ID5059 Knowledge Discovery and Datamining

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	11.00 am Mon (odd weeks), Wed and Fri			
Contemporary data collection can be automated and on a massive scale e.g. credit card transaction databases. Large databases potentially carry a wealth of important information that could inform business strategy, identify criminal activities, characterise network faults etc. These large scale problems may preclude the standard carefully constructed statistical models, necessitating highly automated approaches. This module covers many of the methods found under the banner of Datamining, building from a theoretical perspective but ultimately teaching practical application. Topics covered include: historical/philosophical perspectives, model selection algorithms and optimality measures, tree methods, bagging and boosting, neural nets, and classification in general. Practical applications build sought-after skills in programming (typically R, SAS or python).				
Anti-requisite(s)	You cannot take this module if you take CS5014			
Learning and teaching methods of delivery:	**Weekly contact**: Lectures, seminars, tutorials and practical classes.			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 60%, Practical Examinations = 0%, Coursework = 40%			
	As used by St Andrews: 2-hour Written Examination = 60%, Coursework = 40%			
Re-assessment pattern:	2-hour Written Examination = 60%, Existing Coursework = 40%			
Module coordinator:	Dr S C Drasco			
Module teaching staff:	Dr Steve Drasco, Team taught			

MT3501 Linear Mathematics 2

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	12.00 noon Mon (even weeks), Tue and Thu			
This module continues the study of vector spaces and linear transformations begun in MT2501. It aims to show the importance of linearity in many areas of mathematics ranging from linear algebra through to geometric applications to linear operators and special functions. The main topics covered include: diagonalisation and the minimum polynomial; Jordan normal form; inner product spaces; orthonormal sets and the Gram-Schmidt process; adjoint and self-adjoint operators.				
Pre-requisite(s):	Before taking this module you must pass MT2501			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor J D Mitchell			
Module teaching staff:	Prof James Mitchell			

MT3502 Real Analysis

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	11.00 am Mon (even weeks), Tue & Thu			
This module continues the study of analysis begun in the 2000-level module MT2502 Analysis. It considers further important topics in the study of real analysis including: integration theory, the analytic properties of power series and the convergence of functions. Emphasis will be placed on rigourous development of the material, giving precise definitions of the concepts involved and exploring the proofs of important theorems. The language of metric spaces will be introduced to give a framework in which to discuss these concepts.				
Pre-requisite(s):	Before taking this module you must pass MT2502			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5-hours of lectures and 1 tutorial.			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor K J Falconer			
Module teaching staff:	Prof Kenneth Falconer			

MT3503 Complex Analysis

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	12.00 noon Mon (odd weeks), Wed and Fri			
This module aims to introduce students to analytic function theory and applications. The topics covered include: analytic functions; Cauchy-Riemann equations; harmonic functions; multivalued functions and the cut plane; singularities; Cauchy's theorem; Laurent series; evaluation of contour integrals; fundamental theorem of algebra; Argument Principle; Rouche's Theorem.				
Pre-requisite(s):	Before taking this module you must pass MT2502 or pass MT2503			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 34 hours		**Guided independent study:** 116 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	maths-dot@st-andrews.ac.uk			
Module teaching staff:	Team taught			

MT3504 Differential Equations

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	9.00 am Mon (odd weeks), Wed and Fri			
The object of this module is to provide a broad introduction to analytical methods for solving ordinary and partial differential equations and to develop students' understanding and technical skills in this area. This module is a prerequisite for several other Honours options. The syllabus includes: existence and uniqueness of solutions to initial-value problems; non-linear ODE's; Green's functions for ODE's; Sturm-Liouville problems; first order PDE's; method of characteristics; classification of second order linear PDE's; method of separation of variables; characteristics and reduction to canonical form.				
Pre-requisite(s):	Before taking this module you must pass MT2503			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 examples class (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr D W Rees Jones			
Module teaching staff:	Dr David Rees Jones			

MT3505 Algebra: Rings and Fields

SCOTCAT Credits:	15	SCQF level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	11.00 am Mon (odd weeks), Wed & Fri			
This module continues the study of algebra begun in the 2000-level module MT2505 Abstract Algebra. It places emphasis on the concept of a ring and their properties, which give insight into concepts of factorisation and divisibility. Important examples such as polynomial rings will be used to motivate and illustrate the theory developed.				
Pre-requisite(s):	Before taking this module you must pass MT2505			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 hours of lectures and 1 tutorial.			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr S Huczynska			
Module teaching staff:	Dr Sophie Huczynska; Dr Thomas Coleman			

MT3506 Techniques of Applied Mathematics

SCOTCAT Credits:	15	SCQF level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	12.00 noon Mon (odd weeks), Wed & Fri			
Differential equations are of fundamental significance in applied mathematics. This module will cover important and common techniques used to solve the partial differential equations that arise in typical applications. The module will be useful to students who wish to specialise in Applied Mathematics in their degree programme.				
Pre-requisite(s):	Before taking this module you must pass MT2506 and pass MT3504			
Anti-requisite(s)	You cannot take this module if you take PH3081			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 hours of lectures and 1 tutorial.			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr D W Rees Jones			
Module teaching staff:	Dr David Rees Jones			

MT3507 Mathematical Statistics

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	11.00 am Mon (odd weeks), Wed & Fri			
Together with MT3508, this module provides a bridge between second year and Honours modules in statistics. It will provide students with a solid theoretical foundation on which much of more advanced statistical theory and methods are built. This includes probability generating functions and moment generating functions, as well as widely used discrete distributions (binomial, Poisson, negative binomial and multinomial) and continuous distributions (gamma, exponential, chi-squared, beta, t-distribution, F-distribution, and multivariate normal). It will also provide a foundation in methods of statistical inference (maximum likelihood and Bayesian) and model selection methods based on information theory (AIC and BIC).				
Pre-requisite(s):	Before taking this module you must pass MT2508			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 hours of lectures and 1 tutorial.			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr G Minas			
Module teaching staff:	Dr Giorgos Minas; Dr Hannah Worthington			

MT3508 Applied Statistics

SCOTCAT Credits:	15	SCQF level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	12.00 noon Mon (even weeks), Tue & Thu			
Together with MT3507, this module provides a bridge between second year and Honours modules in statistics. It deals with the application of statistical methods to test hypotheses and draw inferences from data. This includes a number of nonparametric methods and statistical tests (goodness-of-fit tests and tests of independence). Inference methods include model fitting by least squares and maximum likelihood, and variance estimation by means of the information matrix and the bootstrap. The framework of the generalised linear model is presented covering parameter estimation, deviance, model selection and diagnostics. Further applications include multiple regression, analysis of variance and the (normal) linear model.				
Pre-requisite(s):	Before taking this module you must pass MT2508			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 hours of lectures and 1 tutorial.			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor D L Borchers			
Module teaching staff:	Dr David Borchers; Dr Hannah Worthington			

MT3802 Numerical Analysis

SCOTCAT Credits:	15	SCQF level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	10.00 am Mon (odd weeks), Wed and Fri			
The module will introduce students to some topics in numerical analysis, which may include methods of approximation, iterative methods for solving systems of linear equations, numerical techniques for differential equations.				
Pre-requisite(s):	Before taking this module you must pass MT2501			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 70%, Practical Examinations = 0%, Coursework = 30%			
	As used by St Andrews: 2-hour Written Examination = 70%, Coursework = 30%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr A Naughton			
Module teaching staff:	Dr Aidan Naughton			

MT4003 Groups

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	9.00 am Mon (even weeks), Tue and Thu			
This module introduces students to group theory, which is one of the central fields of the 20th century mathematics. The main theme of the module is classifying groups with various additional properties, and the development of tools necessary in this classification. In particular, the students will meet the standard algebraic notions, such as substructures, homomorphisms, quotients and products, and also various concepts peculiar to groups, such as normality, conjugation and Sylow theory. The importance of groups in mathematics, arising from the fact that groups may be used to describe symmetries of any mathematical object, will be emphasised throughout the module.				
Pre-requisite(s):	Before taking this module you must pass MT2505			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 tutorial and 1 examples class (x 10 weeks).			
	Scheduled learning: 45 hours		**Guided independent study:** 105 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor N Ruskuc			
Module teaching staff:	Prof Nik Ruskuc			

MT4004 Real and Abstract Analysis

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	11.00 am Mon (even weeks), Tue and Thu			
This module continues the development of real analysis that was begun in MT2502 and continued through MT3502. Topics covered will include limits and continuity in metric spaces, differentiation in higher dimensions and the theoretical underpinning of Fourier series. This module will present some of the highlights of the study of analysis, such as Baire's Category Theorem, the Contraction Mapping Theorem, the Weierstrass Approximation Theorem, and the Inverse Function Theorem.				
Pre-requisite(s):	Before taking this module you must pass MT3502			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor L O R Olsen			
Module teaching staff:	Prof Lars Olsen			

MT4005 Linear and Nonlinear Waves

SCOTCAT Credits:	15	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	11.00 am Mon (even weeks), Tue and Thu			
This module gives an introduction to wave motion and its importance in many areas of applied mathematics. It begins with a discussion of the linear approximation for small amplitude waves and discusses properties of these such as dispersion relations, phase and group velocities, dissipation and dispersion. Some nonlinear effects such as wave steepening are then treated and an introduction given to some of the equations, for example Burger's and Korteweg de Vries, which are used to model nonlinear wave propagation.				
Pre-requisite(s):	Before taking this module you must (pass MT2506 or pass PH3081) and (pass MT3503 or pass MT3504)			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr A N Wright			
Module teaching staff:	Dr Andrew Wright; Prof Ineke De Moortel			

MT4111 Symbolic Computation

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	9.00 am Mon (odd weeks), Wed and Fri			
This module aims to enable students to use a computer as a tool in their other modules and to turn naturally to a computer when solving mathematical problems. The module aims to illustrate the following points: computation allows one to conduct mathematical experiments; computation allows one to collect data about a problem being studied. This is similar to the way other scientists work. It is easier to try several different approaches to a problem and see which works. The computer is not intelligent; intelligence comes from the user. The user thinks, the user interprets, the computer calculates.				
Pre-requisite(s):	Before taking this module you must pass 1 module from {MT3501, MT3502, MT3503, MT3504, MT3505, MT3506}			
Anti-requisite(s)	You cannot take this module if you take MT5611			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 practical session (x 10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 70%, Practical Examinations = 0%, Coursework = 30%			
	As used by St Andrews: 2-hour Written Examination = 70%, Coursework = 30%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor J D Mitchell			
Module teaching staff:	Prof James Mitchell; Dr Jochen Kursawe; Prof Colva Roney-Dougal			

MT4113 Computing in Statistics

SCOTCAT Credits:	15	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	12.00 noon Mon (odd weeks) and Wed, 12.00 noon - 2.00 pm Fri			
The aim of this module is to teach computer programming skills, including principles of good programming practice, with an emphasis on statistical computing. Practical work focusses on the widely-used statistical language and environment R. Practical skills are developed through a series of computing exercises that include (1) modular programming; (2) manipulating data; (3) simulating data with specific statistical properties, (4) investigating behaviour of statistical procedures under failure of statistical assumptions.				
Pre-requisite(s):	Undergraduate - Before taking this module you must pass MT2508			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 x practical (x 10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 40%, Practical Examinations = 0%, Coursework = 60%			
	As used by St Andrews: 2-hour Written Examination = 40%, Coursework = 60%			
Re-assessment pattern:	1-hour 40 minute Written Examination = 40%, Coursework (4 new programming assignments) = 60%			
Module coordinator:	Dr R Glennie			
Module teaching staff:	Dr Richard Glennie			

MT4507 Classical Mechanics

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	10.00 am Mon (even weeks), Tue and Thu			
The object of this module is to introduce students to some of the ideas and mathematical techniques used in understanding the behaviour of dynamical systems that obey Newton's Laws. These notions are arguably the foundations of physics and applied mathematics. The module will include: Newton's laws of motion; conservative forces; central forces; non-inertial/accelerating frames of reference; dynamics of a system of particles; mechanics of a rigid body; Euler's equations; Lagrange's equations; Hamilton's equations.				
Pre-requisite(s):	Before taking this module you must (pass MT2506 or pass PH3081) and pass MT3504			
Anti-requisite(s)	You cannot take this module if you take PH4038			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr V Archontis			
Module teaching staff:	Dr Vasilis Archontis			

MT4509 Fluid Dynamics

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	11.00 am Mon (even weeks), Tue and Thu			
This module provides an introduction to the theory of incompressible fluid dynamics, which describes the motion of liquids and gases at speeds small compared to the sound speed. Special attention is paid to a precise foundation of the various conservation laws that govern fluid dynamics, as this provides a convenient framework in which to study specific examples as well as extensions of the basic theory.				
Pre-requisite(s):	Before taking this module you must pass MT2506 and pass MT3504			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr J N Reinaud			
Module teaching staff:	Dr Jean Reinaud			

MT4510 Solar Theory

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	11.00 am Mon (odd weeks), Wed and Fri			
The object of this module is to describe the basic dynamic processes at work in the Sun, a subject which is being enlivened by dramatic new results from space missions.				
Pre-requisite(s):	Before taking this module you must pass MT2506 and pass MT3504			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr A N Wright			
Module teaching staff:	Dr Andrew Wright			

MT4511 Asymptotic Methods

SCOTCAT Credits:	15	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	9.00 am Mon (even weeks), Tue and Thu			
This module is designed to introduce students to asymptotic methods used in the construction of analytical approximations to integrals and solutions of differential equations.				
Co-requisite(s):	If not already passed you must take MT3504			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr A L Wilmot-Smith			
Module teaching staff:	Dr Antonia Wilmot-Smith			

MT4512 Automata, Languages and Complexity

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	This module will run in alternate (even) years: 2020-21, 2022-23, 2024-25, etc. Not available to Joint Honours Mathematics and Computer Science students.			
Planned timetable:	To be arranged			
This module concerns formal languages, and the machines that recognise them. It begins with regular languages and finite state machines, both deterministic and non-deterministic. We then go on to study pushdown automata and context-free grammars. Turing machines are introduced, followed by studies on decidability and the Halting problem. In the final third of the course, we introduce big-O notation, and study the complexity classes P, NP, co-NP, NP-hard, etc..				
Pre-requisite(s):	Before taking this module you must pass MT2504 or ((pass CS2001 or pass CS2101) and pass CS2002)			
Anti-requisite(s)	You cannot take this module if you have taken MT3852. You cannot take this module if you take CS3052			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (X 10 weeks), 1 tutorial (X 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 110 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	Written Examination = 100%			
Module coordinator:	Professor C M Roney-Dougal			
Module teaching staff:	Prof Colva Roney-Dougal			

MT4514 Graph Theory

SCOTCAT Credits:	15	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	10.00 am Mon (even weeks), Tue and Thu			
The aim of this module is to introduce students to the study of graph theory as a tool for representing connections between data. Topics to be covered may include: basic theory and applications, Eulerian graphs, Hamiltonian graphs, planar graphs, spanning trees and applications, networks, matching problems.				
Pre-requisite(s):	Before taking this module you must pass MT1003 or pass MT2504			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr S Huczynska			
Module teaching staff:	Dr Sophie Huczynska			

MT4515 Functional Analysis

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	12.00 noon Mon (even weeks), Tue and Thu			
This object of this module is to familiarise students with the basic notions of functional analysis, that is analysis on normed spaces and Hilbert space. The module will cover normed spaces, convergence and completeness, operators, Hilbert spaces and may include topics such as spectral theory and the Hahn-Banach theorem.				
Pre-requisite(s):	Before taking this module you must pass MT2501 and pass MT3502			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor K J Falconer			
Module teaching staff:	Prof Kenneth Falconer			

MT4527 Time Series Analysis

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	10.00 am Mon (even weeks), Tue and Thu			
This module provides an introduction to univariate linear times series models (ARIMA processes) and univariate non-linear times-series models (ARCH and GARCH). The syllabus includes: forecasting methods for constant mean and trend models, the ARIMA class of models (including seasonal ARIMA models), fitting and forecasting ARIMA models, ARCH and GARCH processes.				
Pre-requisite(s):	Before taking this module you must pass MT2508			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 0.5 tutorial (x 10 weeks).			
	Scheduled learning: 30 hours		**Guided independent study:** 120 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr G Minas			
Module teaching staff:	Dr Giorgos Minas			

MT4531 Bayesian Inference

SCOTCAT Credits:	15	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	10.00 am Mon (even weeks), Tue and Thu			
This module is intended to offer a re-examination of standard statistical problems from a Bayesian viewpoint and an introduction to recently developed computational Bayes methods. The syllabus includes Bayes' theorem, inference for Normal samples; univariate Normal linear regression; principles of Bayesian computational, Markov chain Monte Carlo - theory and applications.				
Pre-requisite(s):	Before taking this module you must pass MT3507 or pass MT3508			
Anti-requisite(s)	You cannot take this module if you take MT5731 or take MT5831			
Learning and teaching methods of delivery:	**Weekly contact**: 24 lectures and 7 practical classes over the semester.			
	Scheduled learning: 31 hours		**Guided independent study:** 119 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework = 20%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr M Papathomas			
Module teaching staff:	Dr Michail Papathomas			

MT4537 Spatial Statistics

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	10.00 am Mon (even weeks), Tue and Thu			
This module will study the practical analysis of spatial data. It commences with a discussion on different types of spatial data. Spatial point processes, random fields and spatial models for lattice data are discussed. There is a strong focus on the practical and computational aspects of model fitting and modern, computationally efficient model fitting software is introduced.				
Pre-requisite(s):	Before taking this module you must pass MT3507 or pass MT3508			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 4 tutorials over the semester.			
	Scheduled learning: 29 hours		**Guided independent study:** 121 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework = 20%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr C R Donovan			
Module teaching staff:	Dr Carl Donovan			

MT4539 Quantitative Risk Management

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	12.00 noon Mon (odd), Wed, Fri, and 2.00 pm Fri			
The module introduces the concept of financial risk and discusses the importance of its regulation. The emphasis is laid on the popular risk measure Value at Risk (VaR). After a brief discussion on asset returns, various modelling techniques - ranging from the simple Historical Simulation to the more advanced ARMA and GARCH models - are presented and applied for the calculation of VaR using real financial data. The aim of this module is to provide a solid basis in risk management for those students considering a career in finance.				
Pre-requisite(s):	Before taking this module you must pass MT2504 and pass MT2508			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 5 tutorials and 5 practical sessions.			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework = 20%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr V M Popov			
Module teaching staff:	Dr Valentin Popov			

MT4552 Population Dynamics Models in Mathematical Biology

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	9.00 am Mon (even weeks), Tue and Thu			
This module will explore real world applications of mathematics to biological problems e.g. harvesting of fish stocks, host-parasitoid systems, predator-prey dynamics, molecular interactions. The mathematical techniques used in the modelling will be nonlinear difference equations and ordinary differential equations. The module will be useful to students who wish to specialise in Applied Mathematics in their degree programme.				
Pre-requisite(s):	Before taking this module you must pass MT3504			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 1 tutorial (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	Take Home Exam = 100%			
Module coordinator:	Professor M A J Chaplain			
Module teaching staff:	Prof Mark Chaplain; Dr Jochen Kursawe			

MT4553 Theory of Electric and Magnetic Fields

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	10.00 am Mon (odd weeks), Wed, Fri			
The module will consider the mathematical and physical principles that describe the theory of electric and magnetic fields. It will first describe the basic principles of electrostatics and magneto-statics and following this electrodynamics. Next Maxwell's equations are described along with the properties of electro-magnetic waves in a variety of media. Finally an application to the area of plasma physics is carried out through considering the orbits of charged particles in a variety of spatially and time varying magnetic fields.				
Pre-requisite(s):	Before taking this module you must pass MT2503 and pass MT2506 and pass MT3504			
Anti-requisite(s)	You cannot take this module if you take PH3007			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 hours of lectures (x 10 weeks), 1-hour tutorial (x 10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 120 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor D H Mackay			
Module teaching staff:	Prof Duncan Mackay			

MT4599 Project in Mathematics / Statistics

SCOTCAT Credits:	15	SCQF level 10	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Available only to students in the final year of a BSc/MA Honours degree programme in the School			
Planned timetable:	none			
The student will choose a project from a list published annually although a topic outwith the list may be approved. Students will be required to report regularly to their supervisor, produce a substantial written report, submitted by the end of April, and give a presentation.				
Learning and teaching methods of delivery:	**Weekly contact**: Typically and on average, 20 mins of project supervisions per week over whole year.			
	Scheduled learning: 8 hours		**Guided independent study:** 142 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 20%, Coursework = 80%			
	As used by St Andrews: Coursework = 100%: Project = 80%, Presentation = 20%			
Re-assessment pattern:	Resubmission of project = 100%			
Module coordinator:	Professor N Ruskuc			
Module teaching staff:	Team Taught			

MT4608 Sampling Theory

SCOTCAT Credits:	15	SCQF level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	10.00 am Mon (odd weeks), Wed and Fri			
The aims of this module are to introduce students to and interest them in the principles and methods of design-based inference, to convince them of the relevance and utility of the methods in a wide variety of real-world problems, and to give them experience in applying the principles and methods themselves. By the end of the module students should be able to recognise good and poor survey design and analysis, to decide upon and implement the main types of survey design in relatively straightforward settings, and analyse the resulting survey data appropriately. The syllabus includes fundamentals of design based vs model-based inference, simple random sampling, sampling with replacement, ratio and regression estimators, stratified sampling, cluster sampling and unequal probability sampling.				
Pre-requisite(s):	Before taking this module you must pass MT2508			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and 8 tutorials over the semester.			
	Scheduled learning: 33 hours		**Guided independent study:** 117 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor D L Borchers			
Module teaching staff:	Prof David Borchers; Dr J J Valletta			

MT4614 Design of Experiments

SCOTCAT Credits:	15	SCQF level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	9.00 am Mon (odd weeks), Wed and Fri			
This module introduces a wide range of features that occur in real comparative experiments. The applications include trials of potential new medicines by the pharmaceutical industry; comparisons of new varieties of wheat for bread-making; evaluating different machine settings in industry. Issues include whether and how to partition the experimental material into blocks (for example, do old and young people respond to this drug differently?); how much replication to use (too much experimental material may be a waste of resources, but too little will not give meaningful results); as well as type of design. The module includes enough about the analysis of data from experiments to show what has to be considered at the design stage. It also includes considerations of consultation with the scientist and interpretation of the results.				
Pre-requisite(s):	Before taking this module you must pass MT2508 and pass MT3501			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks) and either tutorial or practical (x 10 weeks).			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 10%, Coursework = 10%			
	As used by St Andrews: 2-hour Written Examination = 80%, Presentation = 10%, Coursework = 10%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor R A Bailey			
Module teaching staff:	Dr Rosemary Bailey			

MT4794 Joint Dissertation (30cr)				
SCOTCAT Credits:	30	SCQF level 10	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Available only to students in the Second year of the Honours Programme, who have completed the Letter of Agreement, downloadable from https://www.st-andrews.ac.uk/coursecatalogue). No student may do more than 60 credits in Dissertation or Project modules.			
Planned timetable:	To be arranged.			
The dissertation must consist of approximately 6,000 words of English prose on a topic agreed between the student and two appropriate members of staff (who act as supervisors). The topic does not have to relate to work covered in previous Honours modules, though it may be helpful to the student if it builds on previous work. The topic and range of sources should be chosen in consultation with the supervisors in order to determine that the student has access to sources as well as a clear plan of preparation. (Guidelines for printing and binding dissertations can be found at: http://www.st-andrews.ac.uk/printanddesign/dissertation/)				
Pre-requisite(s):	The student requires a Letter of Agreement			
Anti-requisite(s)	Cannot take more than 30 credits in other dissertation/project modules			
Learning and teaching methods of delivery:	**Weekly contact**: As per Letter of Agreement.			
	Scheduled learning: 0 hours		**Guided independent study:** 0 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: As per Letter of Agreement.			
Re-assessment pattern:	As per Letter of Agreement.			
Module coordinator:	Professor N Ruskuc			
Module teaching staff:	Team Taught			
Additional information from Schools:	See also the guidelines within the general BSc/MA Honours project handbook for MT students, available at https://www.st-andrews.ac.uk/maths/current/ug/information/projects/			

MT4796 Joint Project (30cr)

SCOTCAT Credits:	30	SCQF level 10	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Available only to students in the Second year of the Honours Programme, who have completed the Letter of Agreement, downloadable from https://www.st-andrews.ac.uk/coursecatalogue). No student may do more than 60 credits in Dissertation or Project modules.			
Planned timetable:	To be arranged.			
The aim of the project is to develop and foster the skills of experimental design, appropriate research management and analysis. The topic and area of research should be chosen in consultation with the supervisors in order to determine that the student has access to sources as well as a clear plan of preparation.				
Pre-requisite(s):	The Student requires a Letter of Agreement			
Anti-requisite(s)	May not take more than 30 credits in other dissertation / project modules			
Learning and teaching methods of delivery:	**Weekly contact**: As per Letter of Agreement.			
	Scheduled learning: 0 hours		**Guided independent study:** 0 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: As per Letter of Agreement.			
Re-assessment pattern:	As per Letter of Agreement.			
Module coordinator:	Professor N Ruskuc			
Module teaching staff:	Team Taught			
Additional information from Schools:	See also the guidelines within the general BSc/MA Honours project handbook for MT students, available at https://www.st-andrews.ac.uk/maths/current/ug/information/projects/			

MT5599 Advanced Project in Mathematics / Statistics

SCOTCAT Credits:	30	SCQF level 11	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Available only to students in the final year of a MMath/MPhys Honours degree programme in the School.			
Planned timetable:	Regular supervision as arranged with supervisor.			
This is a substantial project for final year students on integrated Masters degrees. The project will be chosen from a list published annually in the project booklet. It is also possible for students to nominate their own project, by agreement with a supervisor. Students will be required to investigate a topic in some depth, reporting regularly to their supervisor, submit a report by the end of April and give a presentation.				
Pre-requisite(s):	Available only to students in the final year of a MMath/MPhys Honours degree programme in the School.			
Learning and teaching methods of delivery:	**Weekly contact**: Typically and on average, 40 mins of project supervisions per week over whole year			
	Scheduled learning: 15 hours		**Guided independent study:** 288 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100% (Project = 80%, Presentation = 20%)			
Re-assessment pattern:	Resubmission of project = 100%			
Module coordinator:	Professor N Ruskuc			
Module teaching staff:	Team Taught			

MT5731 Advanced Bayesian Inference

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	Lectures: co-taught with MT4531. Monday (even) 10-11, Tuesday 10-11, Thursday 10-11; Practicals: co-taught with MT4531, Monday 1-2pm			
This module examines the Bayesian framework for analysing statistical problems, including an introduction to the latest theoretical and practical developments in the field. The syllabus includes Bayes' theorem, standard inference for conjugate Bayesian analyses, prediction, model comparison, principles of Bayesian computational techniques and software, and Markov chain Monte Carlo theory and applications. Instruction of advanced aspects of the Bayesian framework theory and its application is carried out by guided independent study, involving completion of a substantial project.				
Pre-requisite(s):	Before taking this module you must pass MT3507 or pass MT3508			
Anti-requisite(s)	You cannot take this module if you take MT4531 or take MT5831			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 hours of lectures (10 weeks), 1-hour tutorial (9 weeks);			
	Scheduled learning: 47 hours		**Guided independent study:** 103 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 60%, Practical Examinations = 0%, Coursework = 40%			
	As used by St Andrews: 2-hour written examination = 60%, Coursework = 40%.			
Re-assessment pattern:	2-hour written examination = 60%, Coursework = 40%			
Module coordinator:	Dr M Papathomas			
Module teaching staff:	Dr Michail Papathomas			

MT5751 Estimating Animal Abundance and Biodiversity

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	12.00 noon Mon (odd), Wed and Fri			
The module will introduce students to the main types of survey method for wildlife populations. It will cover simple methods in some detail and provide students with a conceptual framework for building understanding of more advanced methods. In the case of multi-species surveys, it will also show how abundance estimates may be combined into biodiversity measures. By the end of the course, students will be able to identify an appropriate assessment method for a given population, design a simple survey to assess the population, perform simple analyses of survey data, and estimate biodiversity trends in a community. Students will get experience in using the methods via computer practical sessions involving design and analyses of surveys.				
Pre-requisite(s):	Before taking this module you must pass MT3507 or pass MT3508 or pass MT5761			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (X10 weeks), 1 computer practical or tutorial (X10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 110 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%			
	As used by St Andrews: 2-hour Written Examination = 50%, Coursework = 50%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor D L Borchers			
Module teaching staff:	Dr David Borchers; Prof Stephen Buckland; Dr Christopher Sutherland			

MT5758 Multivariate Analysis

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	11.00 am Mon (even weeks), Tue and Thu			
This module provides theory and application for the analysis of multivariate data. Fundamental matrix material is presented including mean vectors, covariance matrices, correlation matrices and basic properties of multivariate normal distributions. Multivariate extensions to common univariate tests are subsequently covered. Distance metrics and general measures of similarity are explored, leading to the broader utility of multivariate methods in real-world problems, particularly for classification and dimension reduction. The most common and fundamental methods are covered, including Principal Components Analysis, multidimensional scaling, clustering and discriminant analyses. The practical component of the module focuses on analysis of real data using widespread software.				
Pre-requisite(s):	Before taking this module you must pass MT3507 or pass MT3508			
Anti-requisite(s)	You cannot take this module if you take MT4609			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), and 4 tutorials and 4 project group meetings over the semester.			
	Scheduled learning: 33 hours		**Guided independent study:** 117 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%			
	As used by St Andrews: 2-hour Written Examination = 50%, Coursework = 50%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr S C Drasco			
Module teaching staff:	Dr Steve Drasco			

MT5761 Applied Statistical Modelling using GLMs

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	Mon, Tues, Thur, Fri 3:00 - 4:00 (lectures), Tues, Thur 4:00 - 5:00 (practicals)			
This applied statistics module covers the main aspects of linear models (LMs) and generalized linear models (GLMs). In each case the course describes model specification, various options for model selection, model assessment and tools for diagnosing model faults. Common modelling issues such as collinearity and residual correlation are also addressed, and as a consequence of the latter the Generalized Least squares (GLS) method is described. The GLM component has emphasis on models for count data and presence/absence data while GLMs for multinomial (sometimes called choice-based models) are also covered for nominal and ordinal response outcomes. The largest part of the course material is taught inside an environmental impact assessment case study with reality-based research objectives. Political and medical examples are used to illustrate the multinomial models.				
Pre-requisite(s):	Undergraduates must have passed at least one of MT4113, MT4527, MT4528, MT4530, MT4531, MT4537, MT4539, MT4606, MT4608 MT4609, MT4614.			
Anti-requisite(s)	You cannot take this module if you take MT4607 or take MT5753			
Learning and teaching methods of delivery:	**Weekly contact**: 4 lectures (x 5 weeks), 2 practicals (x 5 weeks), 1 tutorial (x 5 weeks)			
	Scheduled learning: 30 hours		**Guided independent study:** 117 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 50%, Practical Examinations = 0%, Coursework = 50%			
	As used by St Andrews: 2-hour Written Examination = 50%, Coursework = 50%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr V M Popov			
Module teaching staff:	Dr Valentin Popov			

MT5763 Software for Data Analysis

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	Tuesday, Wednesday, Thursday, Friday 2-3:30pm.			
This module covers the practical computing aspects of statistical data analysis, focussing on packages most widely used in the commercial sector (R, SAS, SPSS and Excel). We cover the accessing, manipulation, checking and presentation of data (visual and numerical). We fit various statistical models to data, with subsequent assessment, interpretation and presentation. Good practice and 'reproducible research' is covered, as is computer intensive inference and big data considerations. This module is a short intensive course and is a core, preliminary, requirement for the MSc in Applied Statistics and Datamining and the MSc in Data Intensive Analysis. It covers material essential for study of the more advanced statistical methods encountered in subsequent modules.				
Pre-requisite(s):	Before taking this module you must pass MT1007 or pass MT3507 or pass MT3508 or take MT5762			
Anti-requisite(s)	You cannot take this module if you take MT5756			
Learning and teaching methods of delivery:	**Weekly contact**: Three 2-hour lecture/practical classes (x 5 weeks)			
	Scheduled learning: 30 hours		**Guided independent study:** 120 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	Coursework = 100%			
Module coordinator:	Dr J J Valletta			

MT5764 Advanced Data Analysis

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	Mon 12:00-1:00 Weeks 2, 4, 5, 8, 10 Tues, Thur 12:00-2:00, Weeks 1-10 (lectures) Tues 2:00 - 3:00 Weeks 2-9 (practicals)			
This module covers modern modelling methods for situations where the data fails to meet the assumptions of common statistical models and simple remedies do not suffice. This represents a lot of real world data. Methods covered include: nonlinear models; basic splines and Generalised Additive Models; LASSO and the Elastic Net; models for non-independent errors and random effects. Pragmatic data imputation is covered with associated issues. Computer intensive inference is considered throughout. Practical applications build sought-after skills in R and the commercial packages SAS.				
Pre-requisite(s):	Before taking this module you must pass MT3508 and (pass MT4606 or pass MT5761)			
Anti-requisite(s)	You cannot take this module if you take MT5757			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 hours of lectures lectures (x 10 weeks) and 8 practicals over the semester.			
	Scheduled learning: 33 hours		**Guided independent study:** 116 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 60%, Practical Examinations = 0%, Coursework = 40%			
	As used by St Andrews: 2-hour Written Examination = 60%, Coursework = 40%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr J J Valletta			

MT5765 Medical Statistics

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	10:00 - Mon (odd weeks), Wed, Fri			
This module will cover a number of topics in medical statistics, that are important areas both in terms of methodological development and application. The main topic covered will be Survival Analysis, with others selected from Meta-analysis, Power calculations, Prospective vs Observational studies, Sequential analyses, Clinical trials.				
Pre-requisite(s):	Before taking this module you must pass MT3507 or pass MT3508			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 tutorial (x 10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 115 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 65%, Practical Examinations = 0%, Coursework = 35%			
	As used by St Andrews: Coursework = 35%, 2-hour Written Examination = 65%			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Professor A G Lynch			
Module teaching staff:	Dr Andy Lynch			

MT5842 Advanced Analytical Techniques

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	12noon Monday (odd weeks), Wednesday, Friday			
This module introduces students to important advanced applied analytic techniques such as Variational Calculus, Integral equations and transforms, solutions to differential equations by contour integrals, and the theory of Steepest Descent.				
Pre-requisite(s):	Before taking this module you must pass MT3503			
Anti-requisite(s)	You cannot take this module if you take MT5802			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 tutorial (x 10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%			
	As used by St Andrews: 2-hour written examination = 75%, coursework =25%			
Re-assessment pattern:	2-hour written examination = 100%			
Module coordinator:	Professor A W Hood			
Module teaching staff:	Prof Alan Hood			

MT5846 Advanced Computational Techniques

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	12 noon Monday (even weeks), Tuesday, Thursday.			
This module introduces students to some of the ideas, techniques and constraints that underpin modern approaches to the numerical modelling of physical processes that may be described by partial differential equations. Students will gain experience in implementing a variety of standard numerical methods where they will carry out three projects involving code development, testing and analysis/interpretation of results.				
Pre-requisite(s):	Before taking this module you must pass MT3802 and pass MT4112			
Anti-requisite(s)	You cannot take this module if you take MT5806			
Learning and teaching methods of delivery:	**Weekly contact**: 2 lectures (x 10 weeks), 1 practical (x 11 weeks)			
	Scheduled learning: 29 hours		**Guided independent study:** 120 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	Oral examination = 100%			
Module coordinator:	Dr S J Brooks			
Module teaching staff:	Team Taught			

MT5849 Geophysical Fluid Dynamics

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	11am Monday (odd weeks), Wednesday, Friday			
This module will examine current research in fluid dynamics, with a particular focus on meteorology and oceanography. The large-scale atmosphere and oceans behave quite unlike a 'classical' fluid owing to the presence of stable density stratification and rotation. As a result, the fluid motion is dominated by slow, 'vortical' or eddying motions (like cyclones) which generally spin slower than the Earth. Superimposed on this slow motion are relatively fast wave-like motions analogous to surface waves on a pond. These lectures describe the mathematical basis of these fundamentally different types of motion, and furthermore illustrate the increasingly important role of computer modelling in this research.				
Pre-requisite(s):	Before taking this module you must pass MT4509			
Anti-requisite(s)	You cannot take this module if you take MT5809			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 tutorial (x 10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 117 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour written examination = 100%			
Module coordinator:	Dr R K Scott			
Module teaching staff:	Dr Richard Scott			

MT5850 Advanced Solar Theory

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	12 noon Monday (even weeks), Tuesday, Thursday			
The object of this module is to describe the magnetohydrodynamic processes at work in the Sun, using modern techniques of applied mathematics, and to discuss the latest theories in relation to aspects of current research within the School.				
Pre-requisite(s):	Before taking this module you must pass MT4510			
Anti-requisite(s)	You cannot take this module if you take MT5810			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lecture (x 10 weeks), 1 tutorial (x 10 weeks)			
	Scheduled learning: 34 hours		**Guided independent study:** 117 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour written examination = 100%			
Module coordinator:	Professor T Neukirch			
Module teaching staff:	Prof Thomas Neukirch			

MT5853 Spatial Models and Pattern Formation in Mathematical Biology

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	9am, Monday (odd weeks), Wednesday, Friday			
This module will explore real world applications of mathematics to biological and medical problems (e.g. cell movement, pattern formation in animal coat markings, spread of infectious diseases). The mathematical models that will be considered are mostly formulated in terms of nonlinear partial differential equations whose solutions can exhibit a range of interesting behaviour. The module will be useful to students who wish to specialise in Applied Mathematics in their degree programme.				
Pre-requisite(s):	Before taking this module you must pass MT3504			
Anti-requisite(s)	You cannot take this module if you take MT5852			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 10 tutorials (x 10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 117 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour written examination = 100%			
Module coordinator:	Dr J Kursawe			
Module teaching staff:	Dr Jochen Kursawe; Dr Nikolaos Sfakianakis			

MT5854 Mathematical Oncology

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	9am, Monday (odd weeks), Wednesday, Friday			
Cancer is a complex disease, the second largest cause of death throughout the world (after cardiovascular diseases). Beginning with genetic mutations in a single cell, cancer progresses through several key growth phases - the avascular growth phase (nutrient delivered by diffusion of oxygen), tumour-induced angiogenesis (blood vessel growth), invasion and metastasis (spread to secondary parts of the body). Because of its complexity and multiscale nature (temporal and spatial), treatment of cancer is challenging. This module will introduce students to the mathematical modelling of the key phases of cancer growth and treatment via immunotherapy, chemotherapy and radiotherapy. The mathematical techniques used in the modelling will be nonlinear partial differential equations, and students will be exposed to current research taking place within the Mathematical Biology research group in the School of Mathematics and Statistics.				
Pre-requisite(s):	Before taking this module you must pass MT3504			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 tutorial (x 10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 120 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr N Sfakianakis			
Module teaching staff:	Dr Nikolaos Sfakianakis			

MT5864 Topics in Groups

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	10am, Monday (odd weeks), Wednesday, Friday			
Groups are important mathematical objects that arise in many contexts since they encode the symmetry appearing within any particular setting. This is an area of current research interest in the School and this expertise determines the choice of topics covered in this module. The overall aim of the module is to build on the foundations established in MT4003 and to take students deeper into this important and beautiful branch of mathematics. It will introduce students to advanced techniques used to handle and classify groups.				
Pre-requisite(s):	Before taking this module you must pass MT4003			
Anti-requisite(s)	You cannot take this module if you take MT5824			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 tutorial (x 9 weeks), 1 examples class (x 9 weeks)			
	Scheduled learning: 43 hours		**Guided independent study:** 108 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr M Quick			
Module teaching staff:	Dr Martyn Quick			

MT5865 Measure and Probability Theory

SCOTCAT Credits:	15	SCQF level 11	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	11am Monday (odd weeks), Wednesday, Friday			
This module introduces some of the powerful techniques and ideas of modern mathematical analysis and mathematical probability theory that are important both in analysis in its own right and in its many applications in mathematics and science. The module will include topics such as: measure theory, the mathematical foundations for probability theory, law of large numbers. Mathematical analysis and the use of probabilistic methods in analysis is one of the active research areas within the School, and the choice of topics will reflect current activity.				
Pre-requisite(s):	Before taking this module you must pass MT3502			
Anti-requisite(s)	You cannot take this module if you take MT5825			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 tutorial (x 9 weeks)			
	Scheduled learning: 34 hours		**Guided independent study:** 119 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr M J Todd			
Module teaching staff:	Dr Mike Todd			

MT5870 Hyperbolic Geometry

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Module runs in alternating even years, 2020/21, 2022/23, 2024/25, etc.			
Planned timetable:	10am, Monday (odd weeks), Wednesday, Friday			
We study two dimensional hyperbolic space, which is a fundamental example of a non-Euclidean metric space. Hyperbolic space has a rich structure and many counter intuitive properties and this module will focus on the geometry of this space, including a detailed study of the geodesic structure, the group of isometries, and the actions of Fuchsian groups which lead to beautiful tilings and fractal limit sets. We will combine ideas from analysis, geometry and group theory, with a strong emphasis on visual intuition.				
Pre-requisite(s):	Before taking this module you must pass MT2505 and pass MT3502 and pass MT3503			
Anti-requisite(s)	You cannot take this module if you take MT5828 or take MT5830			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 tutorial (x 10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 110 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr J M Fraser			
Module teaching staff:	Dr Jonathan Fraser			

MT5876 Galois Theory

SCOTCAT Credits:	15	SCQF level 11	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Module runs in alternating even years, 2020/21, 2022/23, 2024/25, etc			
Planned timetable:	11am Monday (odd weeks), Wednesday, Friday			
Galois Theory is one of the most beautiful areas of mathematics, establishing a remarkable connection between the theory of polynomial equations and their roots, and group theory. The subject brings together ideas from the theory of groups and fields in a powerful way, culminating in the Fundamental Theorem of Galois Theory and Galois's Great Theorem. A consequence will be the demonstration that there is no general formula for the solution of quintic equations. There are many additional applications of this theory, for example, the demonstration that certain ruler and compass constructions are impossible.				
Pre-requisite(s):	Before taking this module you must pass MT3505			
Anti-requisite(s)	You cannot take this module if you take MT5826 or take MT5836			
Learning and teaching methods of delivery:	**Weekly contact**: 2.5 lectures (x 10 weeks), 1 tutorial (x 10 weeks)			
	Scheduled learning: 35 hours		**Guided independent study:** 117 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 80% exam, 20% continual assessment.			
Re-assessment pattern:	2-hour Written Examination = 100%			
Module coordinator:	Dr Y Len			
Module teaching staff:	Dr Yoav Len			

MT5991 Professional Skills for Mathematical Scientists

SCOTCAT Credits:	30	SCQF level 11	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Available only to students studying MSc Mathematics			
Planned timetable:	To be arranged.			
This module encompasses a range of skills, both generic and topic specific, together with taught components aimed at providing an appreciation of both breadth and depth of research areas in Pure or Applied Mathematics. The precise programme of study, together with the identification of the relevant software expertise required, will be determined in consultation with the student's supervisor.				
Learning and teaching methods of delivery:	**Weekly contact**: Varies. Typically 1 project supervision per week over whole year.			
	Scheduled learning: 24 hours		**Guided independent study:** 276 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	Resubmission of coursework = 100%			
Module coordinator:	Professor J D Mitchell			
Module teaching staff:	Team Taught			