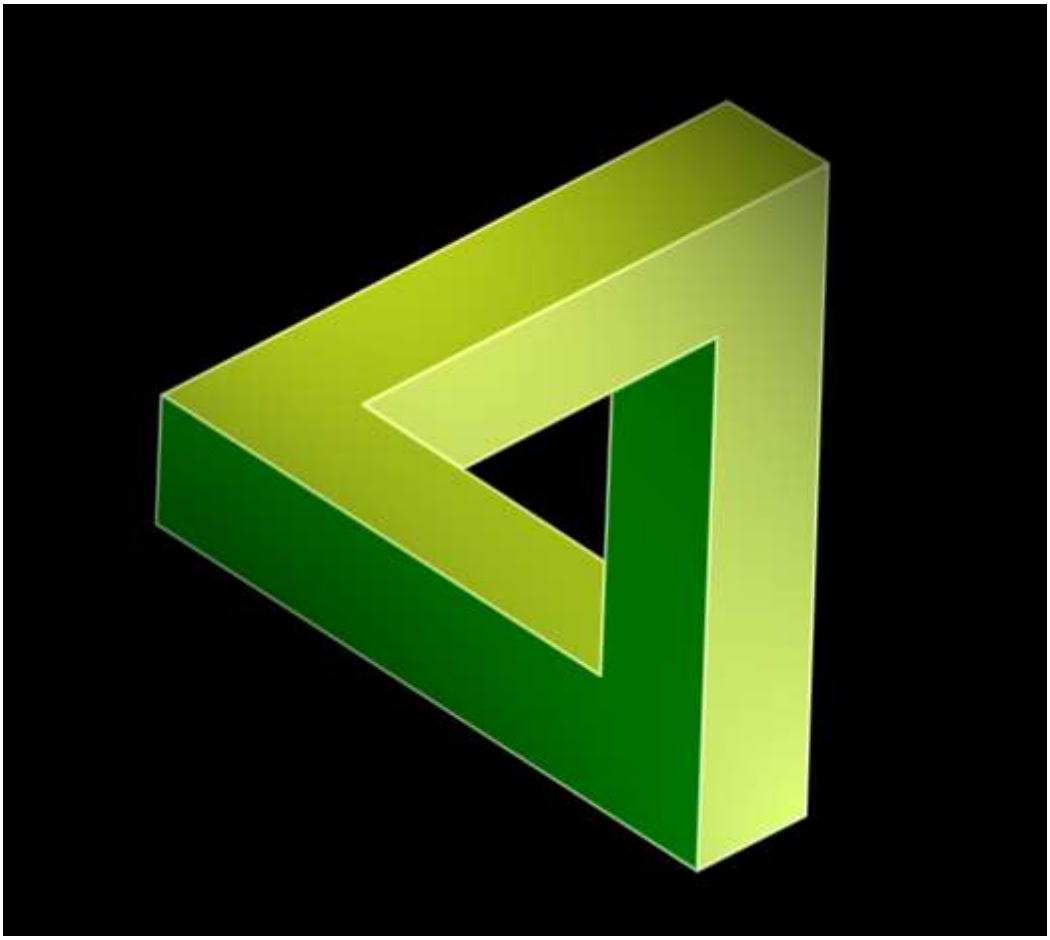
2019
Postgraduate courses
School of Mathematics and Statistics
Te Kura Mātai Tatauranga



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January 2019

ENROLLING FOR POSTGRADUATE STUDY

Domestic students should enrol online for Honours, MSc Part 1 or Diplomas/Certificates. It is advisable to discuss your intended programme first with the Postgraduate Coordinator.

Students can also enrol for Master's by thesis online. To apply for PhD study, please contact the Postgraduate Coordinator and read the application information on the Faculty of Graduate Research website **www.victoria.ac.nz/fgr**

Staff email: **firstname.lastname@vuw.ac.nz**

STAFF CONTACTS

STAFF		ROOM	CONTACT
Head of School			
A/Prof I-Ming (Ivy) Liu		356	463 5648
Deputy Head of School			
Prof Rod Downey		324	463 5067
Mathematics			
Prof Astrid an Huef	Functional analysis, operator algebras and dynamical systems	439	463 6780
A/Prof Lisa Clark	Functional Analysis, Operator Algebras	427	463 6734
Dr Adam Day†	Algorithmic Randomness	442	463 5658
A/Prof Peter Donelan†	Singularities, Invariant Theory, Robotics	356	463 5659
Prof Rod Downey	Computability, Complexity, Combinatorics, Algebra	324	463 5067
Prof Rob Goldblatt†	Mathematical Logic, General Algebra	438	463 5660
Prof Noam Greenberg§	Computability Theory, Set Theory	436	463 6778
Dr Byoung Du (BD) Kim	Number Theory, Arithmetic Geometry	434	463 5665
Dr Hung Le Pham	Functional Analysis	440	463 6732
Dr Martino Lupini	Combinatorics, Dynamical Systems, Operator Algebra, Functional Analysis, Model theory	426	463 6744
Prof Stephen Marsland	Application of mathematical methods to problems in computing	443	463 9695
A/Prof Dillon Mayhew	Matroids, Complexity, Combinatorics, Graph Theory	435	463 5155
Prof Mark McGuinness	Industrial Applied Maths, Modelling	323	463 5059
Dr Dimitrios Mitsotakis†	Numerical Analysis, Differential Equations, Nonlinear Waves	361	463 6739
Prof Iain Raeburn	Functional analysis and its applications to other parts of mathematics	433	463 5662
Dr Dan Turetsky	Multivariable Calculus	438	463 5660
Prof Matt Visser	Black Holes, General Relativity, Cosmology	321	463 5115
Prof Geoff Whittle	Combinatorics, Matroids, Graph Theory	320	463 5650

Statistics

Dr Ryan Admiraal	TBC	Flat 3, 65 Highbury Rd	463 5275
A/Prof Richard Arnold	Biostatistics, Bayesian Statistics, Statistics in Geophysics	538	463 5668
A/Prof Stefanka Chukova†	Warranty Analysis and Reliability	535	463 6786
Dr Laura Dumitrescu†	Data Analysis, Robust Estimation, Longitudinal Data, Central Limit Theorems	542	463 5233 ext 8759
Dr John Haywood	Time Series, Forecasting, Seasonal Adjustment, Statistical Modelling	541	463 5673
Dr Yuichi Hirose†§	Estimation Theory, Model Selection, Sampling Methods	546	463 6421
Prof Estate Khmaladze	Asymptotic Statistics, Random Processes, Martingale Methods	534	463 5652
A/Prof Ivy (I-Ming) Liu	Categorical Data Analysis	424	463 5648
Dr Binh Nguyen	Data Science and Interdisciplinary Computing	362	463 8896
Dr Thuong Nguyen	Asymptotic statistics	432	463 5274
Dr Nokuthaba Sibanda	Biomedical Statistics, Statistical Process Control, Applications of Bayesian Statistics	543	463 6779
Prof Peter Smith	Telecommunications, Statistics in Engineering	539	463 6738
Dr Budhi Surya	Levy Process, Optimal Stopping, Applied Probability, Financial Stochastics	544	463 5669
Dr Yuan Yao	Biostatistics and Statistical Inference	533	463 7059

§ Postgraduate Coordinator

† On leave or unavailable for part of this year

MATH Postgraduate Coordinator
Prof Noam Greenberg
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STAT Postgraduate Coordinator (Taught Course)
Dr Yuichi Hirose
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STAT Postgraduate Coordinator (Research programme)
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Note: Students must discuss their intended programme with the Postgraduate Coordinator.

QUALIFICATIONS AVAILABLE

HONOURS AND MSC PART 1

The programme for the **Bachelor of Arts with Honours (BA(Hons)), Bachelor of Science with Honours (BSc(Hons)),** or **Master of Science (MSc) Part 1**, consists of 120 points, typically made up of eight 15-point courses or the equivalent in an approved combination, to be chosen from the courses described below and subject to availability. While most courses are lecture based, some consist of individual research projects.

The Honours degree is intended to be a single offering based on a coherent programme of study. When courses are substituted from other subjects, they must be relevant and complementary to the rest of the programme. At most 60 points may be substituted, that is at least 60 points must be from those listed for the major subject. With permission of the Postgraduate Coordinator, a part-time student may extend their Honours/Master's Part 1 over more than one year. The maximum time for BSc(Hons) is two years, for BA(Hons) four years.

Those who do MSc Part 1 can do MSc Part 2 the following year, and obtain the MSc degree with a class of Honours. However, the School prefers that students do exactly the same two years' work by obtaining a BSc(Hons) degree in the first year, and then enrolling in MSc Part 2 to complete an MSc degree.

There is no MA Part 1. MA has the same status as MSc Part 2 and, like BA(Hons), can be taken in Mathematics but not in Statistics.

PREREQUISITE FOR HONOURS IN MATHEMATICS

The prerequisite for BA(Hons) or BSc(Hons) in MATH is an undergraduate major in Mathematics, including at least 60 points in 300-level Mathematics courses. An average grade of at least B+ in the relevant 300-level courses is normally required, and students should have completed any specific prerequisites for their proposed courses of study. An equivalent background will be required for a student whose undergraduate study has been undertaken elsewhere.

PREREQUISITES FOR HONOURS IN STATISTICS

You will need a BA or BSc with at least 45 points from MATH 353, 377, OPRE 300-399, STAT 300-399, not including STAT 392 (with an average grade of B+ or better). Other entry combinations are also possible.

Students with interests in the theoretical aspects of Statistics:

Such students, particularly if they are considering the possibility of a research degree, may wish to strengthen their general mathematical background before specialising. The MATH courses in Differential Equations, Algebra, Analysis and Measure Theory all provide valuable background for different aspects of work in Statistics.

POSTGRADUATE CERTIFICATE IN SCIENCE

The Postgraduate Certificate in Science (PGCertSc) is offered in all subjects offered for the MSc. Entry requirements are the same as for the MSc, but the grade requirement may be relaxed slightly. The qualification consists of only 60 points of postgraduate courses in the relevant subject, so provides a shorter coursework postgraduate qualification. It may be suitable for a student in full-time work or managing other commitments and may also be used for those who wish to exit early from another postgraduate qualification. Conversely, a PGCertSc may later be abandoned in favour of a PGDipSc if the requirements for that qualification are subsequently met.

A candidate in PGCertSc should be enrolled for at least one trimester and should complete the requirements within two years.

- The **PGCertSc in Mathematics** requires 60 points in approved courses from MATH 401–489.
- The **PGCertSc in Statistics** requires 60 approved points from STAT 401–489.
- **The PGCertSc in Stochastic Processes in Finance and Insurance** requires 45 points from MATH 441, 442, 477, STAT 433, 435, 457 and a further 15 points from STAT 401–489.

POSTGRADUATE DIPLOMA IN SCIENCE

The Postgraduate Diploma in Science (PGDipSc) is a postgraduate science qualification offered in all subjects offered for the MSc. Entry requirements are the same as for the MSc, but the grade requirement may be relaxed slightly. The PGDipSc requires 120 points of postgraduate study and can be completed in two trimesters (full time) or over four years (part time), and provides an alternative to the Honours and Master's degrees for students.

- The **PGDipSc in Mathematics** requires 120 points in approved courses from MATH 401–489.
- The **PGDipSc in Statistics** requires 120 points from STAT 401–489 or approved alternatives; at least 60 points shall be from 400-level STAT courses.
- The **PGDipSc in Stochastic Processes in Finance and Insurance** requires 120 points in an approved combination from MATH 441, 442, 461–464, 477, STAT 401–489, or approved alternatives; including at least 45 points from MATH 441, 442, 477, STAT 433, 435, 457.

With permission some optional courses in a PGDipSc may be replaced by substitute courses from other subjects offered for postgraduate degrees.

MASTERS

The programmes available at Master's level are:

- Master of Science (MSc) or Master of Arts (MA) in Mathematics
- MSc in Statistics
- MSc in Stochastic Processes in Finance and Insurance
- Master of Applied Statistics (MAppStat)

Candidates for MSc must enrol each year for the individual courses, projects, theses, etc. they will be doing that year. For each student, the requirements for any such course(s) are worked out in consultation with the Postgraduate Coordinator.

With the permission of the Associate Dean (Students), study can be undertaken on a part time basis.

MSC OR MA IN MATHEMATICS

PROGRAMME STRUCTURE

The programme consists of preparation of a research thesis (MATH 591, CRN 667) under the individual supervision of a staff member.

ENTRY REQUIREMENTS

Students entering this programme will normally have completed BA(Hons) or BSc(Hons) with a class of Honours of II(2) or better, or MSc Part 1. Entry requires approval of the Postgraduate Coordinator, and depends on an initial agreement on a programme of study, supervisor, and a provisional thesis topic. Potential areas of research are outlined in the section on the PhD programme.

A Master's thesis is normally an exposition of a piece of mathematical work and may contain new results or may represent a study of known material from a fresh point of view, together with some review of the literature. The thesis must be submitted for examination within 12 months of enrolment for the Master's degree.

MSC IN STATISTICS

PROGRAMME STRUCTURE

Entry to the MSc in Statistics Part 1 requires at least 45 points from MATH 353, 377, OPRE 300-399, STAT 300–399, not including STAT 392 (normally with an average grade of B+ or better).

MSC PART 2 IN STATISTICS

This normally comprises a thesis (STAT 591 or 592, worth 120 or 90 points respectively) and the addition, if required, of 30 points from approved courses* to total 120 points.

The MSc in Statistics, combined Parts 1 and 2, allows a student to enter a 2-year programme leading directly to the MSc degree without the intermediate step of a BSc(Hons) programme in Statistics. Part 1 requires at least 120 points in an approved combination from MATH 477, STAT 401–489 or approved alternatives; at least 60 points shall be from 400-level STAT courses. The second part of the programme (Part 2) requires either (a) 120 point Thesis (STAT 591); or (b) 90 point Thesis (STAT 592) with the addition of 30 points from approved courses*.

* All 400-level STAT and approved 400-level ECON, FINA and MATH courses.

Areas of interest encouraged by the group are biometrics, categorical data analysis, demography, empirical processes, epidemiology, martingale methods, multivariate analysis, population modelling, production theory, queuing theory, reliability theory, simulation, sorting algorithms, statistical theory of diversity, statistics in geophysics, stochastic processes and their applications, financial stochastics and mathematics, time series analysis and its applications, including seasonal adjustment and forecasting.

ENTRY REQUIREMENTS

Students who enter the MSc Part 2 programmes in Statistics will normally have completed the corresponding BSc(Hons) or MSc Part 1 programmes, with a class of Honours of II(2) or better. Students may also enter the MSc Part 2 following the PGDipSc, but need to establish that they have achieved an equivalent standard. In all cases, entry to the Master's programmes requires the explicit approval of the Postgraduate Coordinator (Research) and in addition to prerequisite requirements, requires an initial agreement on a programme of study, a supervisor and a provisional research topic.

MSC IN STOCHASTIC PROCESSES IN FINANCE AND INSURANCE

This two-year (combined Parts 1 and 2) programme addresses the growing demand worldwide for postgraduate students who can solve real-world problems in the finance sector and insurance/actuarial science, using high-level technical knowledge in mathematical and statistical aspects of probability.

A core of courses in advanced probability, functional analysis and stochastic processes are taken, together with coursework in one of a number of relevant areas of application including finance, insurance mathematics and demography. This is followed by a research thesis in the area(s) of specialisation, integrating the theoretical and applied aspects of the programme.

PROGRAMME STRUCTURE

Part 1 of the MSc in Stochastic Processes in Finance and Insurance requires 120 points in an approved combination from MATH 441, 442, 461-464, 477, STAT 401-489, or approved alternatives; including at least 45 points from MATH 441, 442, 477, STAT 433, 435, 457.

Part 2 of the MSc in Stochastic Processes in Finance and Insurance must be preceded by Part 1, and requires a satisfactory thesis (SPFI 591 or 592, worth 120 or 90 points respectively) presented in accordance with the MSc statute, with the addition if required of 30 points of approved courses from the schedules to the BSc(Hons), MSc or other postgraduate degrees, including those from specific exchange programmes.

ENTRY REQUIREMENTS

Entry to the MSc in Stochastic Processes in Finance and Insurance Part 1 requires 45 points from MATH 301, 312, 377, STAT 332; a further 30 points in approved 300-level MATH, ECON, FINA, OPRE or STAT courses. Students should discuss their options for the MSc with the Postgraduate Coordinator, before finalising their course of study.

MASTER OF APPLIED STATISTICS

The Master of Applied Statistics (MAppStat) is a one-year 180-point Master's degree in Applied Statistics. The programme consists of two components: course work and practical training that has a professional focus through the inclusion of practicum and statistical consultancy. These give the programme unique characteristics among applied statistics programmes internationally.

This taught Master's programme may be completed in one year full time (three trimesters: March–June, July–October and November–February) or up to three years part time. Students can start the programme either in March or July.

PROGRAMME STRUCTURE

The MAppStat requires:

- **Part 1**: STAT 487 or STOR 487; 105 points from an approved combination of MATH 477, OPRE 451-482, STAT 431-489, STOR 440–482
- **Part 2**: STAT 480, 501, 581

The Head of School of Mathematics and Statistics may approve substitution of up to 30 points in Part 1 by other relevant 400- or 500-level courses.

A candidate who has completed Part 1 of the degree but not Part 2 may be awarded a Postgraduate Diploma in Science in Statistics.

ENTRY REQUIREMENTS

Students who enter the MAppStat will have completed a Bachelor's degree in a tertiary institution in a relevant subject; and been accepted by the Head of School of Mathematics and Statistics as capable of proceeding with the proposed course of study (normally with an average grade of B+ or better). Students should discuss their course of study with Dr I-Ming (Ivy) Liu.

PHD

The PhD degree is the usual entry to a research or academic career and is awarded for a research thesis. Its essential feature is an original contribution to new developments in the field, by way of new theory or new methodology. A candidate for the degree pursues a course of advanced study and research at the University under the immediate direction of a supervisor, or supervisors.

Study is usually full time, and is for a period of at least two calendar years (the maximum time if studying full time is 48 months (4 years) and if part time it is 72 months (6 years)) from the date of registration. Local students will usually have completed a Master's degree before entering the PhD programme, but entry direct from an Honours degree is possible.

Full information about the PhD degree, including how to apply, qualifications required, fees and scholarships etc. can be obtained from the website of the Faculty of Graduate Research at **www.victoria.ac.nz/fgr**

Any student wishing to enrol for a PhD must discuss possible fields of study with staff members.

RESEARCH AREAS IN MATHEMATICS

Discrete mathematics, algebra and number theory

Current staff interests encompass combinatorics, matroid theory, graph theory, general algebra, category theory, number theory and arithmetic geometry. Staff involved include Prof Rod Downey, Prof Rob Goldblatt, Dr Byoung Du Kim, Dr Dillon Mayhew and Prof Geoff Whittle.

Logic and the theory of computation

This covers aspects of mathematical and philosophical logic and theoretical computer science, including model theory, set theory, computability theory, complexity of computation, algorithmic randomness, algebraic logic, and the mathematics of modal logic. Staff involved include Dr Adam Day, Dr Georgios Barmpalias, Prof Rod Downey, Prof Noam Greenberg and Prof Rob Goldblatt.

Analysis, topology and geometry

There are interests in singularity theory and algebraic invariant theory with applications to robotics (Dr Peter Donelan); functional and harmonic analysis (A/Prof Lisa Clark, Dr Hung Le Pham); and differential geometry (Prof Matt Visser).

Applied mathematics and theoretical physics

Prof Mark McGuinness has research interests in mathematical modelling with differential equations, with applications in biomathematics, industrial processes, geophysical processes, and two-phase fluid flow in porous media. Prof Matt Visser works in general relativity and quantum field theory, as well as in differential equations and modelling. Dr David Balduzzi works in machine learning (kernel methods, neural networks and online learning) and applications of learning theory to models of synaptic plasticity. Dr Dimitrios Mitsotakis' research interests are in the theory and numerical analysis of differential equations and in applications of mathematics in fluid mechanics, coastal hydrodynamics and geophysics. Dr Georgios Barmpalias carries out research on networks, dynamics and game-theoretic approaches in multi-agent systems.

RESEARCH AREAS IN STATISTICS

Bayesian statistics

This covers theoretical developments, computational aspects and applications of Bayesian methods. Staff involved include A/Prof Richard Arnold, Dr Yuichi Hirose and Dr Nokuthaba Sibanda.

Categorical data

Interests include analysis and method development for categorical data (A/Prof Ivy Liu) and logistic regression methods (Dr Yuichi Hirose).

Operations research

Staff interests include stochastic operations research methods. Specific interests are warranty analysis and reliability theory (A/Prof Stefanka Chukova).

Probability theory and stochastic processes

Prof Estate Khmaladze's research interests include asymptotic statistics, empirical processes, martingale methods in statistics, statistical theory of diversity, and mathematics of finance and insurance. It also includes research in intersection of spatial statistical problems and geometry. Dr John Haywood has research interests in stochastic process applications in time series analyses. Dr Budhi Surya has research interests in Levy processes, optimal stopping, applied probability and financial stochastics.

Statistical modelling, estimation and testing

There are interests in modeling of directional and geophysics data (A/Prof Richard Arnold), categorical data (A/Prof Ivy Liu) and survival data (Dr Yuichi Hirose). Dr Hirose also has interests in model selection methods, profile likelihood estimation, finite mixture models, EM algorithm and semi-parametric models, sampling (with A/Prof Richard Arnold) and estimation theory. There are also research interests in goodness-of-fit testing (Prof Estate Khmaladze and Dr John Haywood). Dr Laura Dumitrescu has interests in small area estimation and surveys.

Statistical applications

A number of staff are involved in statistical applications in various fields. These include: geophysics and epidemiology (A/Prof Richard Arnold, Dr Yuichi Hirose), biomedical statistics (A/Prof Richard Arnold, A/Prof Ivy Liu, Dr Nokuthaba Sibanda), finance and insurance (Prof Estate Khmaladze), fisheries science (A/Prof Richard Arnold, Dr Nokuthaba Sibanda), ecology (Dr John Haywood, Dr Nokuthaba Sibanda) and diversity problems in environmental studies and linguistics (Prof Estate Khmaladze).

Statistics and engineering

Prof Peter Smith has research interests in telecommunications and Statistics in Engineering.

Time series and forecasting

Dr John Haywood has interests in time series, forecasting and seasonal adjustments. Prof Estate Khmaladze has interests in forecasting in financial applications.

COURSE INFORMATION INDEX

Course code	Course reference number	Title	Points	Trimester
MATH 432	**CRN 7673**	**MATROID THEORY**	**15 PTS**	**1/3**

PLANNING A PROGRAMME IN MATHEMATICS

MATH 432 CRN 7673 MATROID THEORY 15 PTS 2/3

Prerequisite: MATH 311, 324 or 335
Coordinator: Dr Dillon Mayhew

The notion of dependence occurs naturally in many areas of mathematics: for example, graph theory, linear algebra, and the study of field extensions. These apparently quite different concepts share certain properties. Matroids are the axiomatic mathematical objects that arise from these common properties, in the same way that groups are the objects we discover when we consider the abstract properties of symmetries. This course is an introduction to structural matroid theory, including the basic definitions and results, and excluded-minor characterisations of several classes of matroids.

MATH 433 CRN 7674 MODEL THEORY 15 PTS 2/3

Prerequisite: MATH 309
Coordinator: Prof Rod Downey

This course will introduce students to fundamental notions, ideas, and techniques from model theory, such as structures and formulas, the ultraproduct construction, the compactness theorem, and quantifier elimination. We will also present application to concrete examples from algebra and discrete mathematics, such as fields, groups, and graphs.

MATH 434 CRN 7675 SET THEORY 15 PTS 1/3

Prerequisite: MATH 309
Coordinator: Dr Adam Day

Set theory lies at the foundations of mathematics - all objects of mathematical interest can be construed as sets. Contemporary set theory explores some of the rich structure of the class of all sets, and the limitations of the theory. The course uses ideas from MATH 309, but is not a strict continuation of that course.

MATH 435 CRN 7676 COMPUTABILITY AND COMPLEXITY 15 PTS 2/3

Prerequisite: MATH 335
Coordinator: Prof Noam Greenberg

This is a course about the algorithmic content of mathematics. That is, the part of mathematics that could be performed upon a machine. It will build on the foundation of MATH 335. It is about the underlying mathematics of algorithms and the mathematical ideas behind the discipline of computer science. Structural complexity and computation are studied at a more advanced level. Some study of the theory of distributed systems may be included.

MATH 436 CRN 7677 GALOIS THEORY AND NUMBER THEORY 15 PTS 1/3

Prerequisite: MATH 311
Coordinator: Dr Byoung Du Kim

Galois theory is a fascinating mathematical theory that brings together several branches of mathematics. This course starts with the historical question of solving polynomial equations by radicals. We will rediscover the method with which Galois determined whether a given polynomial is solvable by radicals or not. However, this course goes even further: Galois theory grew to become an interconnection between different areas of algebra such as roots of polynomials, field extensions, algebraic and transcendental numbers, Galois groups, and also algebraic number theory, and we will explore some aspects of it. Galois theory is a natural bridge between algebra and number theory, and in the second half of this course, we will study how algebra is applied to number theory.

MATH 438 CRN 26035 KNOTS AND COMPLEXITY 15 PTS 1/3

Prerequisite: MATH 311 or 324 or 335
Restrictions: MATH 483 in 2011-2013
Coordinator: Prof Geoff Whittle

This course introduces polynomial invariants of knots and graphs, including Jones polynomials of knots and Tutte polynomials of graphs. The focus is on complexity theoretic aspects associated with their evaluation. The course serves as further study in graph theory and as an introduction to knot theory and enumeration complexity.

MATH 441 CRN 7680 MEASURE THEORY 15 PTS 1/3

Prerequisite: MATH 312
Coordinator: Dr Hung Le Pham

Much of modern mathematics, both pure and applied, and ranging from number theory to quantum mechanics, depends on having a method of integrating functions that applies to more functions and has better properties than the Riemann integral taught in undergraduate courses. Such a method was invented by Lebesgue; it depends on the idea of 'measure', which can be thought of as, in origin, an extension of the concepts of 'area' and 'volume', but which was subsequently seen to be precisely what is needed to found a rigorous theory of probability. This is an introduction course on measure theory. Topics cover include: measurable spaces and measures (specific examples include Lebesgue measure on the real line and unordered sums on general sets), integration theory on measure spaces, important convergence theorems (bounded convergence, monotone convergence, dominated convergence theorems), some applications to classical function theory on the real line (e.g. when a function is Riemann integrable or a generalisation of the fundamental theorem of calculus) and to probability.

MATH 453 CRN 593 LIE GROUPS AND LIE ALGEBRAS 15 PTS 1/3

Prerequisites: MATH 243 and either MATH 311 or 312 or 313 or 317 or 318
Coordinator: Dr Peter Donelan

Lie (pronounced 'lee') groups are sets of transformations preserving some geometric structure, such as the set of orthogonal transformations of a Euclidean space. They have two compatible structures: that of a group and of a differentiable manifold. Associated to any Lie group is its Lie algebra of infinitesimal transformations. One can understand a great deal about a Lie group by studying its Lie algebra and its representations—actions of the group on vector spaces. The classification of certain types of Lie groups and algebras is one of the masterpieces of 20th century mathematics. Specifically, the course will cover some or all of - Introduction to real, complex and quaternion matrix groups - Manifolds, Lie groups and their algebras, the exponential map - Structure of Lie algebras - Representations of Lie groups and algebras - Classification of complex semisimple Lie algebras.

MATH 461 CRN 7684 DIFFERENTIAL EQUATIONS 15 PTS 2/3

Prerequisite: MATH 301

Coordinator: Dr Dimitrios Mitsotakis

This course is about *asymptotic methods*, for finding approximate solutions to linear and nonlinear ordinary differential equations, as well as for approximately evaluating integrals. To quote Bender and Orszag: In contrast to methods which we would describe as exact, rigorous, systematic, limited in scope and deadly, these new methods are approximate, intuitive, heuristic, powerful and fascinating.

We will study mainly the following:

- Local Methods: Method of dominant balance, Asymptotic series.
- Asymptotic Expansion of Integrals: Laplace's method, Watson's Lemma, stationary phase method, the method of steepest descents.
- Perturbation Methods: Regular perturbation, Singular perturbation, Boundary layer analysis.

MATH 462 CRN 7685 CHAOTIC DYNAMICS 15 PTS 1/3

Prerequisite: MATH 301

Coordinator: Prof Mark McGuinness

A gourmet's sampling from the smorgasbord of delights in chaos and dynamical systems, from the Cantor set to strange attractors, including the iteration of maps, symbolic dynamics, and Smale horseshoes.

Dynamical systems model aspects of real world, either discretely with maps or continuously with differential equations. We study maps in one and two dimensions and use their properties to understand systems of differential equations via the idea of Poincaré sections. As a result we are led from fixed points via periodic to chaos and fractals.

MATH 464 CRN 10021 DIFFERENTIAL GEOMETRY 15 PTS 1/3

Prerequisite: MATH 301

Coordinator: Prof Matt Visser

This course introduces the notation and ideas of modern Differential Geometry that form an essential background to many fields in Mathematics and Physics. It develops the theory of manifolds and bundles from a largely intuitive standpoint, and discusses the geometric notions of metric, connexion, geodesic, curvature and sectional curvature. Extensive notes are supplied. The course is an essential prerequisite for MATH 465. Topics include:

- topological manifolds and differentiable structure
- affine connexion and curvature: the Riemann tensor
- exterior differential forms: generalized Stokes' theorem.

MATH 465 CRN 10022 GENERAL RELATIVITY AND COSMOLOGY 15 PTS 2/3

Prerequisite: MATH 464

Coordinator: Prof Matt Visser

This course introduces Einstein's general relativity, black holes, gravitational waves, some idealised models of the universe, and a brief discussion of some extensions to the theory. Topics may include:

- special relativity: R^4 with a Lorentzian metric; the Lorentz group; causal structure
- Lorentzian (pseudo-Riemannian) geometry
- general relativity: the Einstein equivalence principle

- Einstein's equations (vacuum); Schwarzschild solution
- Einstein's equations with matter
- gravitational waves
- idealised cosmologies; FLRW universes.

MATH 466 CRN 23076 TOPICS IN APPLIED MATHEMATICS 15 PTS 1/3

Prerequisite: MATH 301 or 321 or 322
Coordinator: Prof Mark McGuinness

Two topics of a more advanced nature in applied mathematics or mathematical physics from a selection that may include: classical mechanics, fluid mechanics, quantum mechanics, special relativity. Topics may not include any already or concurrently taken in MATH 321, 322 or 323 or in MATH 467.

MATH 467 CRN 23075 TOPICS IN APPLIED MATHEMATICS 15 PTS 2/3

Prerequisite: MATH 301 or 321 or 322
Coordinator: Prof Mark McGuinness

Two topics of a more advanced nature in applied mathematics or mathematical physics from a selection that may include: classical mechanics, fluid mechanics, quantum mechanics, special relativity. Topics may not include any already or concurrently taken in MATH 321, 322 or 323 or in MATH 466.

MATH 477 CRN 29142 PROBABILITY 15 PTS 1/3

Prerequisite: MATH 377
Restrictions: STAT 437
Coordinator: Prof Estate Khmaladze

The course starts with weak and almost sure convergence, then covers limit theorems and semi-groups of distributions, infinitely divisible and stable distributions and Lévy processes, with emphasis on compound Poisson processes, random walks and Brownian motion. The material is illustrated by real-life examples from finance, insurance and other fields.

MATH 440 CRN 15207 DIRECTED INDIVIDUAL STUDY 15 PTS 1/3
MATH 460 CRN 15208 DIRECTED INDIVIDUAL STUDY 15 PTS 2/3

Prerequisite: Permission of Course Coordinator
Coordinator: Prof Noam Greenberg

The directed individual study (DIS) label can be used to provide a reading course when there is no suitable Honours course available. The student follows an individual course of study under supervision. One DIS label may be used for different subject matter for different students.

A DIS label can sometimes also be used to enable study in a field taught in a 300-level MATH course not previously passed. As well as attending the 300-level course at its regular time and fulfilling its requirements, the student will be required to prepare additional material for assessment, demonstrating an understanding of a suitable topic at a level appropriate to an Honours degree. It will typically count for 20% of the course grade. At most **one** 15-point course of this nature may be included in an Honours degree, and only at the discretion of the coordinator of the associated 300-level course. It may not count towards the minimum of 60 MATH points required for Honours in Mathematics. It also requires a specific justification, such as the need to provide prerequisite material for some other course in the student's individual Honours programme.

MATH 480–483: SPECIAL TOPICS

The special topic label can be used to create 30-point or 15-point courses tailored to particular interests, or to introduce new topics that may be offered in a particular year. One Special Topic label may be used for different subject matter for different students. There are four labels that can be used, two for 30-point full-year courses, and two for 15-point one-trimester courses that are each available in both 1/3 and 2/3:

	PTS	CRN	
MATH 480	Special Topic	30	6891 (1/3+2/3) **Not offered 2019**
MATH 481	Special Topic	30	6892 (1/3+2/3) **Not offered 2019**
MATH 482	Special Topic	15	9758 (2/3)
MATH 483	Special Topic	15	6894 (2/3)

MATH 482 CRN 9758 TOPICS IN MACHINE LEARNING 15 PTS 2/3

Prerequisite: COMP 421 is strongly recommended.
Coordinator: TBC

The course is an introduction to selected topics in machine learning. In previous years we have focused on game theory and online learning. Topics that may be covered in future include: matrix/tensor factorisation and deep learning.

Students should have a high level of mathematical maturity. Calculus, probability theory and linear algebra are essential. Familiarity with implementing and analysing algorithms will be helpful.

MATH 483 CRN 8795 OPERATOR ALGEBRA 15 PTS 2/3

Prerequisite: MATH 442
Restriction: MATH 483 in 2017
Coordinator: TBC

Operator algebras have a rich algebraic and analytic structure modelled on the properties of bounded linear operators on Hilbert space. This course introduces the basic theory of Banach and C*-algebras with an emphasis on how it is used.

MATH 488 CRN 27014 PROJECT 15 PTS 1/3
MATH 488 CRN 7693 PROJECT 15 PTS 2/3
MATH 489 CRN 7694 PROJECT 30 PTS 1+2/3

Prerequisite: Permission of the Postgraduate Coordinator
Coordinator: Prof Noam Greenberg
Project homepage: **http://msor.victoria.ac.nz/Courses/MATH488_2017T1**

This option allows the student to carry out an individual research project under supervision. It provides an experience of exploring the literature on a certain topic and writing a report that gives a coherent survey of findings and demonstrates mastery of the material. Supervision takes the form of regular meetings between the student and supervisor.

A list of possible project topics and supervisors is available on the project homepage. The Coordinator will allocate a supervisor and topic to each student, taking into account the overall preferences of students and staff.

Only one Project course can be included in an Honours programme: either a one-trimester 15 point project (MATH 488) or the full-year 30-point MATH 489.

SUBSTITUTION FROM OTHER SUBJECTS

Up to half of a Mathematics Honours degree can consist of courses from other subjects. The overall selection of courses must still form a coherent programme and requires approval from the Mathematics Postgraduate Coordinator.

PLANNING A PROGRAMME IN STATISTICS

TAUGHT COURSES AND PROJECTS: HONOURS, PGDIPSC AND MAPPST

The STAT Honours, PGDipSc and MSc Part I programmes require 120 points in an approved combination from MATH 477, STAT 401-489 or approved alternatives (up to 60 points). In addition to the 120 points, the MAppSt requires STAT 480, STAT 501 and STAT 581.

Course code	Title	Prerequisites
TRIMESTER 1		
MATH 477	Probability	MATH 377
STAT 431	Biostatistics	One of (STAT 332, 393, 394)
STAT 435	Time Series	One of (MATH 377, STAT 332)
STAT 438	Generalised Linear Models	One of (STAT 332, 393, 394)
STAT 439	Sample Surveys	STAT 193 or equivalent; 30 approved 200/300 level pts
STAT 440	Directed Individual Study	
STAT 487	Project (15 pts)	
STAT 489	Project (30 pts)	
TRIMESTER 2		
STAT 432	Computational Statistics	One of (STAT 332, 393, 394)
STAT 433	Stochastic Processes	One of (MATH 377, STAT 332)
STAT 434	Statistical Inference	STAT 332; MATH 377 recommended
STAT 441	Directed Individual Study	
STAT 451	Official Statistics	STAT 193 (or equivalent), 30 approved 200/300 level pts
STAT 452	Bayesian Inference	One of (STAT 332, 393, 394)
STAT 483	Special Topic: Data Management, Programming and Applications	Permission of course coordinator
STAT 488	Project	
STAT 489	Project (30 pts)	
STAT 501	Statistical Consulting	Enrolment in the MAppStat; 30 approved STAT points at 400-level or above
TRIMESTER 3		
STAT 480	Research Methods	Enrolment in the MAppStat
STAT 487	Project	
STAT 581	Statistical Practicum (30 pts)	Enrolment in the MAppStat; 60 approved STAT points at 400-level or above
FULL YEAR		
STAT 489	Project (30 pts)	

400-LEVEL COURSES

MATH 477 CRN 29142 PROBABILITY 15 PTS 1/3

Prerequisite: MATH 377
Restrictions: STAT 437
Coordinator: Prof Estate Khmaladze

The course starts with weak and almost sure convergence, then covers limit theorems and semi-groups of distributions, infinitely divisible and stable distributions and Lévy processes, with emphasis on compound Poisson processes, random walks and Brownian motion. The material is illustrated by real-life examples from finance, insurance and other fields.

STAT 431 CRN 23080 BIOSTATISTICS 15 PTS 1/3

Prerequisite: One of (STAT 332, 393, 394)
Restrictions: APST 483, ORST 483
Coordinator: Dr Budhi Surya

This course aims to give a basis for modelling of survival time and EM algorithm. Topics will be selected from: review of maximum likelihood estimator; large sample tests (Likelihood Ratio test, Wald test, Score test); information criteria (AIC, BIC); Mixture model and EM algorithm; Kaplan-Meier estimator and log-rank test; Cox-proportional hazard model and its extension.

STAT 432 CRN 23079 COMPUTATIONAL STATISTICS 15 PTS 2/3

Prerequisite: One of (STAT 332, 393, 394)
Restriction: APST/STAT 483
Coordinator: Dr Nokuthaba Sibanda

This course is a practical introduction to computationally intensive methods for statistical modelling and inference. Topics covered will be chosen from: the jackknife and bootstrap methods for bias correction and variance estimation; permutation tests; maximum likelihood estimation using the EM algorithm; random number generation; simulation from probability distributions; sampling algorithms, mixture models. It is desirable that students enrolling in this course have some knowledge of R.

STAT 433 CRN 23078 STOCHASTIC PROCESSES 15 PTS 2/3

Restriction: STAT 441 (up to 2011)
Coordinator: Prof Estate Khmaladze

We begin with the fundamental concepts of filtrations, i.e. increasing families of sigma-algebras as an abstract model of the ‘flow of growing information’, then adapted processes, i.e. processes adapted to these filtrations, then inequalities and Doob decomposition, all studied in discrete time first. Then we consider Brownian motion and Brownian bridge, their main distributional properties and different forms, properties of their trajectories, Wiener stochastic integral and function-parametric Brownian motion. Next, the course evolves into stochastic analysis ’proper’: Ito stochastic integrals, stochastic differentiation and Ito formula, followed by stochastic differential equations (SDE) and, in particular, linear SDE. Ornstein-Uhlenbeck process, Brownian bridge and Geometric Brownian motion are derived as solutions of the linear SDE. Their properties and applications in financial mathematics are studied. Examples of other applications are shown.

Connection of this material with empirical processes of statistics is demonstrated.

STAT 434 CRN 8109 STATISTICAL INFERENCE 15 PTS 2/3

Prerequisite: STAT 332; MATH 377 recommended

Coordinator: Dr Laura Dumitrescu

In-depth cover of classical statistical inference procedures in estimation and hypothesis testing. Topics include: limit theorems; theory of parametric estimation; sufficiency and efficiency; uniformly most powerful tests and likelihood ratio tests. As time permits, a selection of notions from Bayesian, nonparametric and robust statistics, will be discussed.

STAT 435 CRN 8110 TIME SERIES 15 PTS 1/3

Prerequisite: One of (MATH 377, STAT 332)

Coordinator: Dr John Haywood

A general introduction to the theory and practice of time series analysis. Topics will include: the basic theory of stationary processes; spectral or Fourier models; AR, MA and ARMA models; linear filtering; time series inference; and the sampling of continuous time processes. This foundation course has broad application in many areas. The statistical system R will be used for graphical displays, data analysis and simulation studies.

STAT 436 CRN 8111 FORECASTING 15 PTS 2/3

Prerequisite: 30 approved 300-level ECON, MATH, OPRE, QUAN or STAT pts

Coordinator: Prof Estate Khmaladze

Students will be placed in the position of a financial analyst in an imaginary financial institution and given real data on prices (electricity prices and foreign exchange rates). They will be asked to answer questions typical for real problems of the financial industry. Specific topics include estimation and analysis of trends, detection of abrupt changes in market conditions, estimation of the change-point, selection of models for stationary time-series, analysis of marginal distributions and detection of mixtures of distributions.

Note: This course not offered in 2019

STAT 438 CRN 8113 GENERALISED LINEAR MODELS 15 PTS 1/3

Prerequisite: One of (STAT 332, 393, 394)

Restrictions: APST 438

Coordinator: Dr Yuichi Hirose

Brief outline of generalised linear model theory, contingency tables, binary response models, log-linear models (for contingency tables), repeated measures, GEE analysis, logit models for multinomial responses, and ordinal response models.

STAT 439 CRN 10019 SAMPLE SURVEYS 15 PTS 1/3

Prerequisites: STAT 193 or equivalent; 30 approved 200/300-level pts

Restrictions: APST 439, STAT 392

Coordinator: A/Prof Richard Arnold

An introduction to practical aspects of survey sampling, including sampling theory, sample design, basic analytic techniques, non-response adjustment, questionnaire design and field work. Practical aspects of survey design and implementation form part of the course, including students developing their own survey proposals. Some use of a statistical package such as SAS or Excel will be required. The ability to write good English is expected, as some assignments are to be presented as reports. Students unfamiliar with or unpractised at report writing are advised to take the course WRIT 101. This course is co-taught with STAT 392.

STAT 451 CRN 28349 OFFICIAL STATISTICS 15 PTS 2/3

Prerequisites: STAT 193 (or equivalent), 30 points at 200-level or above (including STAT 292 or STAT 392 or STAT 439)
Restriction: STOR 481 (up to 2015)
Coordinator: A/Prof Richard Arnold

This course provides an overview of key areas of Official Statistics. Topics covered include data sources (sample surveys and administrative data); legal and ethical framework of official statistics; introductory demography; collection and analysis of health, social and economic data; data visualisation including presentation of spatial data; data matching and integration; the system of National Accounts. This course is taught jointly across several New Zealand Universities using videoconferencing.

STAT 452 CRN 28350 BAYESIAN INFERENCE 15 PTS 2/3

Prerequisite: One of (STAT 332, 393, 394)
Restriction: STAT 482 (up to 2015)
Coordinator: Dr Nokuthaba Sibanda

Topics covered will be chosen from: the Bayesian approach, likelihood principle, specification of prior distributions, posterior distribution computation, Bayesian regression models, model determination, Bayesian models for population dynamics, sampling methods, Markov Chain Monte Carlo. The software packages R and WinBUGS will be used for Bayesian computation.

STAT 456 CRN 28366 OPTIMISATION IN OPERATIONS RESEARCH 15 PTS

Note: This course is not offered in 2019

STAT 457 CRN 28358 STOCHASTIC MODELS IN WARRANTY AND MAINTENANCE 15 PTS 1/3

Prerequisite: Approval of Postgraduate Coordinator
Restriction: OPRE 457 prior to 2016
Coordinator: A/Prof Stefanka Chukova

An advanced course in the mathematical and statistical techniques for analysis of warranty or maintenance, warranty/maintenance cost models, and some engineering aspects of warranty or maintenance. Topics covered include: basic concepts and ideas in warranty analysis or maintenance; types of warranty/maintenance policies; overview of renewal theory and its application in warranty analysis or maintenance. The course involves a number of guided research projects. Students must have programming experience and a sufficient background in probability theory.
Note: This course is not offered in 2019

STAT 480 CRN 27124 RESEARCH METHODS 15 PTS 3/3

Prerequisites: Enrolment in the MAppStat
Coordinator: Prof Peter Smith

This course consists of self-directed learning with three one-day workshops, including an introduction to LaTeX, reading research papers; using library resources; constructing literature reviews; developing and discussing research questions; and presenting a research proposal in both written and oral form. Throughout the course, each student will be guided by a mentor in a specific field of research to write a research proposal and will be expected to attend school research seminars.

STAT 481	**CRN 13703**	**SPECIAL TOPIC 1: MATHEMATICAL DEMOGRAPHY AND LIFE INSURANCE MATHEMATICS**	**15 PTS**	**1/3**

Prerequisite: Approval of Postgraduate Coordinator
Coordinator: Prof Estate Khmaladze

This course represents fundamental models of an individual lifetime as a random variable: rates of mortality, distributions of remaining life times, life tables, specific parametric models for these, including: Statistical analysis of cohorts and mixed populations; pricing of insurance contracts, endowments and annuities, analysis of longevity, basic models of population dynamics and analysis of portfolios. Students will be also required to apply the concepts presented during the course to real demographic data and life-insurance data.
Note: This course is not offered in 2019

STAT 482	**CRN 13704**	**SPECIAL TOPIC 2: STOCHASTIC SYSTEMS: MODELLING AND ANALYSIS IN SCIENCE AND ENGINEERING**	**15 PTS**	**1/3**

Prerequisite: Approval of Postgraduate Coordinator
Coordinator: Prof Peter Smith

An overview of statistical modelling and analysis of systems in science and engineering. Modelling topics include fitting and selecting statistical distributions associated with the system. Analysis topics include simulation and the algebra of random variables, such as the use of transformation theory, conditioning and characteristic functions.
Note: This course is not offered in 2019

STAT 487	**CRN 28354**	**PROJECT**	**15 PTS**	**1/3**
	CRN 28438	**PROJECT**	**15 PTS**	**2/3**
	CRN 28377	**PROJECT**	**15 PTS**	**3/3**
STAT 488	**CRN 28355**	**PROJECT**	**15 PTS**	**2/3**
STAT 489	**CRN 28367**	**PROJECT**	**30 PTS**	**1/3**
	CRN 28378	**PROJECT**	**30 PTS**	**2/3**
	CRN 28379	**PROJECT**	**30 PTS**	**3/3**
	CRN 28380	**PROJECT**	**30 PTS**	**1+2/3**
	CRN 28381	**PROJECT**	**30 PTS**	**2+3**
	CRN 28382	**PROJECT**	**30 PTS**	**3+1**

Postgraduate Coordinator: Dr Yuichi Hirose

Student should meet with the Postgraduate Coordinator to identify their areas of interest, for assistance in identifying a suitable supervisor and then contact potential supervisors directly. Fifteen-point projects are usually completed in one trimester. Thirty-point projects can be completed within either a single trimester, or two successive trimesters, and should take 300 hours of study, supervision meetings and writing.

STAT 440 CRN 28352 DIRECTED INDIVIDUAL STUDY 15 PTS 1/3
STAT 440 CRN 28376 DIRECTED INDIVIDUAL STUDY 15 PTS 3/3
STAT 441 CRN 28353 DIRECTED INDIVIDUAL STUDY 15 PTS 2/3

Prerequisites: Approval of Postgraduate Coordinator
Postgraduate Coordinator: Dr Yuichi Hirose

The Directed Individual Study label can be used to provide a reading course when there is no suitable Honours course available. The student follows an individual course of study under supervision. One DIS label may be used for different subject matter for different students.

A DIS label can sometimes be used to enable study in a field taught in a 300-level STAT or OPRE course not previously passed. As well as attending the 300-level course at its regular time and fulfilling its requirements, the student will be required to prepare additional material for assessment, as specified by the course coordinator. At most **one** 15-point course of this nature may be included in an Honours degree, and only at the discretion of the coordinator of the associated 300-level course. It may not count towards the minimum of 60 STAT points required for Honours in Statistics. It also requires a specific justification, such as the need to provide prerequisite material for some other course in the student's individual Honours programme.

STAT 501 CRN 27125 STATISTICAL CONSULTING 15 PTS 2/3

Prerequisites: Enrolment in the MAppStat
Corequisites 30 points from 400-level STAT courses or approval of Postgraduate Coordinator
Coordinator: A/Prof I-Ming (Ivy) Liu

This course provides training in statistical consulting for practical research in other disciplines. Following formal development of skills to determine appropriate analysis methods for clients, students will complete projects based on supervised consultancy with students or staff members.

This course will be taught with a combination of lectures and practical training.

- Lectures: the skills required for statistical consulting, such as client engagement; statistical packages; paper reviews for various types of analysis in Biology, Psychology, etc.
- Practical training: face-to-face meetings with clients (students or staff members in other disciplines); discussion with academic mentors about the methodology used for the clients' projects; report preparation.

STAT 581 CRN 27154 STATISTICAL PRACTICUM 30 PTS 3/3

Prerequisites: Enrolment in the MAppStat; 60 approved STAT points at 400-level or above
Coordinator: A/Prof I-Ming (Ivy) Liu

This course enables students to gain professional work experience in the application of statistics. Each student is supervised by a host organisation involved in statistical consulting or statistical applications in the public or private sectors. The placement allows students to develop teamwork and communication skills in the real world.

This course consists of:

- Practicum briefing: understanding professional expectations and responsibilities; dealing with problems arising in the work place.
- Placement: working on specific projects with significant statistical content assigned by a host employer; developing teamwork and communication skills; and writing a portfolio.
- Seminar: presenting the findings from the projects and sharing the placement experience with the class.

SUBSTITUTION FROM OTHER SUBJECTS

Up to half of a Statistics Honours degree can consist of courses from other subjects as listed below. Information about these courses is contained in the relevant Postgraduate Prospectus or websites of the School responsible for it. The overall selection of courses must still form a coherent programme and requires approval from the Statistics Postgraduate Coordinator (Taught Course). Examples of such courses are listed below.

Course code	Title
Trimester 1	
BIOL 420	Conservation Ecology (30 points)
BIOL 426	Behavioural Ecology (30 points)
COMP 421	Machine Learning
ECON 408	Advanced Econometrics A
FINA 401	Current Topics in Asset Pricing
FINA 413	Risk Management and Insurance
PHYG 414	Climate Change: Lessons from the Past
PSYC 434	Conducting Research across Cultures
PUBL 401	Craft and Method in Policy Analysis
Trimester 2	
COMP 422	Data Mining, Neural Networks and Genetic Programming
ECON 409	Advanced Econometrics B
FINA 402	Current Topics in Corporate Finance
FINA 403	Derivative Securities
FINA 406	Fixed Income Securities
GEOG 415	Introduction to Geographic Information Science and its Applications
GPHS 425	Numerical Weather Prediction
GPHS 446	Advanced Seismology

WHO TO CONTACT

Student Services provides a range of services to all students to help you make the most of your time at university. If you have an issue, need guidance to get through your studies, help is available: **www.victoria.ac.nz/students/support**

STUDENT AND ACADEMIC SERVICES—FACULTY OF SCIENCE

Te Wāhanga Pūtaiao

Address: Level 1, Cotton Building
Phone: 04-463 5101
Email: science-faculty@vuw.ac.nz
Web: www.victoria.ac.nz/science
Hours: 8.30am–3.00pm (4pm during term time) Monday, Wednesday, Thursday, Friday
9.30am–3.00pm (4pm during term time) Tuesday

At the Faculty of Science Student Administration Office, student advisers can help with admission requirements, degree planning, changing courses and transfer of credit from other tertiary institutions. They also deal with other aspects of student administration such as enrolment, exams organisation and the maintenance of student records.

Patricia Stein manages all postgraduate students:
patricia.stein@vuw.ac.nz 04-463 5982

Johan Barnard	Manager, Student and Academic Services	04-463 5980
Marc Wilson	Associate Dean (Postgraduate Students)	04-463 5092