2020
Postgraduate courses
School of Mathematics and Statistics
Te Kura Mātaï Tatauranga

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ENROLLING FOR POSTGRADUATE STUDY

Domestic students should enrol online for Honours, Master of Applied Statistics, 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

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1 Victoria University of Wellington
# Statistics

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$Postgraduate Coordinator
†On leave or unavailable for part of this year

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Note: Students must discuss their intended programme with the MATH Honours Coordinator or the relevant 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. MATH Honours students are expected to sign up for 30 points of project-based work via MATH488 and MATH489.

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 Honours and 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; 105 points from an approved combination of MATH 477, STAT 431-489
- **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 A/Prof Ivy Liu or Dr Yuichi Hirose.

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, Dr Byoung Du Kim, Dr Martino Lupini, 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, Prof Rod Downey, Prof Noam Greenberg, Dr Martino Lupini, and Dr Dan Duretsky.

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 (Dr Hung Le Pham); and differential geometry (Prof Matt Visser). A/Prof Lisa Clark and Professors Astrid an Huef and Iain Raeburn work in Functional Analysis, which is a sub branch of Analysis dealing with infinite-dimensional phenomena. They study algebra of operators associated to graphs, groups and dynamical systems. Stephen Marsland works on the geometry of infinite-dimensional groups, particularly shape spaces, and their applications in machine learning and bioacoustics.

Applied mathematics and theoretical physics
Prof Mark McGuinness has research interests in mathematical modelling with differential equations, with applications in biомathematics, 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 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.

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.
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.

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.

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.

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.
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.

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.

Topology is one of the cornerstones of modern mathematics. It appears everywhere. This course is an introduction to point-set topology; it will give students the background in Topology that they need to pursue higher level mathematics.

Topology is very abstract. The entire subject is built from a few set-theoretic definitions that can be used in a wide variety of situations. For example, many topologies are induced by metrics, but there are topological spaces that are not metric spaces.

This course will include a study of abstract notions of continuity, compactness and connectedness along with an introduction to topological groups.

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  2/3**

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: \( \mathbb{R}^4 \) 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 Astrid an Huef

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.

A DIS label can sometimes 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:

<table>
<thead>
<tr>
<th>Course</th>
<th>Type</th>
<th>Points</th>
<th>CRN</th>
<th>Trimester</th>
<th>Notes</th>
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<tr>
<td>MATH 480</td>
<td>Special Topic</td>
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<td>6891</td>
<td>1/3+2/3</td>
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<tr>
<td>MATH 481</td>
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<tr>
<td>MATH 482</td>
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<td>MATH 483</td>
<td>Special Topic</td>
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<td>6894</td>
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</tbody>
</table>

MATH 482 CRN 9758 TOPICS IN INFINITE COMBINATORICS  15 PTS  1/3

Prerequisite: MATH 309
Coordinator: Dr Martino Lupini

This course will focus on the application of infinitary methods (logic, topology, dynamical systems) in Ramsey theory and the combinatorial study of finite discrete structures. Ramsey Theory studies, broadly speaking, the following question: which combinatorial configurations can be found in a sufficiently large finite structure? This course will provide an overview of this subject, with a special emphasis on its interactions with logic and dynamics.

MATH 483 CRN 8795 OPERATOR ALGEBRA  15 PTS  1/3

Prerequisite: MATH 318
Coordinator: Prof Iain Raeburn

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 (NOT OFFERED 2018)  30 PTS  1+2/3

Prerequisite: Permission of the Honours Coordinator
Coordinator: Prof Astrid an Huef

These courses offer the 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. It is expected that MATH Honours students take 30 points of project-based courses.

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.

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.

<table>
<thead>
<tr>
<th>Course code</th>
<th>Title</th>
<th>Prerequisites</th>
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<tr>
<td><strong>TRIMESTER 1</strong></td>
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<tr>
<td>MATH 477</td>
<td>Probability</td>
<td>MATH 377</td>
</tr>
<tr>
<td>STAT 431</td>
<td>Biostatistics</td>
<td>One of (STAT 332, 393, 394)</td>
</tr>
<tr>
<td>STAT 435</td>
<td>Time Series</td>
<td>One of (MATH 377, STAT 332)</td>
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<tr>
<td>STAT 438</td>
<td>Generalised Linear Models</td>
<td>One of (STAT 332, 393, 394)</td>
</tr>
<tr>
<td>STAT 439</td>
<td>Sample Surveys</td>
<td>STAT 193 or equivalent; 30 approved 200/300 level pts</td>
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<td>STAT 440</td>
<td>Directed Individual Study</td>
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<tr>
<td>STAT 452</td>
<td>Bayesian Inference</td>
<td>One of (STAT 332, 393, 394)</td>
</tr>
<tr>
<td>STAT 487</td>
<td>Project (15 pts)</td>
<td></td>
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<td>STAT 489</td>
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<tr>
<td><strong>TRIMESTER 2</strong></td>
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<tr>
<td>STAT 432</td>
<td>Computational Statistics</td>
<td>One of (STAT 332, 393, 394)</td>
</tr>
<tr>
<td>STAT 433</td>
<td>Stochastic Processes</td>
<td>One of (MATH 377, STAT 332)</td>
</tr>
<tr>
<td>STAT 434</td>
<td>Statistical Inference</td>
<td>STAT 332; MATH 377 recommended</td>
</tr>
<tr>
<td>STAT 441</td>
<td>Directed Individual Study</td>
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<tr>
<td>STAT 451</td>
<td>Official Statistics</td>
<td>STAT 193 (or equivalent), 30 approved 200/300 level pts</td>
</tr>
<tr>
<td>STAT 482</td>
<td>Special Topic: System Modelling and Analysis in Science and Engineering</td>
<td>Permission of course coordinator</td>
</tr>
<tr>
<td>STAT 483</td>
<td>Special Topic: Data Management, Programming and Applications</td>
<td>Permission of course coordinator</td>
</tr>
<tr>
<td>STAT 488</td>
<td>Project</td>
<td></td>
</tr>
<tr>
<td>STAT 489</td>
<td>Project (30 pts)</td>
<td></td>
</tr>
<tr>
<td>STAT 501</td>
<td>Statistical Consulting</td>
<td>Enrolment in the MAppStat; 30 approved STAT points at 400-level or above</td>
</tr>
<tr>
<td><strong>TRIMESTER 3</strong></td>
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<tr>
<td>STAT 480</td>
<td>Research Methods</td>
<td>Enrolment in the MAppStat</td>
</tr>
<tr>
<td>STAT 487</td>
<td>Project</td>
<td></td>
</tr>
<tr>
<td>STAT 581</td>
<td>Statistical Practicum (30 pts)</td>
<td>Enrolment in the MAppStat; 60 approved STAT points at 400-level or above</td>
</tr>
</tbody>
</table>
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.

### 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 1/3

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

**Restriction:** STOR 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 2020.

**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: mathematical and statistical techniques for analysis of warranty/maintenance; warranty/maintenance cost models; some engineering aspects of warranty/maintenance. Topics covered include: basic concepts and ideas in warranty/maintenance analysis; types of warranty/maintenance policies; overview of renewal theory and its application in warranty/maintenance analysis. The course involves several guided research projects. Students must have programming experience and basic understanding of probability theory.

**STAT 480 CRN 27124 RESEARCH METHODS** 15 PTS 3/3

**Prerequisites:** Enrolment in the MAAppStat

**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 2020.

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

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.

STAT 483  CRN 28351  SPECIAL TOPIC: DATA MANAGEMENT, PROGRAMMING AND APPLICATIONS  15 PTS  2/3

Prerequisite: Permission of Course Coordinator
Coordinator: TBC

This course introduces practical aspects of data management for statisticians, mathematicians, and data scientists. Students will learn the principles of programming in a high level language and in SQL in order to read, write, manipulate, transform, combine, summarise, display and otherwise manage data sets of all sizes. Students will apply programming and data management techniques in data rich settings, such as simulation and queuing. Students will demonstrate their knowledge by completing a software project.
### Mathematics and Statistics

<table>
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<th>CRN</th>
<th>Project</th>
<th>Points</th>
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<td>28438</td>
<td>PROJECT</td>
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<td></td>
<td>28377</td>
<td>PROJECT</td>
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<td>STAT 488</td>
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<td>STAT 489</td>
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<td>28382</td>
<td>PROJECT</td>
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<td>3+1</td>
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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.
The Direct 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.

<table>
<thead>
<tr>
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<tr>
<td><strong>Trimester 1</strong></td>
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<tr>
<td>BIOL 420</td>
<td>Conservation Ecology (30 points)</td>
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<tr>
<td>BIOL 426</td>
<td>Behavioural Ecology (30 points)</td>
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<tr>
<td>COMP 421</td>
<td>Machine Learning</td>
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<td>ECON 408</td>
<td>Advanced Econometrics A</td>
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<tr>
<td>FINA 401</td>
<td>Current Topics in Asset Pricing</td>
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<tr>
<td>FINA 413</td>
<td>Risk Management and Insurance</td>
</tr>
<tr>
<td>PHYG 414</td>
<td>Climate Change: Lessons from the Past</td>
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<tr>
<td>PSYC 434</td>
<td>Conducting Research across Cultures</td>
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<tr>
<td>PUBL 401</td>
<td>Craft and Method in Policy Analysis</td>
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<td><strong>Trimester 2</strong></td>
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<tr>
<td>COMP 422</td>
<td>Data Mining, Neural Networks and Genetic Programming</td>
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<td>ECON 409</td>
<td>Advanced Econometrics B</td>
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<td>FINA 402</td>
<td>Current Topics in Corporate Finance</td>
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<td>FINA 406</td>
<td>Fixed Income Securities</td>
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<tr>
<td>GEOG 415</td>
<td>Introduction to Geographic Information Science and its Applications</td>
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<tr>
<td>GPHS 425</td>
<td>Numerical Weather Prediction</td>
</tr>
<tr>
<td>GPHS 446</td>
<td>Advanced Seismology</td>
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</table>
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–4.00pm Monday, Wednesday, Thursday, Friday
9.30am–4.00pm 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.

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