries
Dominic Lee

STAT445 **Special Topic: Multivariate and Financial Time Series**

STAT445-07S1 (C) Semester One

This course covers topics in univariate and multivariate time series analysis bridging into models for volatility, widely used in financial markets but relevant in many other fields. The course covers the following topics: ARIMA models, GARCH models, Kalman filter, stochastic volatility model, multivariate ARMA models and multivariate volatility models.

Enquiries
Marco Reale

STAT446 **Special Topic: Generalised Linear Models**

STAT446-07S1 (C) Semester One

How do you analysis data that does not fit the standard methods such as ANOVA and regression? How do you deal with data that are very non-normal, are counts rather than measurements, are correlated and have interdependencies? In this course we introduce you to the very useful toolbox of Generalised Linear Models (GLM's). This is a natural progression from understanding ANOVA, regression and multivariate techniques. We will learn about the general framework for GLM's, and how to use GLM's for analysing data. We will introduce you to the package R, and will use this software throughout the course. Some background in statistical analysis methods is necessary, and useful courses to have completed are STAT220, STAT212 and STAT315. No experience in R is necessary.

Enquiries
Jennifer Brown or Marco Reale

STAT449 **Project**

STAT449-07W (C)

Enquiries
Department of Mathematics and Statistics reception

STAT452 **Applied Statistics**

STAT452-07S1 (C) Semester One
STAT452-0722 (C) Semester Two

A project-based course in applied statistics.

Enquiries
Jennifer Brown

STAT455 **Sampling Methods**

STAT455-07S1 (C) Semester One

This course looks at practical methods for gathering new data, the raw material of statistics.

See STAT312.

Enquiries
Jennifer Brown

STAT456 **Time Series Methods**

STAT456-07S1 (C) Semester One

Here we explain some techniques to model observations taken sequentially over time. This kind of data is very common in biology, environmental sciences, economics and finance. Time series methods are widely used for forecasting. This course is application oriented, and computers are used to analyse real time series data.

See STAT317.

Enquiries
Easaw Chacko

STAT458 **Applied Stochastic Modelling**

STAT458-07S2 (C) Semester Two

This course studies Markov processes. These are sequences of random variables where dependence on past history may be reduced to dependence only on the most recent value. Such a simple form of dependence leads to a remarkably rich variety of models.

See STAT316.

Enquiries
Easaw Chacko

STAT459 **Computational Statistics**

STAT459-07S2 (C) Semester Two

This course explores computational ideas and techniques for data analysis and statistical inference that exploit the power of modern computers. Computational Statistics complements the analytical and asymptotic approaches to data analysis and inference in two ways: (a) by providing solutions beyond the limitations of the latter approaches; (b) by providing ways to compute some of the more complicated solutions obtained by the latter approaches. Topics that may be covered include:

1. Methods for generating random vectors: Rejection sampling, importance sampling, sampling/importance resampling, slice sampling, MCMC, perfect sampling.
2. Density estimation and nonparametric regression/smoothing: Kernel and mixture methods.
3. Resampling methods: Jackknife and bootstrap.
4. Numerical MLE: EM and MCEM algorithms.
5. Graphical visualization techniques.

Students should have good foundations in Statistics and Probability, at least up to the level of STAT214, STAT218 or STAT224. They should also be computer-savvy and be familiar with, or can independently learn, MATLAB.

Enquiries
Dominic Lee

STAT460 **Special Topic: Extreme Value Statistics**

STAT460-07S2 (C) Semester Two

This course aims to develop the theory and methods for modelling the extremes of random processes. Extreme value theory moves away from more traditional statistical techniques where the aims are to model the usual (or in some sense average) behaviour, to consider the unusual or rare events. It has received wide application in many fields where the risk associated with rare events are of concern, e.g. finance/economics, hydrological modelling, climate change, engineering (structural design) and material science (material fatigue/failure).

The course will cover the mathematics underlying extreme value models, statistical inference using likelihood and applications to real data, with implementation in the software package R. Recommended preparation includes second year statistics (preferably STAT214) and at least full first year mathematics (MATH105 or equivalent).

Textbook
Coles (2001). *An Introduction to Statistical Modelling of Extreme Values*, Springer-Verlag.

Enquiries
Carl Scarrott

STAT461 **Special Topic: Bayesian Statistics**

STAT461-07S2 (C) Semester Two

This course explores the Bayesian approach to Statistics by considering the theory, methods for computing Bayesian solutions, and examples of applications. Topics that will be covered include:

1. Theoretical foundations of Bayesian Statistics.
2. Choice of prior distribution.
3. Bayesian estimation and credible regions.
4. Bayesian tests and model selection.
5. Methods for computing Bayesian solutions.
6. Hierarchical models.

Students should have a sound mathematical background and a good foundation in Statistics and Probability, at least up to the level of STAT214.

Enquiries
Dominic Lee

STAT462 **Special Topic: Data Mining**

STAT462-07S2 (C) Semester Two

Data mining refers to a collection of tools to discover patterns and relationships in data, especially for large data bases. It involves several fields including data base management, statistics, artificial intelligence, and machine learning, and it has had a considerable impact in business, industry and science.

This course provides an introduction to the principal methods in data mining: data preparation and warehousing, supervised learning (tree classifiers, neural networks), unsupervised learning (clustering methods), association rules, and the dealing with high-dimensional data (PCA, ICA, multidimensional scaling). Students will see applications from various fields, such as commerce (fraud detection, product placement, targeted marketing, assessing credit risk) and medicine (diagnostics). We will use data mining software to illustrate methods with data sets from these fields.

Students must (i) do problems that are assigned throughout the term and (ii) research an area and write an account of it; the instructor will give suggestions for topics in class.

See STAT392.

Enquiries
Marco Reale

STAT463 Multivariate Statistical Methods

STAT463-07S2 (C) Semester Two

Multivariate statistical methods extract information from datasets which consist of variables measured on a number of experimental units. The application of these methods is blooming with the availability of large datasets from a wide range of scientific fields, combined with the advent of computing power to implement them. Examples abound in fields as diverse as bioinformatics, internet traffic analysis, clinical trials, finance and marketing. This course will cover the theory and applications of various multivariate statistical methods.

See STAT315.

Enquiries
Carl Scarrott

STAT464 Statistical Inference

STAT464-07S1 (C) Semester One
STAT464-07S2 (C) Semester Two

This course looks at the foundations of statistical inference. It covers estimation and test of hypotheses from the classical viewpoint and includes the introduction to the Bayesian approach.

See STAT314.

Enquiries
Easaw Chacko

STAT491 Statistics Project

STAT491-06SU2 (C) Summer (November 2006)

This 150 hour course provides students with an opportunity to develop statistical research skills and to extend and strengthen their understanding of an area of statistics.

Enquiries
Alex James or Ben Martin

Engineering Mathematics

The Department is a member of the College of Engineering and runs programme of Engineering Mathematics (EMTH) courses. EMTH courses are only available to students enrolled in a BE.

In many engineering departments students are encouraged to take further mathematics courses to aid their chosen discipline – see the UC Calendar for more details.

EMTH171 **Mathematical Modelling and Computation** **18 points**

EMTH171-06S2 (C) Semester Two

In this mathematical modelling course for engineers, you will be introduced to the use of computational methods in an applications context. The case studies considered will be chosen from a range of engineering and scientific applications. The course complements existing level 100 ones in the mathematical sciences, and is in proscribed for engineering students.

You will have a three hour computer lab each week during the course, which will contribute to your final grade.

Topics
Structured computer programming in application context. The MATLAB package. Case studies from engineering and scientific problems, showing the process of modelling through formulation, solution and interpretation.

Recommended Reading
Pratap, *Getting Started with MATLAB 6: A Quick Introduction for Scientists and Engineers*, Oxford University Press.

Prerequisites
Subject to approval of the Dean of Engineering and Forestry.

Restrictions
MATH171.

Recommended Preparation
MATH108. Currently enrolled in or have completed MATH105 or MATH109.

Enquiries
Alex James

EMTH202 **Calculus** **15points**

EMTH202-07W (C) Whole Year (S1 and S2)

Semester 1. This course extends the ideas of differentiation and integration to functions of several variables. As well as being essential for the study of mathematics in its own right, the material covered will be useful to students engineering.

Semester 2. One of the standard techniques of problem solving is converting the given problem to a different (hopefully simpler) one. This course covers various methods for solving ordinary differential equations. Essentially all of these methods employ this technique. As well as being essential for the study of mathematics in its own right the material covered will be useful to students in engineering.

Topics
Multivariate differentiation, extreme values, optimisation for functions of two variables, Taylor's theorem for two variables. Line integrals, conservative fields, potential functions, curl. Surface integrals, double and triple integrals. Vector calculus.

Classification of differential equations; linear equations of higher order: independence of solutions, reduction of order, Laplace Transform; Fourier Series; an introduction to the Fourier Transform.

Text
Anton, *Calculus*, Wiley, 7th ed.

Recommended Reading
Adams, *Calculus of Several Variables*, Addison-Wesley.
Boyce and DiPrima, *Elementary Differential Equations and Boundary Value Problems*, Wiley, 7th Ed.

Prerequisites
Subject to approval of the Dean of Engineering and Forestry.

Enquiries
Mike Plank or Mark Hickman

EMTH203	**Linear Algebra**	**15points**

EMTH203-07W (C)   Whole Year (S1 and S2)

Semester 1. Linear algebra is an essential part of the mathematical toolkit required in the modern study of many areas in engineering. This course begins to develop the fundamental concepts of linear algebra, emphasizing practical applications. The computer package MATLAB will be used to do some numerical calculations and graphing.

Semester 2. The eigenvalue problem for linear operators is of fundamental importance for the application of linear algebra in engineering. This course provides a basic understanding of eigenvalues and eigenvectors. Both the mathematical background and (some of) the multifarious applications, e.g. recursive sequences, differential equations, stability and resonances, are discussed at length. Also, computing eigenvalues and -vectors is a central topic in numerical linear algebra. Accordingly, state-of-the-art algorithms for this purpose are presented. The computer package MATLAB may be used at times.

This course gives a sound and hands-on introduction to an all-important topic in applied linear algebra.

Topics
Review of matrix algebra. Linear independence. Vector spaces - a generalization of Euclidean space. Inner products, orthogonality, Gram-Schmidt. Eigenvalue problems.

Text
Poole, *Linear Algebra: A Modern Introduction*, Brooks/Cole, 2003.

Prerequisites
Subject to approval of the Dean of Engineering and Forestry.

Enquiries
Mark Hickman or Arno Berger

EMTH204 **Calculus and Linear Algebra** **30 points**

EMTH204-07W (C) Whole Year (S1 and S2)

Semester 1. Calculus is a way of modelling and understanding any system where changes occur smoothly; such systems arise in engineering. The aim of this course is to give you the tools to analyse such systems. In the first part of this course we look at the differentiation and integration of functions of several variables, while in the second part we look at various ways of solving the types of differential equations which arise in science in engineering.

Much of the course is concerned with how to calculate various quantities (rates of change, maxima and minima, lengths, area, volumes and flows). We use the computer package MAPLE to take the tedium out of these calculations, and to provide a visual interpretation of them. We also use MAPLE to solve differential equations, and to examine the behaviour of the resulting solutions.

Semester 2. Linear Algebra is the study of matrices and vectors. It is elegant mathematics (and also the key to Calculus!). As well, it is a powerful tool for applications in electronics, physics, chemistry, engineering, probability and statistics, economics and biology. The course covers the main concepts and underlying ideas, important techniques, and examples using the MATLAB package.

Topics
Multivariate calculus. Background connections to calculus and complex numbers, Linear systems, Vector spaces, Norms, Projection and Inner-product spaces, Eigenvalues and Eigenvectors, Linear Transformations, Special Matrices.

Text
Anton, Calculus, Wiley, 7th ed.

Recommended Reading
Adams, *Calculus of Several Variables*, Addison-Wesley.
Anton, *Elementary Linear Algebra*, Wiley, 6th or 7th ed.
Fraleigh and Beauregard, *Linear Algebra*, Addison-Wesley, 3rd ed.
H. Anton and Robert Busby, *Contemporary Linear Algebra*.

Prerequisites
Subject to approval of the Dean of Engineering and Forestry.

Enquiries
John Hannah or Peter Renaud

EMTH205 **Engineering Statistics** **6 points**

EMTH205-07S2 (C) Semester Two

Data form an integral part of engineering practice. They are encountered in engineering research, design, prototype development, product testing, production, reliability and quality control, and maintenance. In all of these engineering activities, data contribute to decision-making by providing information that is relevant to the problems that may arise. The process of eliciting useful information from data is known as inference. This process is complicated by the fact that real data are never perfect but uncertain. Uncertainty arises from imperfections in the procedures, mechanisms or devices for obtaining data, as well as from natural variations in the objects from which data is sought. To perform inference with uncertain data, mathematical descriptions of uncertainty are required. The descriptions that have been very successful in balancing mathematical rigor on one hand, and practical usefulness on the other, are provided by Probability Theory. Using probability models to describe uncertainty, the formalism for doing inference is provided by Statistics. Thus, probability models and statistical inference together can provide powerful tools for solving certain engineering problems.

This course considers the engineering implications of probability models and statistical inference. The goal is to foster statistical thinking, not as an end in itself, but as a means to more effective engineering practice. This is achieved through a practical problem-oriented approach that utilizes real data and illustrates how probability models and statistical techniques are used throughout the problem-solving process. Thus, the course focuses on data, concepts, models, methods (of inference) and interpretation with emphasis on engineering applications.

Topics
Introduction and descriptive statistics, probability, distributions, estimation and confidence intervals, maximum likelihood estimation, statistical tests, linear regression, reliability analysis.

Text
Johnson, R.A., Miller and Freund's *Probability and Statistics for Engineers* (7th edition), Pearson/Prentice Hall, 2005.

Recommended Reading
McKenzie, J. and Goldman, R. *The Student Guide to MINITAB Release 14*. Pearson/Addison-Wesley, 2005.

Prerequisites
Subject to approval of the Dean of Engineering and Forestry.

Enquiries
Dominic Lee

EMTH210 **Engineering Mathematics** **15 points**

EMTH210-07S1 (C) Semester One

Topics

- Partial Differentiation: chain rule, differentials, directional derivatives, gradient, divergence and curl. Extreme values and Lagrange multipliers.
- Differential Equations: first and second order linear differential equations, Laplace transforms.
- Integration: line integrals, elements of area, change of order of integration, polar coordinates, volume elements, cylindrical and spherical coordinates.
- Fourier series: an introduction.
- Linear Algebra: eigenvalues and eigenvectors, applications to systems of equations and geometry.

Text

Zill and Cullen, *Advanced Engineering Mathematics*

Recommended Reading

Jordan and Smith, *Mathematical Techniques*
Anton, *Calculus with Analytic Geometry*
Stroud, *Further Engineering Mathematics*

Prerequisites

Subject to approval of the Dean of Engineering and Forestry.

Enquiries

Chris Price

EMTH 271 **Mathematical Modelling and Computation 2** **15points**

EMTH271-07S2 (C) Semester Two

An application-oriented course in scientific computation. Numerical methods and approximations underlie much of modern science, engineering and technology, such as modelling structures, aircraft, geophysical situations, the spread of viruses, design of integrated circuits, and for image processing problems such as creating special effects for movies. The blend of theory, numerical methods, modelling and applications forms the basis for scientific computation.

The emphasis will be to survey a number of different numerical techniques rather than discuss any single topic in great detail. It will involve a mix of techniques from calculus and linear algebra, together with algorithmic and programming considerations. Programming exercises will be conducted using MATLAB. The interplay between mathematics, algorithmic concepts, the coding and numerical experiments is what makes scientific computation such a fascinating subject.

Topics
Iterative methods for nonlinear equations; numerical solution of linear and nonlinear systems; interpolation and approximation; numerical solution of ordinary differential equations. MATLAB: matrix algebra; structured programming; writing M-files; user-define functions; visualisation techniques.

Prerequisites
Subject to approval of the Dean of Engineering and Forestry

Restrictions
MATH271.

Enquiries
John Hannah

EMTH391 **Engineering Applied Mathematics and Statistics** **12 points**

EMTH391-07S2 (C) Semester Two

Elementary probability and statistics, distributions, estimation and confidence intervals, goodness of fit tests. Partial differential equations, their use in modelling engineering applications, methods of solution and properties of these solutions.

Recommended Reading
Zill and Cullen, *Advanced Engineering Mathematics*

Prerequisites
(EMTH210 or EMTH271) and subject to approval of the Dean of Engineering and Forestry.

Restrictions
MATH361, ENCI303, EMTH205, ENME330.

Enquiries
Mike Plank or Carl Scarrott

Engineering students are able to take level 300 and 400 mathematics and statistics courses as part of their Engineering degree.

A further six engineering mathematics courses are offered for the Master of Engineering degree – see the Calendar for more details.