University of St Andrews - School of Mathematics and Statistics

This is a list of the 1000-level and 2000-level modules that were available to students during the 2019-2020 academic year. The School's sub-honours courses remain broadly the same from year to year, but this list of module offerings is for illustration purposes only and does not constitute a guarantee of the specific modules, module content or timetabling to be offered in future years.

1000-level modules

MT1001 Introductory Mathematics
MT1002 Mathematics
MT1003 Pure and Applied Mathematics
MT1007 Statistics in Practice
MT1010 Topics in Mathematics: Problem-solving Techniques

ID1003 Great Ideas 1

MT1901 Topics in Contemporary Mathematics (Evening degree programme only)

MT1001 Introductory Mathematics

Credits	20.0
Semester	1
Academic year	2019/20
Timetable	9.00 am
Description	This module is designed to give students a secure base in elementary calculus to allow them to tackle the mathematics needed in other sciences. Students wishing to do more mathematics will be given a good foundation from which they can proceed to MT1002. Some of the work covered is a revision and reinforcement of material in the Scottish Highers and many A-Level syllabuses.

Prerequisites	Higher or A-Level Mathematics (A/S level Mathematics with approval of Head of School).
Antirequisites	MT1003, MT2501-MT5999
Lectures and tutorials	5 lectures (weeks 1 - 10), 1 tutorial and 1 laboratory (weeks 2 -11).
Assessment	Written Examination = 90% (2-hour final exam = 70%, 2 class tests = 10% each), Coursework = 10%
Module coordinator	Dr C V Tran
Lecturer	Dr V Archontis, Dr P Pagano, Dr C V Tran, Dr S Yardley

Syllabus

- Basic properties of real numbers (real numbers, intervals, inequalities)
- Algebraic equations (including quadratic equations)
- Sequences and series (definitions, arithmetic and geometric series, binomial series)
- Functions (domain and range, odd and even, one to one, function composition, inverse functions)
- Exponential and logarithm (including expressions in different bases, solving equations involving exp and log)
- Trigonometry (basic functions, inverse functions, trigonometric identities, solving trigonometric equations)
- Curve sketching
- Geometry: straight lines and circles
- Limits and continuity
- Differentiation (introduction, derivatives of elementary functions, rules for calculating derivatives)
- Integration (introduction, connection with differentiation, techniques of integration)

MT1002 Mathematics

Credits	20.0
Semester	Both
Academic year	2019/20
Timetable	9.00 am

This module is designed to introduce students to the ideas, methods and techniques which they will need for applying mathematics in the physical sciences or for taking the study of mathematics further. It aims to extend and

Description	enhance their skills in algebraic manipulation and in differential and integral calculus, to develop their geometric insight and their understanding of limiting processes, and to introduce them to complex numbers and matrices.
Prerequisites	MT1001 or B at Advanced Higher Mathematics or B at A-Level Mathematics or equivalent qualification
Antirequisites	
Lectures and tutorials	5 lectures (weeks 1 - 10), 1 tutorial and 1 laboratory (weeks 2 - 11).
Assessment	Written Examination = 90% (2-hour final exam = 70%, 2 class tests = 10% each), Coursework = 10%
Module coordinator	Dr A Wilmot-Smith (S1); Dr T Coleman (S2)
Lecturer	Dr T Coleman, Prof C E Parnell, Dr M Todd, Dr A Wilmot-Smith (S1); Dr T Coleman, Dr A P Naughton, Dr A Wilmot-Smith (S2)

Syllabus

- Revision of integration techniques, hyperbolic functions and applications to integration;
- Limits of functions, l'Hospital's rule;
- Complex numbers: their arithmetic, Argand diagram, modulus-argument form, de Moivre's theorem, powers and roots, geometric and trigonometric applications;
- Differential equations: first order separable, first order linear, second order with constant coefficients both homogeneous and inhomogeneous;
- Matrices, determinants and linear equations: basic matrix operations, inverses including by row operations, determinants and their properties, solutions of systems of linear equations, including degenerate cases;
- Vectors: Vector operations, including scalar and vector product, geometrical applications including equations of lines and planes;
- Proof: the need for precision in mathematics, basic types of proof, including induction;
- Sequences and series: convergence of sequences, convergence of series, geometric series, tests for convergence, power series, Taylor-Maclaurin series, including standard examples (exp, sine, etc.).

Reading list

- E. Kreyszig, *Advanced Engineering Mathematics* (John Wiley, 2011). [This book covers much more material than just this module and will be useful for many level 2 modules.]
- Robert A. Adams, *Calculus - A Complete Course (6th Edition)* (Prentice Hall, 2006).
- E. W. Swokowski, M. Olinick, D. Pence, *Calculus (6th Edition)* (Addison Wesley, 2003). [This book is out of print, but is in the library and may be available second-hand.]
- K. E. Hirst *Numbers, Sequences and Series*, (Edward Arnold, 1995).
- K. E .Hirst *Vectors in 2 and 3 Dimensions*, (Edward Arnold, 1995).

MT1003 Pure and Applied Mathematics

Credits	20.0
Semester	2
Academic year	2019/20
Timetable	9.00 am
Description	The aim of this module is to provide students with a taste of both pure and applied mathematics, to give them insight into areas available for study in later years and to provide them with the opportunity to broaden their mathematical experience.
Prerequisites	MT1002
Antirequisites	
Lectures and tutorials	5 lectures (weeks 1 - 10), 1 tutorial and 1 laboratory (weeks 2 - 11).
Assessment	Written Examination = 90% (2-hour final exam = 70%, 2 class tests = 10% each), Coursework = 10%
Module coordinator	Dr H Cammack
Lecturer	Dr C Bleak, Dr H Cammack

Syllabus

- Functions and Relations.
- Natural numbers and integers. Elementary number theory.
- Rational numbers, irrational numbers, real numbers.
- Groups. Permutations and geometric symmetries,subgroups.
- Graphs. Hamiltonian and Eulerian paths, planarity, trees.
- Discrete and continuous descriptions.
- Simple continuous mathematical models applied to mechanical, thermal and biological problems. Autonomous systems.
- Solution of difference equations with applications to economics and population dynamics. The logistic and related equations. Chaos.
- Difference equations as iterative methods for solving algebraic equations.
- Numerical solution of initial value problems using simple difference schemes.

Reading list

- *Advanced Engineering Mathematics* E Kreyszig; Wiley; 2001

- *Calculus*, R A Adams; Pearson; 2002.
- *Calculus (6th Edition)* E W Swokowski, M Olinick, D Pence; PWS; 1994.

MT1007 Statistics in Practice

Credits	20.0
Semester	2
Academic year	2019/20
Timetable	11.00 am
Description	This module provides an introduction to statistical reasoning, elementary but powerful statistical methodologies, and real world applications of statistics. Case studies, such as building an optimal stock portfolio, and data vignettes are used throughout the module to motivate and demonstrate the principles. Students get hands-on experience exploring data for patterns and interesting anomalies as well as experience using modern statistical software to fit statistical models to data.
Prerequisites	An A grade at GCSE or an A grade National 5 Mathematics or a C grade at AS level Mathematics or a C grade at Higher Mathematics.
Antirequisites	
Lectures and tutorials	4 lectures (weeks 1 - 10), 1 tutorial and 1 laboratory (weeks 2 - 11).
Assessment	2-hour Written Examination = 50%, Coursework = 50%
Module coordinator	Dr M L Burt
Lecturer	Dr M L Burt, Dr C G Paxton

MT1010 Topics in Mathematics: Problem-solving Techniques

Credits	10.0
Semester	1
Academic year	2019/20
Timetable	10.00 am Mon (odd weeks), Wed and Fri

Description	This module introduces some important basic concepts in mathematics and also explores problem-solving in the context of these topics. It is intended to strengthen the mathematical skills of an undergraduate entering on the Fast Track route into the MMath degree programme.
Prerequisites	Admission onto the Fast Track MMath degree programme
Antirequisites	
Lectures and tutorials	1.5-hour lecture, 1 practical and 1 tutorial (x 10 weeks)
Assessment	1.5-hour Written Examination = 50%, Coursework = 50%
Module coordinator	Dr J N Reinaud
Lecturer	Dr T Coleman, Dr V M Popov, Dr J N Reinaud

This module is taken only by students on the Fast Track route through the MMath degree programme.

Syllabus

The syllabus splits into five blocks, each consisting of two weeks, covering:

1. Divisibility properties of integers, the Euclidean Algorithm;
2. Polynomials, their roots and divisibility properties;
3. Sequences and convergence (iterative schemes, Newton's Method, Euler Algorithm);
4. Euclidean geometry (possible topics including conic sections, equations of parabolae, ellipses, etc.);
5. Combinatorics and probability.

Block 5 will tie in with the material that students are covering during the semester in MT2504.

Reading list

- David M. Burton, *Elementary Number Theory*, Allyn & Bacon, 1976
- Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley, 2011
- Earl W. Smokowski, Michael Olinick & Dennis Pence, *Calculus*, PWS Pub. Co., 1994
- Sheldon Ross, *A First Course in Probability*, Pearson, 2014

ID1003 Great Ideas 1

Credits	20.0
Semester	1
Academic year	2019/20

Timetable	1.00 pm Mon, 1.00 pm Tue, 1.00 pm Thu
Description	The aim of this module is to trace some of the major intellectual and societal threads in the development of modern civilisation: the 'canon' of modern thought. The module is in three sections. Part 1 is "Arguments and Facts" and explores the fundamentals of logic, analysis and reasoning. Part 2. "Rhetoric, Debate and Understanding" will explore how argument can be used to cajole, convert, persuade and entertain and emphasise the importance in understanding another person's position. Part 3 "Applying Analysis" takes the learning and skills of the previous sections and applies them to some of the great texts and artworks of western civilisation.
Prerequisites	
Antirequisites	
Lectures and tutorials	2 to 3 lectures and 1 tutorial.
Assessment	2-hour Written Examination = 50%, Coursework = 50%
Module coordinator	Dr C Paxton
Lecturer	Team taught

MT1901 Topics in Contemporary Mathematics

Credits	20.0
Semester	1
Academic year	TBD
Timetable	Next available TBD
Description	This module will introduce areas of contemporary mathematics and statistics at a basic level. Topics may include chaos and fractals, the golden ratio, mathematical modelling of populations and analysis of the resulting equations. The statistical component will consider how to graph data, and will introduce probability, odds and betting, basic descriptive statistics and uncertainty and risk. The topics will be illustrated by simple examples and day-to-day situations.

Prerequisites	Entry to the Evening Degree programme. Basic algebraic manipulation, but not any knowledge of calculus, will be assumed. (Maths Standard Grade (Credit level) or Maths GCSE (Higher tier) would provide sufficient algebraic background.)
Antirequisites	
Lectures and tutorials	1 x 3-hour session (lecture plus tutorial).
Assessment	Coursework = 100%
Module coordinator	TBC
Lecturer	TBC

This module runs in alternate years.

Syllabus

- Recurrence relations and applications, Fibonacci numbers;
- Newton's mathematics;
- Fractals, chaos, Julia sets and the Mandelbrot set;
- Modern statistics, looking at data, basic probability;
- Statistical inference and hypothesis testing.

Assumed knowledge

Basic algebraic manipulation, but not any knowledge of calculus, will be assumed. (Maths Standard Grade (Credit level) or Maths GCSE (Higher tier) would provide sufficient algebraic background.) This material will be reviewed in the first session.

Reading list

- Stephen B. Maurer & Anthony Ralston, *Discrete Algorithmic Mathematics* (Addison-Wesley, 1991) [Chapter 5, p366-437].
- Richard Johnsonbaugh, *Discrete Mathematics* (Pearson, 2005) [Chapter 7.1-7.2, pp279-304].
- Kenneth H. Rosen, *Discrete Mathematics and Its Applications*, (McGraw-Hill, 1999) [Chapter 5.1-5.2, pp308-332].
- Louis Trenchard More, *Isaac Newton* (Scribners 1934).
- Kenneth Falconer, *Fractals – A Very Short Introduction* (Oxford UP, 2013).
- H.-O. Peitgen, H Jürgens & D Saupe, *Chaos and Fractals* (Springer-Verlag, 1992).
- Ian Stewart, *Does God Play Dice?* (Penguin, 1990).
- M. Blastland & A. Dilnot, *The Tiger that Isn't: Seeing Through a World of Numbers* (Profile Books, 2007).
- D. Huff, *How to Lie with Statistics* (Penguin, 1991).
- David Salsburg, *The Lady Tasting Tea?: how statistics revolutionized science in the twentieth century* (Henry Holt, 2002).

University of St Andrews - School of Mathematics and Statistics

This is a list of the 2000-level modules that were available to students during the 2019-2020 academic year. The School's sub-honours courses remain broadly the same from year to year, but this list of module offerings is for illustration purposes only and does not constitute a guarantee of the specific modules, module content or timetabling to be offered in future years.

2000-level modules

MT2501 Linear Mathematics
MT2502 Analysis
MT2503 Multivariate Calculus
MT2504 Combinatorics and Probability
MT2505 Abstract Algebra
MT2506 Vector Calculus
MT2507 Mathematical Modelling
MT2508 Statistical Inference
MT2901 Mathematical concepts through history

ID2003 Science Methods
ID2005 Scientific Thinking

MT2501 Linear Mathematics

Credits	15.0
Semester	Both
Academic year	2019/20
Timetable	12.00 noon Mon (odd weeks), Wed and Fri [Semester 1]; 11.00 am on Mon (even weeks), Tue and Thu [Semester 2]

This module extends the knowledge and skills that students have gained concerning matrices and systems of linear equations. It introduces the basic

Description	theory of vector spaces, linear independence, linear transformations and diagonalization. These concepts are used throughout the mathematical sciences and physics. It is recommended that students in the Faculties of Arts and Divinity take an even number of the 15-credit 2000-level MT modules.
Prerequisites	MT1002, or A at Advanced Higher Mathematics, or A at A-level Further Mathematics, or A at both A-level Mathematics and A-level Physics
Antirequisites	MT2001
Lectures and tutorials	2.5-hours lectures (x 10 weeks), 1 tutorial (x 4 weeks), 1 examples class (x 6 week)
Assessment	2-hour Written Examination = 70%, Coursework (including class test) = 30%
Module coordinator	Prof N Ruskuc (S1), Dr A Wilmot-Smith (S2)
Lecturer	Prof N Ruskuc (S1), Dr A Wilmot-Smith (S2)

Continuous assessment

- Class test (50 minute): 15%
- Coursework problem sets: 15%

Syllabus

- Matrices and determinants: basic revision of matrices & relevant fields (especially complex numbers); revision of e.r.o.'s; system of linear equations; determinants and their basic properties; matrix inverses; solutions of systems of linear equations.
- Vector spaces: Definition of vector spaces; examples of vector spaces (with emphasis on geometrical intuition); basic properties of vector spaces; subspaces.
- Linear independence and bases: spanning sets; linear independence, bases, dimension.
- Linear transformations: definition of linear transformation and examples (including trace), the matrix of a linear transformation; rank and nullity (including proof of Rank-Nullity Theorem); the rank of a matrix and reduced echelon form; rank and the matrix of a linear transformation.
- Eigenvalues, eigenvectors and diagonalization: eigenvalues and eigenvectors; change of basis; powers of matrices, symmetric matrices and quadratic forms.

Reading list

- T.S. Blyth & E.F. Robertson, *Basic Linear Algebra*, Springer, 2002.
- R.B.J.T. Allenby, *Linear Algebra*, Edward Arnold, 1995.
- Richard Kaye & Robert Wilson, *Linear Algebra*, OUP, 1998.

MT2502 Analysis

Credits	15.0
Semester	1
Academic year	2019/20
Timetable	11.00 am Mon (even weeks), Tue and Thu
Description	The main purpose of this module is to introduce the key concepts of real analysis: limit, continuity and differentiation. Emphasis will be placed on the rigourous development of the material, giving precise definitions of the concepts involved and exploring the proofs of important theorems. This module forms the prerequisite for all later modules in mathematical analysis. It is recommended that students in the Faculties of Arts and Divinity take an even number of the 15-credit 2000-level MT modules.
Prerequisites	MT1002 or A at Advanced Higher Mathematics or A at A-level Further Mathematics
Antirequisites	MT2002
Lectures and tutorials	2.5 hours lectures (x 10 weeks), 1-hour tutorial (x 5 weeks), 1-hour examples class (x 5 weeks)
Assessment	2-hour Written Examination = 70%, Coursework (including 1 class test) = 30%
Module coordinator	Dr J M Fraser
Lecturer	Dr J M Fraser

Continuous assessment

- Class tests (50 minute): 15%
- Fortnightly assessed tutorial questions: 5 x 3% = 15%

Syllabus

- The rationals and the reals: maximum & minimum, supremum & infimum, completeness.
- Sequences, series and convergence: the Bolzano-Weierstrass Theorem, tests for convergence - the ratio test, the root test, the comparison test, Cauchy sequences.
- Continuous functions: algebraic properties of continuous functions, the Intermediate Value Theorem.
- Differentiable functions: the chain rule, Rolle's Theorem, the Mean Value Theorem, Taylor polynomials.

These topics will be introduced from a rigorous point of view, giving precise definitions, applying an ε-δ approach and giving examples.

Reading list

- John M. Howie, *Real Analysis*, Springer, 2001, Chapters 1-4.
- Robert G. Bartle & Donald R. Sherbert, *Introduction to Real Analysis*, Wiley, 1992, Chapters 2-6.
- Kenneth Ross, *Elementary Analysis*, Spring, 1980, some parts of Chapters 1-6.

MT2503 Multivariate Calculus

Credits	15.0
Semester	1
Academic year	2019/20
Timetable	12 noon Mon (even weeks), Tue and Thu
Description	This module extends the basic calculus in a single variable to the setting of real functions of several variables. It introduces techniques and concepts that are used throughout the mathematical sciences and physics: partial derivatives, double and triple integrals, surface sketching, cylindrical and spherical coordinates. It is recommended that students in the Faculties of Arts and Divinity take an even number of the 15-credit 2000-level MT modules.
Prerequisites	MT1002, or A at Advanced Higher Mathematics, or A at A-level Further Mathematics, or A at both A-level Mathematics and A-level Physics, or Co-requisite MT1010
Antirequisites	MT2001
Lectures and tutorials	23 hours of lectures, 1-hour tutorial (x 4 weeks), 1-hour examples class (x 4 weeks)
Assessment	2-hour Written Examination = 70%, Coursework = 30% (including 1 class test)
Module coordinator	Dr A P Naughton
Lecturer	Prof A W Hood, Dr A P Naughton

Continuous assessment

- 50-minute class test: 15%
- Projects involving computer-based work: 15%

Syllabus

- Revision of basic differentiation rules: product rule, quotient rule, chain rule. Hyperbolic

functions & inverse hyperbolic function: graphs, derivatives, integrals & identities.
- Power series, including Taylor series about an arbitrary point. Limits, continuity & differentiability of functions on one variable (definitions). l'Hopital's Rule.
- Revision of vectors and dot product. Functions of several variables, representation as surfaces, surface sketching, and limits of functions of several variables, continuity and differentiability for functions of two variables.
- Partial derivatives, chain rule for functions of *n*-variables.
- Implicit differentiation and contours, higher order partial derivatives, derivatives in *n*-dimensions, tangent planes
- Taylor series for functions of two variables. Maxima and minima.
- Directional derivative and gradient. Lagrange multipliers.
- Revision of integration for functions of one-variable. Double integrals. Spherical and cylindrical coordinates. Triple integrals.

Reading list

- Earl W. Swokowski, Michael Olinick & Dennis Pence, *Calculus, 6th ed.*, PWS Pub. Co., 1994.
- Wilfred Kaplan, *Advanced Calculus, 3rd ed.*, Addison-Wesley, 1984.
- Erwin Kreyszig, *Advanced Engineering Mathematics, 10th ed.*, Wiley, 2011.
- Alan Jeffrey, *Advanced Engineering Mathematics*, Harcourt Academic, 2002.
- Robert Adams & Christopher Essex, *Calculus*, 8th ed, Pearson 2013.

MT2504 Combinatorics and Probability

Credits	15.0
Semester	1
Academic year	2019/20
Timetable	4pm Mon (odd weeks), Thu and Fri
Description	This module provides an introduction to the study of combinatorics and finite sets and also the study of probability. It will describe the links between these two areas of study. It provides a foundation both for further study of combinatorics within pure mathematics and for the various statistics modules that are available. It is recommended that students in the Faculties of Arts and Divinity take an even number of the 15-credit 2000-level MT modules.
Prerequisites	MT1002 or A at Advanced Higher Mathematics or A at A-level Further Mathematics, or Co-requisite MT1010
Antirequisites	MT2004 or MT2005
Lectures and	2.5 hours of lectures (x 10 weeks), 1-hour tutorial (x 4 weeks), 1-hour examples

tutorials	class (x 5 weeks)
Assessment	2-hour Written Examination = 70%, Coursework = 30%
Module coordinator	Prof C M Roney-Dougal
Lecturer	Prof C M Roney-Dougal, Dr H Worthington

Continuous assessment

- Computer project: 15%
- Fortnightly assessed tutorial questions: 5 x 3% = 15%

Syllabus

- Counting & elementary probability: definition of sets, unions of disjoint sets, pigeonhole principle, notation needed for probabilities (e.g., events, complement); axioms of probability and concept of probability using counting argument; Inclusion-Exclusion.
- Basic rules of probability (building on elementary counting), conditional probability, multiplication rule, Bayes Theorem, independence.
- Ordered pairs, double-counting, size of Cartesian products of sets, choosing with repetition; functions, permutations.
- Recursion and generating functions: Binomial numbers, recursively and via generating functions; Fionacci numbers including some recursive formulae; Catalan numbers, including some recursive formulae; more on generating functions; counting partitions of a set.
- Random variables and distributions: definition of a discrete random variable (r.v.), probability mass functions, Bernoulli distribution, Binomial distribution, Poisson distribution, geometric distribution (including lack of memory property).
- Continuous r.v.s, probability density functions, uniform distribution; exponential distribution, normal distribution; cumulative distribution function (c.d.f., discrete & continuous cases), inverse c.d.f.
- Expectation; variance, introduction to probability generating functions; moment generating functions.
- Bivariate distributions: discrete/continuous distributions, joint, marginal and conditional probability mass/density functions; expectation, covariance and correlation, independence.

Reading list

- Norman L. Biggs, *Discrete Mathematics, 2nd ed.*, OUP, 2002.
- Ian Anderson, *A First Course in Discrete Mathematics*, Springer, 2001.
- John A. Rice, *Mathematical Statistics and Data Analysis*, Belmont, CA: Brooks/Cole CENGAGE, 2007.
- Richard D. De Veaux, Paul F. Velleman & David E. Bock, *Stats: Data and Models*, Pearson/Addison Wesley, 2005.

MT2505 Abstract Algebra

Credits	15.0
Semester	2
Academic year	2019/20
Timetable	11.00 am Mon (odd weeks), Wed and Fri
Description	This main purpose of this module is to introduce the key concepts of modern abstract algebra: groups, rings and fields. Emphasis will be placed on the rigourous development of the material and the proofs of important theorems in the foundations of group theory. This module forms the prerequisite for later modules in algebra. It is recommended that students in the Faculties of Arts and Divinity take an even number of the 15-credit 2000-level MT modules.
Prerequisites	MT1002 or A at Advanced Higher Mathematics or A at A-level Further Mathematics
Antirequisites	MT2002
Lectures and tutorials	2.5 hours of lectures (x 10 weeks), 1-hour tutorial (x 5 weeks), 1-hour examples class (x 5 weeks)
Assessment	2-hour Written Examination = 70%, Coursework = 30%
Module coordinator	Dr M R Quick
Lecturer	Dr M R Quick

Continuous assessment

- Computer project: 15%
- Fortnightly assessed tutorial questions (4 weeks): 15%

Syllabus

- Preliminaries and prerequisites; equivalence relations
- The definitions and familiar examples of rings and fields
- The definition of a group, Cayley tables, elementary properties of groups
- Examples of groups: modular arithmetic including the Euclidean algorithm; permutation groups and symmetries
- The order of an element, subgroups, cyclic groups, alternating groups, cosets and Lagrange's Theorem
- Homomorphisms and isomorphisms, normal subgroups, ideals, quotient groups and rings, the First Isomorphism Theorem

Reading list

- R.B.J.T. Allenby, *Rings, Fields and Groups, 2nd ed.*, Edward Arnold, 1991.
- T.S. Blyth & E.F. Robertson, *Essential Student Algebra, Vol.3: Abstract Algebra*, Chapman & Hall, 1986.
- T.S. Blyth & E.F. Robertson, *Algebra Through Practice, Book 3: Groups, Rings and Fields*, CUP, 1984.
- D.A.R. Wallace, *Groups, Rings and Fields*, Springer, 1998.

MT2506 Vector Calculus

Credits	15.0
Semester	2
Academic year	2019/20
Timetable	9.00 am Mon (even weeks), Tue and Thu
Description	This module introduces students to some of the fundamental techniques that are used throughout the mathematical modelling of problems arising in the physical world such as grad, div and curl as well as cylindrical and spherical coordinate systems. Fundamental theorems such as Green's Theorem, Stokes' Theorem and Gauss's Divergence Theorem will also be studied. It provides the foundation for many of the modules available in applied mathematics later in the Honours programme. It is recommended that students in the Faculties of Arts and Divinity take an even number of the 15-credit 2000-level MT modules.
Prerequisites	MT2503
Antirequisites	MT2003
Lectures and tutorials	2.5 hours of lectures (x 10 weeks), 1-hour tutorial (x 5 weeks), 1-hour examples class (x 5 weeks)
Assessment	2-hour Written Examination = 70%, Coursework (including class test) = 30%
Module coordinator	Prof D G Dritschel
Lecturer	Prof D G Dritschel

Continuous assessment

- Class test (50-minute): 15%
- Fortnightly assessed tutorial questions: 5 x 3% = 15%

Syllabus

- Revision of modulus, dot and scalar products (& derivation of cosine formula).

- Grad and directional derivatives of a scalar field; calculation of div and curl of vectors, and curl curl of a vector; verification of identities for div and curl of (scalar times vector); div and curl in cylindrical coordinates; derivatives of unit vectors in spherical coordinates; identity div curl = 0.
- Parametric line integrals in the (x,y) plane; potential function use in line integrals (result depends upon starting and finishing points only).
- Surface integrals of: scalars in spherical coordinates; vectors (in cartesians) using the method of projection; vectors in cylindrical coordinates.
- Green's Theorem in (x,y) with parametric integration; Stokes' Theorem in cartesian and spherical coordinates; Gauss' Divergence theorem in cartesian and cylindrical coordinates.

Reading list

- Erwin Kreyszig, *Advanced Engineering Mathematics, 10th ed.*, Wiley, 2011.
- Murray R. Spiegel, *Vector Analysis*, Schaum's Outline Series, McGraw-Hill, 1981.
- Robert A. Adams, *Calculus: A Complete Course, 6th ed.*, Pearson Addison Wesley, 2006.
- Robert Adams & Christopher Essex, *Calculus*, 8th ed, Pearson 2013.

MT2507 Mathematical Modelling

Credits	15.0
Semester	2
Academic year	2019/20
Timetable	12.00 noon Mon (odd weeks), Wed and Fri
Description	This module provides an introduction to a variety of techniques that are used throughout applied mathematics. It discusses how to translate physical problems into mathematics and covers such topics as differential equations, dynamics, numerical methods and Fourier series. It illustrates how these are used when solving problems. It is recommended that students in the Faculties of Arts and Divinity take an even number of the 15-credit 2000-level MT modules.
Prerequisites	MT2503
Antirequisites	MT2003
Lectures and tutorials	2.5 hours of lectures (x 10 weeks), 1-hour tutorial (x 5 weeks), 1-hour examples class (x 5 weeks)
Assessment	2-hour Written Examination = 70%, Coursework = 30%
Module coordinator	Prof T Neukirch
Lecturer	Prof T Neukirch

Continuous assessment

- Three homework assignment: 3 x 5% = 15%
- Computer project: 15%

Syllabus

- Revision of ODEs: separable 1st order ODEs, integrating factors, homogeneous linear 2nd order ODEs with constant coefficients, inhomogeneous linear 2nd order ODEs with constant coefficients. Simple applications: radioactive decay, logistic ODE. Nonlinear coupled ODEs: application, e.g., predator-prey models, etc., stationary states, linearization.
- Phase plane analysis.
- Dynamics: Newton's laws, motion under constant gravitational force (1D, 2D), friction, use of total energy.
- Numerical methods: applied to previous nonlinear ODEs, Newton-Raphson (1D, 2D) for calculating stationary states, solution of nonlinear ODEs with numerical methods to supplement phase plane analysis.
- Fourier series: Use of 2D Laplace equation for potential in Cartesian coordinates as motivation, sine and cosine as a system of orthogonal functions, definition of Fourier Coefficients, examples of Fourier series.

Reading list

- Robert A. Adams, *Calculus: A Complete Course, 6th ed.*, Pearson Addison Wesley, 2006.
- Anton Howard, Irl Bivens & Stephen Davis, *Calculus, 9th ed.*, John Wiley, 2009.
- Alan Jeffrey, *Advanced Engineering Mathematics*, Harcourt Academic, 2002.
- Erwin Kreyszig, *Advanced Engineering Mathematics, 10th ed.*, Wiley, 2011.

MT2508 Statistical Inference

Credits	15.0
Semester	2
Academic year	2019/20
Timetable	12.00 noon Mon (even weeks), Tue and Thu
Description	This module provides an introduction to the mathematical models of randomness. These models are used to perform statistical analysis, where the aim is to evaluate our uncertainty on a certain quantity after observing data. Important topics in statistics are described including maximum likelihood estimation, confidence intervals and hypothesis testing, permutation tests, and linear regression. It forms a prerequisite for the statistics modules in the Honours programme. It is recommended that students in the Faculties of Arts

and Divinity take an even number of the 15-credit 2000-level MT modules.

Prerequisites	MT2504
Antirequisites	MT2004 or EC2003
Lectures and tutorials	2.5 hours lectures (x 10 weeks), 1-hour tutorial (x 5 weeks), 1-hour examples class (x 5 weeks)
Assessment	2-hour Written Examination = 70%, Coursework = 30%
Module coordinator	Dr H Worthington
Lecturer	Dr H Worthington

Continuous assessment

- Computer project performing statistical analysis using R: 15%
- Fortnightly assessed tutorial questions: 5 x 3% = 15%

Syllabus

- Difference between population and sample: Sample mean and variance as estimates of population mean and variance; sample covariance and correlation.
- Likelihood and maximum likelihood estimation: Discrete data and examples (sequence of binary trials, Poisson counts all with the same mean, Poisson with mean a function of a covariate); continuous data and example (*n* observations from $N(m,s^2)$, m.l.e.s of mean and variance); invariance of m.l.e.s
- Confidence intervals and hypothesis testing: Unbiased and consistent estimators, interval estimation, hypothesis testing
- Basic properties of Normal distributions, Central Limit Theorem (statement and application to binomial and Poisson), assessing normality (normal scores)
- Hypothesis testing and interval estimation for normal distributions with s^2 known; c^2, *t* and *F* distributions and their basic properties; one-sample *t*-test, paired *t*-test; two-sample *t*-tests and confidence intervals for means of normal distributions; *F*-tests for equality of variances of normal distributions; permutation tests: 2-sample permutation test; perm test for matched pairs and one-sample test; randomizaiton tests.
- Simple linear regression: Intro and least squares, normal linear regression, regression in R, CIs and PIs, checking assumptions.

Reading list

- John A. Rice, *Mathematical Statistics and Data Analysis*, Belmont, CA: Brooks/Cole CENGAGE, 2007.
- Richard D. De Veaux, Paul F. Velleman & David E. Bock, *Stats: Data and Models*, Pearson/Addison Wesley, 2005.
- Bryan F.J. Manly, *Randomization, Bootstrap and Monte Carlo Methods in Biology*, Chapman & Hall, 2007.

ID2003 Science Methods

Credits	10.0
Semester	1
Academic year	2019/20
Timetable	1.00 pm Mon, 1.00 pm Tue, 4.00 pm Thu
Description	This module provides an overview of the rationale, methods, history and philosophy of science. We explore the different definitions of science, the distinction between science and pseudo-science, the design of experiments, critical thinking, errors in reasoning, methods of making inferences and generalisations, the role of personal experience and anecdotes in science, the process of scientific publication and the role of anomalies in science. The module is collaboratively taught by staff from a number of schools in the university providing a useful methodological background for all science students.
Prerequisites	
Antirequisites	
Lectures and tutorials	2x 1-hour lectures (x 11 weeks), 1-hour practical class (x 11 weeks)
Assessment	1.5-hour Written Examination = 50%, Coursework = 50%
Module coordinator	Dr C G M Paxton
Lecturer	Team Taught

ID2005 Scientific Thinking

Credits	15.0
Semester	1
Academic year	2019/20
Timetable	Lectures: 1.00 pm Mon, Tue, Wed Tutorials: 4.00 pm - 6.00 pm Thu
	This module provides an overview of the rationale, methods, history & philosophy of science and is a more detailed, 15-credit version of ID2003. We explore the different definitions of science, the distinction between science and non-science, the design of experiments, errors in reasoning, critical thinking,

Description	personal experience & science, the grammar of graphics, the process of science, peer review, research reproducibility, data cataloguing, the treatment of anomalies & outliers, and ethics. The module is collaboratively taught by staff from a number of Schools of the University providing a useful methodological background for all science students.
Prerequisites	
Antirequisites	ID2003
Lectures and tutorials	3 x 1-hour lectures (x 11 weeks), 1-hour tutorials (x 8 weeks), 1-hour seminar (x 1 week) 2-hour practical (x 1 week), 6 hours film/video viewing in total.
Assessment	1.75-hour Written Examination = 50%, Coursework = 50%
Module coordinator	Dr C Paxton
Lecturer	Team taught

MT2901 Mathematical concepts through history

Credits	20
Semester	1
Academic year	2020/21
Timetable	6.00 - 9.00 pm Wed
Description	This module will trace the historical origins and development of some fundamental mathematical concepts - such as ideas relating to number and shape - and processes such as proof, iteration and generalisation. The module views mathematics as a human activity, shaped by people's experience, need, and curiosity. Students will gain an understanding of the concepts and processes studied together with the historical and societal contexts that supported them. The evolving concept of number will create a timeline through the module from prehistoric times to the twentieth century. The selection of other topics in any year will be dependent on staff availability.
Prerequisites	
Antirequisites	
Lectures and tutorials	1 x 2.5-hour session: lectures, tutorials, seminars, presentations
Assessment	Coursework = 100% (33% class test, 33% essay 1, 34% essay 2)

Module coordinator	Dr I J Falconer
Lecturer	TBC