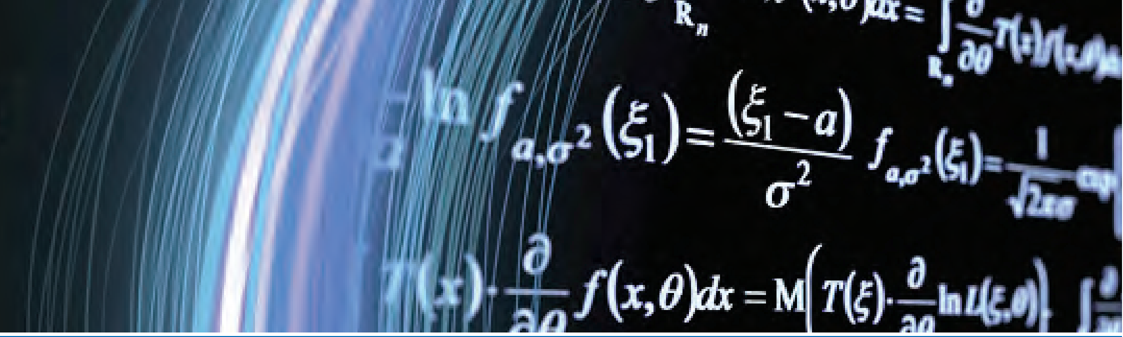
LA TROBE UNIVERSITY



SCIENCE, TECHNOLOGY AND ENGINEERING

MATHEMATICS AND STATISTICS STUDENT HANDBOOK 2010 BUNDOORA CAMPUS

A guide for students studying units in mathematics and statistics

► latrobe.edu.au/mathstats

Table of Contents

Benefits of studying mathematics and statistics

- Maths+Stats is an enjoyable area of study that will provide you with interesting and rewarding career path opportunities.
- There is a serious shortage of maths+stats graduates in Australia. For more information on careers in maths+stats, go to www.mathscareers.org.au and www.statsci.org/jobs/index.html
- La Trobe's Department of Mathematics and Statistics has the strongest teaching credentials of any maths/stats department in Australia.
- La Trobe maths+stats graduates are extremely satisfied with their experiences; our Course Experience Questionnaire (CEQ) scores have been consistently outstanding. As well, several of our staff members have received prestigious awards for excellence in teaching, including two national awards.
- La Trobe and ANU are the only universities in Australia with a Statistics Program that is accredited by the Statistical Society of Australia Inc.
- La Trobe is a full member of the Australian Mathematical Sciences Institute (AMSI), and through this and other activities, La Trobe plays an important role on the national stage.
- La Trobe works closely with the Mathematical Association of Victoria (the MAV); La Trobe annually hosts both the MAV Maths Talent Quest and the MAV annual conference.
- La Trobe's research output in maths+stats is at a top international level, outperforming bigger departments such as Monash and RMIT.
- The Department offers a wide variety of units that may be used to complement other areas of study.

National Shortage of Statisticians

There is a continuing shortfall of graduates from professional statistics programs. Professional statistics graduates are employed as consultants in a wide range of activities including medicine, epidemiology, health sciences, psychological science, bioinformatics, biostatistics, econometrics, market research, business forecasting, finance, insurance, engineering, environmental science, biological science and agriculture.

The Chief Statistician, Dennis Trewin (who heads the Australian Bureau of Statistics) stated in his submission to the *Review of the State of Statistics in Australian Universities* (held in February 2005) that

“At present ABS is experiencing difficulty in obtaining an adequate supply of statistics graduates who fulfil our requirements. ... From discussions with other large employers of these graduates, it is clear that they are also suffering similar difficulties in attracting graduates and are concerned that universities are not providing enough graduates with sufficient skills in mathematical statistics”.

As noted in the December 2006 report of the *National Strategic Review of Mathematical Sciences Research in Australia*, there is a serious, chronic shortage of professional statisticians in Australia.

Teaching staff

For a complete list of contacts, please visit the Department of Mathematics and Statistics website www.latrobe.edu.au/mathstats

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Administrative Contacts

Head of Department

Prof Robert Staudte: Room 228, PS2 Building

Advisors of Studies

Mr Kevin Bicknell: Room 219, PS2 Building

Dr Ajay Chandra: Room 226, PS2 Building

Dr Andriy Olenko: Room 224, PS2 Building

Dr Narwin Perkal: Room 323, PS2 Building

Year Level Co-ordinators

Second year – Dr Andriy Olenko: Room 224, PS2 Building

Third year – Dr Marcel Jackson: Room 317, PS2 Building

Fourth year – Dr Paul Kabaila: Room 225, PS2 Building

Postgraduate – Dr John Banks: Room 327, PS2 Building

Mathematics Statistics Department Office

Room 209 – Level 2, Physical Sciences 2 Building

Opening Hours: 10:00 am to 11:00 am Monday to Friday,
2:00 pm to 3:00 pm Monday, Tuesday, Thursday, Friday

Computing Officer

Dr Darren Condon

Course Advisors

Bachelor of Science / Bachelor of Science Education

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Bachelor of Science

For further information contact: Dr John Banks
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Bachelor of Science with a specialisation in Statistics

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T: 03 9479 2610
E: L.Prendergast@latrobe.edu.au

Bachelor of Finance/Bachelor of Science

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T: 03 9479 2609
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Maths and Stats careers web sites

www.austms.org.au/jobs

www.statsci.org/jobs

www.careerone.com.au

www.graduatecareers.com.au

www.mycareer.com.au

Prizes and scholarships

FIRST YEAR PRIZES

First Year Scholarship in Mathematics and Statistics

Value – $1000
Description – Awarded to a first year student with high overall performance in VCE studies (or equivalent) who has a demonstrated interest and intention to pursue major studies in mathematics or statistics.

The Texas Instruments Prize

Value – Advanced Texas Instruments programmable calculator
Donor – Texas Instruments
Description – The prize of an advanced Texas Instruments programmable calculator is awarded to the student having achieved the highest combined mark in MAT1CNS/MAT1CFE and MAT1CLA, and who enrols in 45 credit points of second year mathematics units (or 30 credit points for part-time students or students in a double degree) in the year immediately following.

The Department Prize in Mathematics and Statistics

Value – $100
Description – Awarded to the top first year student based on their performance in MAT1CNS/MAT1CFE and MAT1CLA, and at least one of MAT1DM, STA1SS and STA1LS.

First Year Prize in Statistics

Value – $150 book voucher
Description – Awarded to the most outstanding student in first year statistical science units.

SECOND YEAR PRIZES

Arthur Jones Essay Prize

Value – $250
Description – This prize is to be awarded annually to a student enrolled in at least one second year or third year mathematics unit, for a mathematical essay on a topic not covered in undergraduate units offered by the Department. The prize is in honour of Dr Arthur Jones, who inspired staff and students by his dedication to student learning.

Professor CJ Eliezer Prize in Mathematics

Value – $200
Donor – CJ Eliezer Prize Fund
Description – Awarded to the top second year mathematics student enrolled in at least 45 credit points of second year mathematics units.

Second Year Prize in Statistics

Value – $150 book voucher
Description – Awarded to the most outstanding student in second year statistical science units.

THIRD YEAR PRIZES

Arthur Jones Essay Prize

Value – $250
Description – This prize is to be awarded annually to a student enrolled in at least one second year or third year mathematics unit, for a mathematical essay on a topic not covered in undergraduate units offered by the Department. The prize is in honour of Dr Arthur Jones, who inspired staff and students by his dedication to student learning.

The National Bank of Australia Prize

Value – $500
Donor – National Bank of Australia
Description – Awarded annually to the student in either at least 60 credit points of third year mathematics and statistics units in the double degree - Bachelor of Finance/Bachelor of Science, or enrolled in at least 60 credit points of third year mathematics units in the any other degree, who has achieved the highest combined mark in third year mathematics units.

Third Year Prize in Statistics

Value – $150 book voucher
Description – Awarded to the most outstanding student in third year statistical science units.

EJ Hannan Prize for 3rd Year Component of the Accredited Major in Statistics

Value – $250
Description – Awarded annually to the student or students who have completed both a Major in Mathematics and the Accredited Major in Statistics, with the best mark averaged over third year subjects comprising the Accredited Major in Statistics. The prize honours the memory of Professor EJ Hannan, an eminent Australian statistician.

FOURTH YEAR PRIZES

Professor CJ Eliezer Prize in Mathematics

Value – $300
Donor – C.J. Eliezer Prize Fund
Description – Awarded to the top fourth year mathematics student in any degree.

Fourth Year Prize in Statistics

Value – $150 book voucher
Description – Awarded to the most outstanding student in fourth year statistical science units.

What units should you enrol in?

There is a variety of different degree programs, and within them there is a number of options for studying mathematics and statistics.

The department's advice is that the Bachelor of Science (BSc) is an excellent degree in which to pursue your studies. Why?

- The BSc is a classic degree that is well respected in the community and the work place.
- The BSc is a flexible degree that will enable you to combine maths+stats with your other areas of interest.

Regardless of which degree you are enrolled in, we hope you will consider taking a major in mathematics or statistics, or preferably a double major mathematics/statistics or mathematics/ mathematics. A major in an area of study is obtained by taking 60 credit points at third year level in that area. You can do a major in *mathematic*s, in *statistics*, or in *mathematics and statistics*. So for example, if you do 30 credit points in mathematics at third year level, and 30 credit points in statistics at third year level, you will have a major in *mathematics and statistics.* If you do 60 credit points in mathematics at third year level, and 60 credit points in statistics at third year level, you will have a major in *mathematics* and a major in *statistics.* If you do 75 credit points in mathematics at third year level, and 45 credit points in statistics at third year level, you will have a double major in *mathematics and statistics.*

There is a number of streams that you might wish to study: applied mathematics, pure mathematics, statistics, applied statistics. Whatever you do, make sure you keep your options open for the future. For example, to be a teacher you should aim for majors in two areas of study. Also, your job prospects will be expanded by the more maths and stats that you take. In particular, the demand for professional statisticians far exceeds supply, so keep an eye on the rules for the:

Accredited Professional Statistics Program

La Trobe University and ANU are currently the only universities in Australia to have their Statistics Program accredited by the Statistical Society of Australia.

This accredited program is the major in statistics consisting of the units STA2AS (or STA2BS or STA2MS) and STA2MD in second year and STA3BS, STA3SI, STA3LM and STA3AS in third year. This major entitles the holder to Graduate Statistician status upon joining Statistical Society of Australia. Students interested in taking the major in statistics should see a Statistics Advisor of Studies each year about their choice of units. Students wanting to take this major need to take one of the first year statistics units, with STA1SS recommended. It is also recommended that these students take the mathematics units MAT1CNS, MAT1CLA and MAT2LAL.

Minor in Statistics

Students in the experimental and related areas, for example, biology, nutrition, medical sciences, health sciences, agricultural sciences, and animal sciences are advised to choose the following units:

- First Year – STA1LS or STA2LS
- Second Year – One or more of STA2MS, STA2LM, STA2BS, STA2MAS

Students majoring in Psychology are advised to choose the following:

- First Year – STA1PSY
- Second Year – One or more of STA2MS, STA2LM, STA2BS, STA2MAS

These students are also encouraged to take a minor in statistics consisting of a total of 70 credit points in Statistical Science, with a minimum of 30 credit points at third-year level.

Choosing Maths Units

Mathematics is currently experiencing a remarkable period of growth. Problems that have been open for hundreds of years have been solved in the last decade or two, and there is optimism that some of the remaining great unsolved problems of mathematics may also soon be solved. Advances in computing capabilities have also made mathematics an increasingly powerful tool with many new applications. In addition to their traditional employment avenues, mathematics graduates are now finding new positions in areas such as computing, banking, medical sciences, etc.

If you want to study mathematics at second and third year we strongly advise that you take MAT1CNS , MAT1CLA and MAT1DM. CNS and CLA are partner units and CLA treats linear algebra and differential equations, topics fundamental to many fields in science, engineering and commerce and finance.

The second year units all grow out of topics introduced in Mathematics 1CNS/1CLA or the first year DM courses (note that 1CNS and/or 1CLA are prerequisites for most of the options). Our approach to teaching second year is also very similar to that used in Mathematics 1CNS/1CLA and 1DM: units texts are generally available and there are twice weekly tutorials where students learn to solve problems under the guidance of experienced supervisors. There are also fortnightly assignments.

The various mathematics units offered in second year are natural partners for units in statistics, computer science and physics. Students who like mathematics or who wish to major in it are strongly encouraged to take all the second year mathematics units. Without a broad base at second year level, your future choices of mathematics units will be restricted.

Our third year offerings build upon your experience at first and second year and cover a very wide range of modern mathematics and its applications. You will be able to choose units according to your interest and ability. While there are no tutorials at third year, most of the units do involve practice classes, usually once a week.

A significant number of our graduates go on to Honours study in Mathematics and we strongly recommend that prospective Honours students in Mathematics take as many mathematics units at third year as possible. However, combinations at third year such as Maths and Physics, Maths and Statistics and Maths and Computer Science can also be good preparations for Honours in Mathematics. You should read the honours section of this handbook before choosing your third year units.

First Year Units

This unit information is correct at time of printing. The subject guides in LMS and the Unit Database provide the most recent, updated information.

PRINCIPAL FIRST YEAR UNITS

Semester 1

MAT1CNS
Calculus and Number Systems

MAT1DM
Discrete Mathematics

STA1SS
Statistical Science

Semester 2

MAT1CLA
Calculus and Linear Algebra

FURTHER FIRST YEAR UNITS

Semester 1

MAT1CFE
Calculus and Functions for Economics

MAT1CPE
Calculus and Probability for Engineers

STA1LS
Statistics for the Life Sciences

Semester 2

MAT1MAB
Mathematical Applications in Biology

STA1LS
Statistics for the Life Sciences

STA1PSY
Statistics for Psychology

MAT1CFE
Calculus and Functions for Economics

Credit Points: 15
Semester: 1
Coordinator: Dr Yuri Nikolayevsky

Unit Description

MAT1CFE covers a range of mathematical tools that are useful in economics and science. The techniques of calculus are crucial and half of the unit is devoted to differentiation and integration. The other half of the unit is further divided. The first seven weeks include topics on sets, functions, sequences, series, and complex numbers. The last six weeks are devoted to topics from economics.

Learning Outcomes

At the successful completion of this unit students should be able to:

- combine differentiation techniques and algebra to check solutions of differential equations,
- understand the relationship between integration and signed area,
- use more-advanced techniques to calculate integrals,
- apply calculus techniques to sketch graphs,
- use set notation,
- calculate limits of sequences and sums of infinite series,
- work with complex numbers,
- calculate economic quantities in a variety of contexts,
- find maxima and minima of constrained and unconstrained functions of several variables.

Enrolment Information

Recommended Prior Studies: VCE Mathematical Methods 3 and 4 or Specialist Mathematics.
Incompatibles: MAT11CFN, MAT1CFN, MAT11EN, MAT1EN, ECO11IQA, ECO12IQA, MAT1CNS, MAT1CPE.

Assessment Type	%
Assignments	10
Diagnostic tests	10
Exam (3 hour)	80

MAT1CLA
Calculus and Linear Algebra

Credit Points: 15
Semester: 2
Coordinator: Dr Narwin Perkal

Unit Aim

For students to develop knowledge and skills crucial to the mathematical description of the real world in terms of differential equations and systems of linear equations, while further enhancing their skills in reasoning and presentation of logical arguments.

This unit consists of two streams of topics and techniques — Calculus and Linear Algebra — taught in parallel. Common to both streams is an emphasis on understanding mathematical concepts and results so that they can be applied and so that it can be seen how one result follows from another. The development of reasoning skills and the clear presentation of arguments will stand you in good stead not only in all your studies, but also in later employment.

Unit-Specific Skills

As this unit progresses you should become able to:

- Identify and apply appropriate techniques to solve first and second order ordinary differential equations.
- Understand the necessity for approximation of functions and numerical solution of differential equations, using techniques of calculus.
- Describe objects in three-dimensional space and calculate their properties using vector techniques.
- Solve systems of linear equations systematically, and interpret the solutions geometrically.
- Present your thinking clearly, using both words and mathematical notation meaningfully and succinctly.

Enrolment Information

Prerequisites: MAT1CFN or MAT1CFE or MAT1CNS or MAT1CPE or MAT1EN.
Incompatibles: MAT1FEN, MAT12CLA, MAT12FEN, CSE1LAP

Assessment Type	%
Assignments	10
Diagnostic tests	10
Exam	80

MAT1CNS
Calculus and Number Systems
Credit Points: 15
Semester: 1
Coordinator: Dr Narwin Perkal

Unit Description

MAT1CNS covers a range of mathematical tools that are useful in the physical, biological, information and social sciences. The techniques of calculus are crucial and half of the unit is devoted to differentiation and integration. The other half of the unit is further divided. The first seven weeks include topics on sets, functions, sequences, series, and complex numbers. The last six weeks are devoted to elementary logic and proofs.

Learning Outcomes

At the successful completion of this unit students should be able to:

- combine differentiation techniques and algebra to check solutions of differential equations,
- understand the relationship between integration and signed area,
- use more-advanced techniques to calculate integrals,
- apply calculus techniques to sketch graphs,
- use set notation,
- calculate limits of sequences and sums of infinite series,
- work with complex numbers.
- understand elementary logic,
- understand the proofs of some famous theorems,
- write simple proofs including a careful proof by mathematical induction.

Enrolment Information

Recommended Prior Studies: VCE Mathematical Methods 3 and 4 or Specialist Mathematics.
Incompatibles: MAT1CFE, MAT1EN, ECO1IQA, MAT1CFN, MAT1CPE.

Assessment Type	%
Assignments	10
Diagnostic tests	10
Exam (3 hour)	80

MAT1CPE
Calculus and Probability for Engineers
Credit Points: 15
Semester: 1
Coordinator: Dr Marcel Jackson

Unit Description

MAT1CPE covers a range of mathematical tools that are essential in engineering. The techniques of calculus are crucial and half of the unit is devoted to differentiation and integration. The other half of the unit is further divided. The first seven weeks are include topics on sets, functions, sequences, series, and complex numbers. The last six weeks are devoted to topics in probability.

Learning Outcomes

At the successful completion of this unit students should be able to:

- combine differentiation techniques and algebra to check solutions of differential equations,
- understand the relationship between integration and signed area,
- use more-advanced techniques to calculate integrals,
- apply calculus techniques to sketch graphs,
- use set notation,
- calculate limits of sequences and sums of infinite series,
- work with complex numbers,
- meaningfully calculate basic probabilities,
- recognise and use basic probability distributions.

Enrolment Information

Recommended Prior Studies: VCE Mathematical Methods 3 and 4 or Specialist Mathematics.
Incompatibles: MAT1CNS, ECO1IQA, MAT1CFE, MAT1EN, MAT1CFN.

Assessment Type	%
Assignments	10
Diagnostic tests	10
Exam (3 hour)	80

MAT1DM
Discrete Mathematics
Credit Points: 15
Semester: 1
Coordinator: Kevin Bicknell

Unit Description

MAT1DM presents mathematical tools that are essential in engineering and information sciences. The unit has two parallel themes: the first covers topics such as arithmetic in different number bases, recurrence relations growth of functions and sorting algorithms; the second covers combinatorics, Boolean algebra, graph theory and finite state automata.

Learning Outcomes

At the successful completion of this units students should be able to:

- perform arithmetic in different number bases;
- solve basic recurrence relations;
- analyse algorithms and their complexity;
- perform algorithms for sorting lists;
- have a familiarity with basic combinatorics;
- use Karnaugh maps to simplify Boolean expressions and logic circuits;
- apply graph algorithms in selected applications.

Enrolment Information

Recommended Prior Studies: VCE Mathematical Methods 3 and 4 or VCE Specialist Mathematics. MAT1CNS is highly recommended as a co-requisite.
Incompatibles: CSE21DMO, MAT12DM, MAT11DM.

Assessment Type	%
Assignments	10
In-class Quizzes	10
Exam (3 hour)	80

MAT1MAB
Mathematical Applications in Biology
Credit Points: 15
Semester: 2
Coordinator: Dr John Banks

Unit Description

In this unit students are introduced to how mathematical models are used in biological, biophysical and health sciences and insight into how they may be derived from biophysical assumptions. A small but representative range of biophysical applications is investigated. The unit is organised in modules, each focusing on a specific application. Typical applications include population dynamics, vaccination and epidemics, water catchment models, greenhouse models, growth and form in organisms and flocking behaviour in animal populations.

The unit is delivered mainly online. Learning resources including all lecture materials will be available online. Students meet one hour per week for a problem solving class to work through problem sets designed to strengthen basic mathematical skills. Considerable use is made of spreadsheets as a tool for understanding mathematical models and performing calculations. Assessment involves a mixture of paper based work and electronically submitted work.

Assessment Type	**%**
Weekly online quizzes	20
Class quizzes	10
Electronic assignments	20
Written assignments	20
Exam (1.5 hour)	30

STA1LS / STA2LS
Statistics for Life Sciences
Credit Points: 15-STA1LS / 20-STA2LS
Semester: 1 and 2
Coordinators: Dr Ajay Chandra / Dr Siew Pang Chan

Unit Description

In this unit students will be introduced to the basic statistical methods that would be very useful essentially for students in biological sciences, medical sciences, agricultural sciences, nutrition, and health sciences. For example, this unit provides a platform for students in analysing data from experiments and report writing. It is specifically designed for students who do not have a strong background in mathematics, and further, it does not assume any previous training in statistics or probability. Unit topics include descriptive statistics, estimation, hypothesis test for proportions and means, analysis of variance, regression analysis, and chi-square tests. The use of statistical software (Minitab) is an integral part of this unit.

Learning Outcomes

On successful completion of this unit, the student should be able to:

- understand descriptive statistics, parameter estimation and hypothesis testing concepts
- working knowledge of basic statistical methods
- identify and apply appropriate statistical tests for one and two sample designs
- competently use statistical software package MINITAB

Enrolment Information

Recommended Prior Studies: None.
Students have 5 contact hours; 3 lectures, 1 problem class and 1 computer lab class. In addition to this, STA2LS enrolled students must also attend a project class.
Incompatibles: STA11LS, STA12LS, STA21LS, STA22LS, STA2LS, STA1SS, STA2SS, ECO10BES, ECO11BES, ECO12BES, ECO1BES, ECO11ISB, ECO12ISB, ECO1ISB.

Assessment	**STA1LS**	**STA2LS**
Assignments	10%	10%
Minitab tests	30%	20%
Projects	N/A	20%
Final Exam	60%	50%

STA1PSY
Statistics for Psychology
Credit Points: 15
Semester: 2
Coordinator: Mitra Jazayeri

Unit Description

The material covered in this unit aims to help students understand statistical concepts through the introduction of basic statistical procedures. This unit will also help students read and understand statistical terms and components in scientific research papers. The material covered aims to develop each student's analytic and critical thinking.

Psychology students should note that this unit is a pre-requisite for STA2PYA and STA2PYB.

Learning Outcomes

On successful completion of this unit, students should be able to accomplish the following items:

1. Understand and carry out descriptive statistics such as mean; measure of central tendency, variance and standard deviation; measure of variability of a distribution of scores.
2. Understand patterns of correlation, issues in interpreting the correlation coefficient, and have an understanding of correlation and prediction in research articles.
3. Understand the concept of Normal curve and be able to convert raw scores to Z scores and vice versa as well as be able to obtain probabilities for standardized data.
4. Be able to enter data in SPSS and carry out descriptive and inferential statistical analysis using SPSS.
5. In the context of inferential statistics, carry out hypothesis testing and calculate confidence intervals.
6. Making sense of statistical significance by introducing effect size and statistical power.
7. Carry out single sample t-test, and test for dependent means.
8. Carry out two independent sample t-tests. Be able to distinguish between two dependent means test and two independent means tests.
9. Know when and how to conduct an analysis of variance. Be able to use F distribution and use an F table. Be able to interpret the results of analyses of variance as reported in research articles.

10. Carry out Chi-Square tests and strategies when population distributions are not normal.

Enrolment Information

Corequisites: For students in the Faculty of Science, Technology and Engineering, this subject is normally a co-requisite for PSY1PYB.
Incompatibles: STA12OCT, STA1OCT.

Assessment	**%**
Two Computer Lab Tests	30
Assignments	15
Exam	55

STA1SS / STA2SS
Statistical Science
Credit Points: 15-STA1SS / 20-STA2SS
Semester: 1
Coordinator: Dr Ajay Chandra

Unit Description

Students who complete either STA1SS or STA2SS qualify for all second year statistics units. Objectives include providing a working knowledge of exploratory data analysis, parameter estimates and hypothesis tests, as well as a working knowledge of the statistical computer software, Minitab. Simulation studies and real data are used to gain familiarity with random sampling and probability models. Statistical methods to be learned include inference for a binomial parameter, difference of two proportions, population means, measure of association, fitting a straight line by the method of least squares, test of homogeneity for independent classification in a two by two contingency table.

Note that STA2SS is the same as STA1SS, with an additional one-hour project class per week in which students are guided in writing reports on practical problems.

Learning Outcomes

By the end of this unit students should be able to:

- organise and summarise data graphically and numerically
- analyse data using appropriate statistical tools
- draw conclusions from the results of data analysis

Enrolment Information

Pre-requisites: Year-12 mathematics or STA1LS or STA2LS
Incompatibles for STA1SS: ECO11BES, ECO12BES, ECO1BES, ECO11ISB, ECO12ISB, ECO1ISB, ECO11BSW, ECO12BSW, STA21SS, STA2SS, STA1LS, STA2LS.
Incompatibles for STA2SS: STA11SS, STA1SS, STA1LS, STA21LS, STA22LS, STA2LS, STA21PR, STA22PR, STA2PR, ECO11ISB, ECO12ISB, ECO1ISB, ECO11BES, ECO12BES, ECO1BES.

Assessment	**STA1SS**	**STA2SS**
Assignments	20%	15%
Minitab Test	20%	20%
Exam	60%	45%
Project	N/A	20%

Second Year Units

This unit information is correct at time of printing. The subject guides in LMS and the Unit Database provide the most recent, updated information.

PRINCIPAL SECOND YEAR UNITS

Semester 1

MAT2ANA
Analysis

MAT2VCA
Vector Calculus

STA2AS
Modern Applied Statistics

Semester 2

MAT2AAL
Applied Algebra

MAT2LAL
Linear Algebra

MAT2MEC
Mechanics

STA2MD
Models for Data Analysis

FURTHER SECOND YEAR UNITS

Semester 1

STA2AS
Modern Applied Statistics

STA2BS
Biostatistics

STA2LS
Statistics for Life Sciences

STA2PR
Statistics Projects

STA2MS
Medical Statistics Projects

STA2RSP
R Statistical Programming

STA2SS
Statistical Science

Semester 2

MAT2MFC
Mathematics for Computer Science

STA2LS
Statistics for Life Sciences

STA2PR
Statistics Projects

STA2RSP
R Statistical Programming

MAT2AAL

Applied Algebra
Credit Points: 15
Semester: 2
Coordinator: Prof Brian Davey

Unit Description

The study of algebraic structures, such as groups, fields and vector spaces underpins a large amount of modern computer science. Group theory, the principal mathematical tool for analysing symmetry, is genuinely 20th century mathematics and has widespread applications in all areas of science. Field theory and linear algebra have important applications to coding theory, which is used to preserve the security of computer networks. The unit is taught in two parallel streams: one begins with some number theory then develops the basics of group theory, while the other begins with an introduction to error-correcting codes and ends with the axiomatic treatment of vector spaces. The material is presented with an emphasis on an understanding of the structures, and their applications.

Learning Outcomes

On successful completion of this unit, the student should have:

- A testable understanding of modular arithmetic including the Euclidian Algorithm.
- A testable understanding of basic group theory including Lagrange's Theorem and the Stabilizer-Orbit Theorem.
- A testable understanding of the basics of vector spaces over arbitrary fields.
- A testable understanding of the basics of error-correcting codes.

Enrolment Information

Prerequisites: MAT1CLA or MAT1CB
Incompatibles: MAT2PDM

Assessment Type	%
Assignments	15
Exam (3 hour)	85

MAT2ANA

Analysis
Credit Points: 15
Semester: 1
Coordinator: Dr Yury Nikolayevsky

Unit Description

This unit studies limits of sequences and limits of functions in a more rigorous way than was done in first year. Initially we study them in one dimensional space and then in higher dimensions. We also study series and various tests are derived to determine the convergence or otherwise of these series. We then extend the basic idea of limit to include sequences of functions and sequences of sets. A powerful theorem called the Contraction Mapping Theorem will be derived. This theorem plays a fundamental role in analysis and its applications. We will use it to establish the existence and uniqueness of solutions to certain differential equations. Finally we use it together with the Hausdorff metric to study iterated function systems which are used in computer graphics.

The mode of teaching is two lectures and two tutorials per week. Each tutorial is based on the lecture that it proceeds from.

Learning Objectives

On successful completion of this unit, the student should be able to:

- Find limits of certain sequences and prove their results.
- Prove the convergence or otherwise of certain series.
- Find limits of certain functions and prove your results.
- Gain an understanding and an ability to manipulate bounds and least upper bounds.
- Obtain an understanding of function and metric spaces.
- Gain insight to the contraction map theorem and be able to use it in various situations.

Enrolment Information

Prerequisites: MAT1CLA or MAT1CB
Incompatibles: MAT2PAA

Assessment Type	%
Assignments	15
Exam (3 hours)	85

MAT2LAL
Linear Algebra
Credit Points: 15
Semester: 2
Coordinator: Dr Peter Van Der Kamp

Unit Description

This unit extends ideas from the geometry of 3-dimensional space to non-geometrical contexts, such as decomposing a signal into periodic components. Key ideas are linear dependence and independence, spanning sets and the properties of linear maps. The 26 tutorials within the unit play a key role in helping you learn the unit content and develop generic skills.

Learning Outcomes

At the completion of this unit students should be able to

- find a spanning set for a given subspace, decide if a given vector belongs to a span, decide if a given set is linearly independent and find coordinates of a vector relative to a given basis.
- construct an orthonormal set from a spanning set and should be able to apply the theory of orthonormal bases to calculate Fourier series.
- analyse linear maps using matrix representations, including the calculation of eigenvalues and eigenspaces and the associated representations by diagonal matrices.
- apply the analysis of linear maps to the solutions of systems of linear differential equations, the description of quadratic forms and to finding least squares solutions to systems of linear equations.

Enrolment Information

Prerequisites: MAT1CLA or MAT1FEN
Incompatibles: MAT21LA, MAT21ELA, MAT2LA, MAT2ELA

Assessment Type	**%**
Assignments	15
Exam (3 hour)	85

MAT2MEC
Mechanics
Credit Points: 15
Semester: 2
Coordinator: Dr Jeffrey Brooks

Unit Description

This subject aims to synthesise the study of vectors and solutions of differential equations from first year with the subject matter of MAT2VCA MAT2LAL and investigate mechanics of particles, rigid bodies and continuous systems.

Mathematical highlights of the subject include Newton’s three laws, projectile and simple harmonic motion, effects of different types of resistance on motion, orbits of planets, solution of differential equations with varying coefficients and an introduction to Hamiltonian descriptions of mechanics.

No undergraduate physics is required in this subject.

Learning Outcomes

On successful completion of this unit, the student should have:

- A testable understanding of the use of Newton’s laws in describing simple motions of particles and rigid bodies.
- A testable ability to solve differential equations arising in mechanics of particles and rigid bodies.
- A testable understanding of the nature and properties of the orbits of satellites and planets.
- A testable understanding of simple models of the mechanics of continuous systems and solution of differential equations with varying coefficients. Cosmology.
- A testable basic understanding of the nature of Hamiltonian mechanics.

Enrolment Information

Prerequisites: MAT1CLA or MAT1FEN
Incompatibles: MAT21LA, MAT21ELA, MAT2LA, MAT2ELA

Assessment Type	**%**
Assignments	15
Exam (3 hour)	85

MAT2MFC
Mathematics for Computer Science
Credit Points: 15
Semester: 2
Coordinator: Kevin Bickell

Unit Description

This unit develops some of the ideas from first year discrete mathematics, building especially on finite state machines and their languages and provides a new perspective on recurrence relations. The unit treats theoretical foundations and numerical aspects of topics including relational algebra, finite state machines, regular and context free languages, Turing machines and computability. Also covered are the Z-transform (generating functions), random number generators, cryptography, parameterised curves and Bezier curves. These topics have applications to areas such as databases, performance analysis and computer graphics.

Learning Outcomes

On successful completion of this unit, the student should have:

- A testable understanding of some theoretical foundations of relational algebra
- A testable method for simplifying nondeterministic automata.
- A working understanding of countability and computability.
- A testable method for using some types of transformation matrices: namely rotation, reflection and translation.
- A testable understanding of modular arithmetic.

Enrolment Information

Prerequisites: MAT1DM and (MAT1CNS or MAT1CPE or MAT1CFN)
Incompatibles: MAT2MCS

Assessment Type	**%**
Tutorial assignment	5
Assignments	15
Exam (3 hour)	80

MAT2VCA
Vector Calculus
Credit Points: 15
Semester: 1
Coordinator: Dr Katherine Seaton

Unit Aim

For students to develop a solid foundation of concepts and techniques relating to functions of several variables, with a view to subsequent application.

We generalise many of the techniques you have used previously (to analyse functions of a single variable) to the several variable case, as most real-world systems depend crucially on multiple factors. The teaching approach is similar to first year, with increased maturity and independence expected of students. You will also find that, unlike some first year topics, the material will all be new (rather than a deeper treatment of material you have seen before).

Unit-Specific Learning Objectives

As this unit progresses you should become able to:

- Solve linear differential equations using the Laplace Transform technique.
- Describe and classify features of a function of several variables, analysing them using graphical and computational techniques.
- Apply the processes of calculus (differentiation and integration) meaningfully to functions of several variables in rectangular and curvilinear coordinates.
- Solve partial differential equations in appropriate coordinates using the technique of separation of variables.
- Recognise the similarities and differences between single-variable and multi-variable calculus, and ordinary and partial differential equations.
- Appreciate that the concepts and techniques of vector calculus have application to physics, electronics and further studies in applied mathematics.

Generic Skills Explicitly Taught and Assessed in this Unit

- Communication of your understanding (of vector calculus) using both words and mathematical notation in a precise and succinct manner.
- Problem solving skills.
- Critical and reflective thinking.

Enrolment Information

Prerequisites: MAT12CLA OR MAT12FEN OR MAT1CLA OR MAT1FEN
Incompatibles: MAT2AVC

Assessment Type	%
Assignments	15
Exam (3 hour)	85

STA2AS / STA2BS / STA2MS
Modern Applied Statistics / Biostatistics / Medical Statistics
Credit Points: 15-STA2AS / 20-STA2BS / 20-STA2MS
Semester: 1
Coordinator: Dr Luke Prendergast

Unit Description

This is a composite unit consisting of STA2AS (Modern Applied Statistics), STA2BS (Biostatistics) and STA2MS (Medical Statistics).

The topics covered within this course are very useful in many areas of statistics. They build on the understanding of applied statistical methods developed in first year statistics units and provide an understanding of these methods at an intermediate level. Key topics included power and sample size determination for hypothesis tests, non-parametric tests, the testing of categorical data and multiple linear regression. This course also provides an introduction to the open source statistical computing package R.

STA2BS students will be introduced to some important concepts often encountered in the biosciences. These include the spatial Poisson process, testing for Hardy-Weinberg Equilibrium and dose-response models.

STA2MS students will be introduced to important concepts that are often utilized in medical research. These concepts include block randomization to account for confounding variables and the assessment of risk through hypothesis testing of risk ratios and odds ratios.

Learning Outcomes

On successful completion of this unit, the student should have:

- Understand the importance of choosing the ‘correct’ method of analysis.
- Appreciate the importance of thinking ahead when designing and planning statistical experiments.
- Write and carry out intermediate tasks using the statistical software package R.
- Assess the effectiveness of statistical methods using simulation.

Enrolment Information

Pre-requisites for STA2AS: STA1SS or STA2LS or STA1LS or STA1PSY or STA1OCT or ECO11BES or ECO12BES or ECO1ISB.
Incompatibles for STA2S: STA2MS, STA2MAS, STA2RSP, STA2BS

Pre-requisites for STA2BS: STA1OCT or STA1PSY or STA1LS or STA2LS or STA1SS or STA2SS or ECO1ISB.
Incompatibles for STA2BS: STA2RSP, STA2AS, STA2MS.

Pre-requisites for STA2MS: STA1OCT, STA1PSY, STA1LS, STA2LS, STA1SS, STA2SS, ECO11BES, ECO12BES, ECO1ISB.
Incompatibles for STA2MS: STA21MAS, STA2MAS, STA2RSP, STA2AS, STA2BS.

Assessment Type	%
Assignments	20
Minor Lab Assignment	3
Major Lab Assignment	7
Computer Lab Test	15
Examination	55

STA2MD
Models for Data Analysis

Credit Points: 15
Semester: 2
Coordinator: Dr Andriy Olenko

Unit Description

The analysis of scientific, engineering and economic data makes extensive use of probability models. This unit describes the most basic of these models and their properties. Applications of these models are illustrated with examples from digital communication systems, expert systems, financial risk assessment and bioinformatics. Specific topics covered in this unit include a wide range of discrete and continuous univariate distributions; joint distributions; conditional expectation; mean and variance of linear combinations of random variables; Chebyshev's inequality; moment generating functions; the law of large numbers; the Central Limit Theorem; the method of moments; maximum likelihood and confidence interval construction using pivots.To help students with little or no previous knowledge in calculus one lecture per week consists of both lecture and tutorial work in “calculus for statistics”.

Learning Outcomes

On successful completion of this unit, the student should be familiar:

- with basic probability theory;
- with basic statistical theory;
- know when particular models should be applied.

Enrolment Information

Prerequisites: STA1SS or STA11SC or STA1LS or STA2LS or STA1PSY or STA1OCT or STA2SS
Incompatibles: STA2MDA

Assessment Type	%
Examination (2.5-hour)	80
Ten assignments	20

STA2PR
Statistics Projects

Credit Points: 5
Semester: 1 or 2
Coordinator: Dr Ajay Chandra

Unit Description

Students are guided through the design, collection of data, statistical analysis and report writing for two 750-word projects.

Learning Outcomes

On successful completion of this unit, students should be able to:

- collect, organise and summarise data numerically
- evaluate the accuracy and relevance of data for reporting purposes
- use appropriate statistical packages for data analysis
- draw conclusions from the results of data analysis

Enrolment Information

Prerequisites: ECO11ISB or ECO12ISB or ECO11BES or ECO12BES or STA1SS or STA1LS
Incompatibles: STA21LS, STA21SC, STA21SS, STA21PR, STA22PR, STA22LS, STA2SS, STA2LS

Assessment Type	%
Project Report 1	50
Project Report 2	50

STA2RSP
R Statistical Programming
Credit Points: 5
Semester: 1
Coordinator: Dr Luke Prendergast

Unit Description

This unit provides an introduction to the statistical computing package R. This package is open source and available free of charge. R is a very powerful computing package that includes many excellent graphical displays.

Enrolment Information

Prerequisites: STA1LS or STA1SS or STA1PSY or STA1OCT or STA2SS or STA2LS
Incompatibles: STA2AS, STA2MS, STA2BS

Assessment Type	%
Minor Assignment	15
Major Assignment	35
Computer Based Test	50

Third Year Units

This unit information is correct at time of printing. The subject guides in LMS and the Unit Database provide the most recent, updated information.

Semester 1

MAT3AC
Advanced Calculus and Cosmology

MAT3CZ
Complex Analysis

MAT3SC
Scientific Computing

MAT3TA
Topology and Analysis

STA3BS
Biostatistics

STA3SI
Statistical Inference

Semester 2

MAT3AMP
Applied Mathematics Projects

MAT3DQ
Dynamics and Quantum Mechanics

MAT3DS
Discrete Algebraic Structures

MAT3LPG
Linear Programming and Game theory

MAT3MFM
Mathematics of Fluid Mechanics

STA3AP
Applied Probability for Computer Systems Engineers

STA3AS
Applied Statistics

STA3LM
Analyses based on Linear Models

MAT3AC
Advanced Calculus and Cosmology

Credit Points: 15
Semester: 1
Coordinator: Dr Peter van der Kamp

Unit Description

This subject aims to synthesise the subject matter of MAT2VCA and MAT2LAL into the metric differential geometry of R^n and its surfaces on the one hand and the advanced calculus of R^n on the other. The mathematical highlights of the subject are three theorems: Gauss's *Theorema Egregium* which gives describes the curvature of surfaces; the implicit function theorem which tells us, for example, when a relation f(x,y,z) = 0 describes a surface, and the inverse function theorem which gives conditions under which a mapping f : $R^n \rightarrow R^n$ is locally invertible.

The advent of differential geometry has had a profound effect on physics with Einstein's General Theory of Relativity being founded on it. Toward the end of this subject we develop the cosmological metric of general relativity central to Big Bang cosmology. No undergraduate physics is required in this subject.

Learning Outcomes

On successful completion of this unit, the student should have:

- A testable understanding of the metric differential geometry of R^3 and the formal construction of curvilinear coordinate systems.
- A testable understanding of advanced differential calculus on R^n, in particular, differential forms, mappings and the inverse and implicit function theorems.
- A testable understanding of the concepts of surfaces, their geodesics and curvature.
- A semi-intuitive understanding of Einstein's gravitational theory and its role in cosmology.
- A testable understanding of the construction of the Robertson-Walker metric in cosmology.

Enrolment Information

Prerequisites: Both MAT21LA and MAT21AVC or both MAT2LAL and MAT2VCA

Assessment Type	%
Assignments	30
Exam (3 hour)	70

MAT3CZ
Complex Analysis

Credit Points: 15
Semester: 1
Coordinator: Dr Katherine Seaton

Unit Description

The unit extends calculus to the complex domain, where many beautiful new features appear. This gives a new perspective to many topics studied in first and second year. The new tools covered are also very useful in applications to a wide variety of areas, including electronics. The 13 practice classes within the unit play a key role in helping you learn the unit content and develop generic skills.

Learning Outcomes

At the completion of this unit students should

- be able to differentiate and integrate functions of a complex variable, including the evaluation of contour integrals using the Residue Theorem and the evaluation of some real integrals using contour integration.
- become aware of the distinctive features of complex functions and learn to handle the complex extensions of the familiar rational, logarithm, exponential and trigonometric functions.
- become familiar with Taylor and Laurent series for complex analytic functions and be able to classify singularities, including the connection with Laurent series.
- learn how to calculate and invert Fourier transforms and apply Fourier transforms to the solution of differential equations.

Enrolment Information

Prerequisites: MAT21AVC and MAT22APD; or MAT21PAA; or MAT2ANA; or MAT2VCA
Incompatibles: MAT31CZE, MAT3CZE

Assessment Type	%
Assignments	15
Exam (3 hour)	85

MAT3DQ
Dynamics and Quantum Mechanics
Credit Points: 15
Semester: 2
Coordinator: Dr Yury Nikolayevsky

Unit Description

The unit is in two separate but related parts. The first part covers classical mechanics using the approach pioneered by William Hamilton, which produces symmetrical systems of differential equations for which the symmetry properties provide an aid to solution and analysis. This approach to classical mechanics provides the foundation for a study of quantum mechanics, the theory of microscopic systems, which is studied in the second part of the subject.

Learning Outcomes

The first part of the subject should enable students to gain some understanding of

- using appropriate coordinate systems to describe the kinetic and potential energy of simple mechanical systems;
- deriving, and in simple cases solving, the systems of first order linear equations which result from a knowledge of the energy of a conservative system;
- describing the classical motion of a system with n degrees of freedom by trajectories in a 2n-dimensional phase space.

The second part of the subject should enable students to gain some understanding of

- the algebraic representation of states and
- observables in quantum mechanics;
- the importance of probability and uncertainty;
- the special role of eigenstates, eigenvalues and related measurement outcomes;
- the analysis of several specific quantum systems.

Enrolment Information

Prerequisites: MAT2MEC or (MAT2AM and MAT2APD)

Assessment Type	%
Assignments	15
Exam (3 hour)	85

MAT3DS
Discrete Algebraic Structures
Credit Points: 15
Semester: 2
Coordinator: Dr Marcel Jackson

Unit Description

This unit is a continuation and expansion of MAT2PDM. Approximately two thirds of the unit will be devoted to ordered sets, lattices and Boolean algebras. Applications of lattices to concept analysis and applications of ordered sets to computer science will be discussed. Further applications of finite groups to counting problems will be given. Normal subgroups will be discussed. If time permits, finite fields and their applications will be discussed and the applications of ring theory to the classification of cyclic codes will be presented.

An important secondary aspect of the unit involves the development of problem solving skills and ability to write proofs and explain arguments convincingly to other students.

Learning Outcomes

At the end of the unit, the student should be able to:

- analyse simple examples of ordered sets, lattices, groups and rings;
- apply lattices to concept analysis;
- use the duality between distributive lattices and ordered sets;
- use group theoretic techniques to solve counting problems;
- write clear and precise proofs and explain the orally to other students.

Enrolment Information

Prerequisites: MAT2PDM or MAT2AAL

Assessment Type	%
Assignments	40
Hurdle requirements: Attendance of at least 80% of all classes and present solutions to problems at the board. All assignments to be resubmitted until correct.	
Exam (2 hour)	60

MAT3LPG
Linear Programming and Game Theory
Credit Points: 15
Semester: 2
Coordinator: Dr Grant Cairns

Unit Description

Linear Programming and Game Theory are relatively new branches of mathematics. Linear Programming involves maximising and minimising a linear function subject to inequality and equality constraints. Such problems have many economic and industrial applications. Game Theory deals with decision making in a competitive environment. This unit studies the simplex technique for solving linear programming problems and gives an introduction to game theory and its applications.

Learning Outcomes

At the successful completion of these units all students should be able to:

- Solve linear programming problems graphically
- Employ the simplex method
- Use artificial variables, employing the 2 phase and big M methods
- Understand duality in linear programming and move freely between a problem and its dual.
- Undertake sensitivity analysis on linear programming problems
- Compute the nim value of combinatorial games and determine which player has the winning strategy
- Understand the minimax theorem
- Solve 2 player zero sum games
- Understand the concept of Nash equilibria points

Enrolment Information

Prerequisites: MAT21LA or MAT21ELA or MAT2LAL
Incompatibles: MAT3ALP

Assessment Type	%
Examination	70
Assignments	30

MAT3MFM
Mathematical Fluid Mechanics
Credit Points: 15
Semester: 2
Coordinator: TBA

Unit Description

This unit gives an introduction to the theory of the motion of compressible fluids. It covers the basic equations of fluid flow some exact solutions, approximations via potential theory, surface motion of fluids, linearised fluid mechanics and a brief introduction to boundary layer theory and turbulence.

The unit is delivered entirely online and serves as an introduction to online ways of learning mathematics. There are no lectures or tutorials, but the learning material is divided into modules linked to a calendar indicating when various modules should be studied.

Learning Outcomes

On successful completion of this unit, the student should have:

- An understanding of the bases of the equation of continuity and the Navier Stokes' equation.
- A testable understanding of exactly solvable problems in fluid mechanics.
- A testable understanding of approximate methods to study fluid mechanics in bulk fluids and at surfaces.
- A testable understanding of techniques to solve problems in linearised fluid mechanics.

Enrolment Information

Prerequisites: Both MAT21AVC or MAT2AVC and MAT3CZ or MAT3CZE

Assessment

There is a 3 hour examination worth 70% and two assignments worth 15% each.

Assessment Type	%
Assignments	30
Exam (3 hour)	70

MAT3SC
Scientific Computing
Credit Points: 15
Semester: 1
Coordinator: Dr Chris Ormerod

Unit Description

This unit covers theory and practice of basic numerical computation. It covers solution of equations, interpolating data, evaluation of integrals and solving initial value problems associated with ordinary differential equations. There is a pronounced emphasis on error, both algorithmic error and round-off error, and the way minimising the two types of error works in competing ways. The methods introduced are analysed against this background of error considerations.

The unit has two lectures per week and one two hour lab class per week. Programming exercises are carried out using MATLAB. No previous knowledge of computing languages is assumed.

Learning Outcomes

On successful completion of this unit, the student should have:

- A testable understanding of techniques to solve equations of the type $f(x) = 0$, and errors in the solutions.
- A testable understanding of interpolation methods and errors in interpolation.
- A testable understanding of numerical methods to evaluate integrals, and the errors in the methods considered.
- A testable understanding of techniques to solve ordinary differential equations with initial conditions and the way errors propagate in numerical solutions.
- A testable understanding of the use of MATLAB in a range of numerical applications.

Enrolment Information

Prerequisites: MAT1CLA or MAT1FEN
Incompatibles: MAT3NA, CSE31NC

Assessment

There is a 3 hour examination worth 70% and three compulsory hurdle assignments worth 10% each.

Assessment Type	%
Assignments	30
Exam (3 hour)	70

MAT3TA
Topology and Analysis
Credit Points: 15
Semester: 1
Coordinator: Dr John Banks

Unit Description

We start with a careful construction of the real numbers. We then discuss metric spaces and use general properties of open sets in metric spaces to devise a more general definition of a topological space. We study some fundamental concepts in the theory of topological spaces, particularly connectedness and compactness. We then apply these concepts to problems in real analysis by proving some familiar theorems from first year calculus, giving a rigourous definition of integrals along the way. We conclude with a discussion of quotients and products of topological spaces.

Learning Outcomes

On successful completion of this unit, students should have an understanding of:

- How the real numbers may be constructed from first principles.
- The basic ideas in point set topology, particularly connectedness and compactness.
- How topological results are used in the proofs of familiar theorems in analysis and calculus.
- How to communicate mathematical arguments clearly in the form of a mathematical proof.

Enrolment Information

Prerequisites: MAT22PAB or MAT2ANA

Assessment Type	%
Assignments	20
Exam	80

STA3AP
Applied Probability for Computer Systems Engineers
Credit Points: 15
Semester: 2
Coordinator: Dr Andriy Olenko

Unit Description

This unit is designed for students taking one of the Computer Systems Engineering degrees, but is also available to any student who has completed either STA2MDA or STA2MD. The aim of this unit is to introduce important probability models frequently encountered in areas related to the engineering sciences. In particular, students will be provided with fundamental tools in the areas of system reliability and queuing theory. Topics include series-parallel system reliability, analysis of system functionality via Markov chain modelling, and analysis of queues and networks of queues with emphasis on the Poisson process in time. This unit may also be useful to students with an interest in applications of statistical modelling.

Learning Outcomes

On successful completion of this unit, the student should be familiar:

- with system reliability and queuing theory;
- with applications of statistical modelling;
- know when particular models should be applied.

Enrolment Information

Prerequisites: both MAT1EN and MAT1FEN or both MAT1CPE and MAT1CLA or both STA2MDA or STA2MD.
Incompatibles: STA31PM, STA3PE.

Assessment Type	%
Examination	80
Assignments	20

STA3AS
Applied Statistics
Credit Points: 15
Semester: 2
Coordinator: Dr Paul Kabaila

Unit Description

This unit provides advanced-level introductions to the topics of sample surveys, multivariate analysis and time series analysis. These topics are very important in applied statistics. The unit also includes an introduction to statistical consulting.

Learning Outcomes

On successful completion of this unit, the student should have:

- An understanding of the subtle difficulties encountered when analysing data sampled using simple random sampling.
- A theoretical understanding of some common, yet powerful, statistical methods for the analysis of multivariate data.
- An understanding of formulating, estimating and interpreting various linear time series models for empirical studies.
- An understanding of conducting basic statistical inquiries with meaningful interpretation.

Enrolment Information

Prerequisites: STA2MDA or STA2MD

Assessment Type	%
Assignments	30
Exam	70

STA3BS
Biostatistics
Credit Points: 15
Semester: 1
Coordinator: Dr Paul Kabaila

Unit Description

Students will learn to design and analyse experiments in the life sciences and agriculture. The topics covered in this unit include a brief review of non-parametric methods; randomisation, blocking and randomised block designs; one-way and two-way layouts; multiple comparison procedures; fixed and random effects; mixed models; multiple linear regression; analysis of covariance; factorial designs; and an introduction to fractional factorial designs.

Learning Outcomes

On successful completion of this unit, the student will understand:

1. The principle of randomization in the design of experiments.
2. The principle of blocking in the design of experiments.
3. The difference between fixed and random effects.
4. Factorial designs and their analysis.
5. The idea behind fractional factorial designs.

Enrolment Information

Prerequisites: One of STA2MAS, STA2BS, STA2MS, STA2MDA, STA2MD, STA2AS
Incompatibles: AGR41EXP, AGR4AED

Assessment Type	%
Assignments	20
Exam (3 hour)	80

STA3LM
Analyses Based On Linear Models
Credit Points: 15
Semester: 2
Coordinator: Prof Robert Staudte

Unit Description

Linear models are the most commonly used class of models in applied statistics. They are used to relate a response variable to one or more explanatory variables to both determine the form of this relationship and to make predictions.

The methods are widely used in many areas of application including agricultural science, biological science, economics, engineering, health science, medical science and psychological science.

Topics covered in this unit include the simple linear regression model, derivation and properties of the ordinary least squares estimators, inference, diagnostics and prediction in the simple linear regression model, the multiple linear regression model, inference in the multiple linear regression model, the use of dummy variables and general regression models when the classical regression assumptions are violated. This unit has a combined flavour of both theoretical derivations and practical application through the use of a software package.

Learning Outcomes

On successful completion of this unit, the student will be able to:

- Carry out elementary operations on vectors and matrices, and use linear algebra to derive properties of estimators in multiple linear regression.
- Estimate model parameters and test hypotheses regarding parameters for the multiple linear regression model.
- Check model adequacy using residual analysis, outlier detection and tests for lack of fit.
- Carry out transformations to linearize the model.
- Use weighted least squares when required.
- Make predictions based on a chosen model.

Enrolment Information

Assumed prior knowledge: confidence intervals and significance testing; some familiarity with normal, Student-t, chi-squared and F-tests; and ability to find means and variances of linear combinations of random variables.
Prerequisites: one of STA2MAS, STA2BS, STA2MS, STA2MDA, STA2AS, STA2MD, STA2LM
Incompatibles: ECO31EME, ECO3EME

Assessment Type	**%**
Assignments	20
Exam (3 hour) open book	80

STA3SI
Statistical Inference
Credit Points: 15
Semester: 1
Coordinator: Dr Andriy Olenko

Unit Description

This unit comprises components in estimation and testing hypotheses. Topics in the first component include method of moments and maximum likelihood, reduction by sufficiency and invariance, unbiasedness, consistency, efficiency and robustness. The second component examines size and power of tests, Neyman-Pearson lemma, optimality of tests, the likelihood ratio test and relationship to confidence interval estimation.

Learning Outcomes

On successful completion of this unit, the student should be familiar:

- with the theory of estimation procedures;
- with the theory of hypothesis tests;
- know when particular tests should be applied.

Enrolment Information

Assumed prior knowledge: Basic knowledge of probability theory and calculus
Pre-requisites: STA2MDA or STA2MD

Assessment Type	**%**
Examination (3 hours)	70
Assignments	30

Honours in Mathematics and Statistics

The Honours year in Mathematics and Statistics course allows students to pursue advanced undergraduate studies in mathematics, statistics or mathematics & statistics. The choice of units selected will reflect your interests and one of our Advisers of Studies will be happy to discuss your choice of units with you.

Honours Coordinator

Dr Paul Kabaila
Room 225, Physical Sciences 2
P: 03 9479 2594
E: P.Kabaila@latrobe.edu.au

Eligibility

To be eligible for entry into Honours in Mathematics and Statistics, students require a grade average of 70% or more in 60 credit points of MAT3 and/ or STA3 units (not including STA3AP) and an average grade of 60% or more across all third year units. Students achieving this requirement are not necessarily guaranteed entry into the program as places are limited by the number of staff available to supervise honours theses. In instances where there are more students eligible for entry than there are positions, preference will usually be based on academic merit including performance in key third year units.

- Key third year units for mathematics students include Advanced Calculus and Cosmology (MAT3AC), Complex Analysis (MAT3CZ), Discrete Algebraic Structures (MAT3DS), Topology and Analysis (MAT3TA) and other units that would be considered prerequisites to the thesis project of interest to the student.
- Key third year units for statistics students are Applied Statistics (STA3AS) and Statistical Inference (STA3SI).
- As well as a letter from the Faculty of Science, Technology and Engineering notifying the student that they are eligible to pursue honours in Mathematics and Statistics at La Trobe University, at enrolment the student must also provide a signed letter from their proposed supervisor agreeing to supervise the student on their thesis work.

Structure of the Honours Course

Important note: All enrolments must be approved by the Mathematics and Statistics Honours Coordinator.

The honours year in mathematics and statistics consists of 120 credit points usually taken across two full time semesters (60 credit points each): 45 credit points are allocated to work on an honours project thesis (some potential projects that may be offered in 2010 are listed at the end of this entry) and the remaining 75 credit points consist of coursework units. Further details are provided below.

Students must complete 120 credit points which includes either

- MAT4THA (Mathematics Thesis A, 15cp) and MAT4THB (Mathematics Thesis B, 30 cp)

  OR

- STA4THA (Statistics Thesis A, 15 cp) and STA4THB (Statistics Thesis B, 30 cp)

The remaining 75 credit points consist of

- STA4 (15 cp each) and/or MAT4 (15 cp each) honours level units (not including the thesis units).
- Up to two approved STA3 or MAT3 units (15 cp each). Example of appropriate units include STA3SI (Statistical Inference, 15 cp) and MAT3TA (Topology and Analysis, 15 cp) for students who have not yet completed these units (or equivalent at other institutions).
- Up to two fourth year level units (15 cp each) from related disciplines where the units have sufficient mathematical or statistical content. An example appropriate unit is ECO4ATE (Advanced Time-Series Econometrics, 15 cp) for students wishing to pursue an analytical career in finance.
- At least 45 credit points must consist of MAT4 and/or STA4 units (not including the thesis units).

Access Grid Room (AGR), Key Centre of Statistical Science (KCSS) and Australian Mathematical Sciences Institute (AMSI) summer school units offered from external institutions.

- MAT4ATA & MAT4ATB (Advanced Topics in Mathematics A & B, 15 cp each) are shell units that allow students to enrol in honours level AGR units or AMSI summer school units.
- STA4ATA, STA4ATB, STA4ATC, STA4ATD and STA4ATE (Advanced Topics in Statistics A, B, C, D & E, 15 cp each) are shell units that allow students to enrol in honours level KCSS units, honours level AGR units or AMSI summer school units.

The selection of MAT4 and STA4 units available to honours students is subject to enrolment numbers and student interest.

Thesis Work

The independence with which students conduct their project work is a significant part of the assessment of the thesis. The thesis supervisor is required to report to the honours examiners' meeting on the level of independence. This being the case, students should endeavour to pursue their research topic as independently as possible, following up their own ideas and leads. However, students should balance the need to work independently with the need to complete the thesis on time. If students find themselves unable to make any progress for more than a week, they should not hesitate to seek assistance from their supervisor. In any case, it is recommended that students report their progress to their supervisor at least once per week. The department has copies of honours theses from previous years. They provide a useful guide to the expected style and scope of an honours thesis. Supervisors can arrange to make copies available to students.

The department will provide a form of binding for students theses submitted for grading and storage. Other appropriate forms of binding may be acceptable but must be paid for by the student and agreed to by the Honours Coordinator. Three bound hardcopies of each honours thesis is to be submitted to the supervisor by the thesis submission date for assessment. One of these will be returned to the student and one of these will be stored in either maths or stats departmental libraries. A pdf version of each thesis should also be sent to the Honours Coordinator for electronic storage.

Facilities

- Each honours student will be provided with a desk for personal use throughout the duration of their enrolment. The desk will be situated in a room nominated for use exclusively by Honours and/or Masters by Coursework students.
- Each honours student will also be provided with a computer for personal use throughout the duration of their enrolment. The computer will include all relevant freeware and software that is provided to undergraduate students within the department's computer laboratories. The installation of software packages that require individual licence agreements (such as MATLAB) may be requested but must also be agreed to by the Head of Department in consultation with the relevant thesis supervisor.
- Students will have after-hours building access via their student identification card.
- Each room designated for exclusive honours student use will include a printer connected to all computers within the relevant room. Each student will be provided with two reams of white A4 paper for personal use.

Preliminary Talks

- Each honours student will give a 10 minute presentation outlining their chosen topic once they have completed one semester's worth of work on their honours thesis.
- For students who commence the honours program at the beginning of the academic year, these talks will be held towards the end of 1st semester on a day and time determined by the Honours Coordinator.
- For students who commence honours mid-year, these talks will be held towards the end of 2nd semester on a day and time determined by the Honours Coordinator.
- These preliminary talks are not graded and therefore do not form part of the honours year assessment. They are, however, compulsory for all students.

Final Talks

- Each honours student will give a 20 minute presentation detailing work that they covered in their thesis topic.
- For fulltime students who commence the honours program at the beginning of the academic year, these talks will be held towards the end of 2nd semester on a day and time determined by the Honours Coordinator.
- For fulltime students who commence honours mid-year, these talks will be held towards the end of 1st semester the following year on a day and time determined by the Honours Coordinator.
- These final talks are not graded and therefore do not form part of the honours year assessment. They are, however, compulsory for all students.

Honours Units

Honours Units in Mathematics

Note: MAT4 units that may be offered by the Department of Mathematics and Statistics in 2010.

MAT4AA
Asymptotic Analysis
Not available in 2010

In this unit we consider how we can describe a function as its argument becomes large, using the language of asymptotics. This unit also introduces or expands your knowledge of special functions, such as the Bessel functions and the Airy functions.
Prerequisite: MAT3CZ

MAT4CI
Computability and Intractability
Taught through the AMSI Summer School 2010
Coordinator: Dr Marcel Jackson
E: M.G.Jackson@latrobe.edu.au

When does a problem have an effective algorithmic solution? What does it mean for an algorithm to be effective? In this component we attempt to give rigorous meaning to questions of this type and investigate some possible answers. Algorithmic problems in mathematics are the primary focus.
Prerequisite: (MAT1DM and MAT2PDM and MAT1CLA) or any third year mathematics unit.

MAT4DS
Chaos and Order in Dynamical Systems
Not available 2010
Coordinator: Prof Reinout Quispel
E: R.Quispel@latrobe.edu.au

What is chaos? How does it arise in dynamical systems? What other dynamical phenomena exist, or, to put it slightly differently: what are the different kinds of dynamical systems? If one has a differential equation that exhibits chaos, how should one solve it? These are some of the ingredients of this unit.
Prerequisite: 30 credit points of second or third year mathematics units.

MAT4DT – Duality Theory
Semester: 1
Coordinator: Prof Brian Davey
E: B.Davey@latrobe.edu.au

The unit will begin with a primer on category theory, general algebra and topology. We shall cover the general theory of dualities between classes of algebras and classes of topological relational structures. Applications of duality theory will also be presented.
Prerequisites: MAT3DS and MAT3TA

Note: At most one of MAT4DT and MAT4GA will be offered in any year.

MATM4FM
Mathematical Fluid Mechanics
Coordinator: TBA

An introduction to incompressible fluid flow, with emphasis on the structure of basic approximations in the theory of fluids. Solution of problems using the approximations. This component is fully online and is not available to students who have taken the subject MAT3MFM.
Prerequisites: MAT2AVC, MAT3CZ

MAT4GA
General Algebra
Not available in 2010
Coordinator: Brian Davey
E: B.Davey@latrobe.edu.au
Prerequisite: MAT3DS (with MAT3TA highly recommended)

General algebra, otherwise known as universal algebra, provides a theory within which to study the common features of all algebraic systems such as vector spaces, groups, rings, lattices and semigroups. The component will present all of the basic results in the theory. The close relationship between general algebra and lattice theory will be emphasized throughout the unit.

Note: At most one of MAT4DT and MAT4GA will be offered in any year.

MAT4GG
Group Actions
Taught through the AMSI Summer School 2010
Coordinator: Prof Grant Cairns
E: G.Cairns@latrobe.edu.au

This unit studies the foundations of the theory of group actions. In doing so, it touches on a selection of topics which display interconnections between geometry, group theory, topology and calculus. The unit is problem based.
Prerequisites: MAT3TA

MAT4GM
Geometric Methods for Differential Equations
Not available in 2010
Coordinator: Prof Geoff Prince
E: G.Prince@latrobe.edu.au

This course aims to show how geometric symmetry of the solutions of differential equations can be used to find those solutions using integrating factors. These integrating factors exist for all ordinary differential equations, not just the ones you learnt about in first year Mathematics.
Prerequisite: MAT3AC

Note: At most one of MAT4GM and MAT4GR will be offered in any year.

MAT4GR
General Relativity
Not available in 2010
Coordinator: Prof Geoff Prince
E: G.Prince@latrobe.edu.au

This is unit is not a comprehensive first course in general relativity. Instead it covers tensor and exterior calculus, metric differential geometry (following from MAT31AAC) and the geometry of geodesics. After studying curvature, Einstein's field equations are developed and the spacetime of the solar system is studied, including two of the famous experimental tests of general relativity.
Prerequisite: MAT3AC

Note: At most one of MAT4GM and MAT4GR will be offered in any year.

MAT4MP
Applied Mathematics Projects
Not available in 2010

This component introduces students to mathematical modelling using some of the computer-based tools available to the professional applied mathematician. Models in various areas of application, such as heat and mass transport, financial mathematics, biomathematics, statistical mechanics and dynamic systems, are considered.
Prerequisites: MAT2AM and MAT2APD; MAT3NA or (CSE1IPC and CSE1OOP or equivalent).

Note: Not available to students who have taken MAT3AMP.

MAT4NT
Introduction to Number Theory
Not available in 2010
Coordinator: Dr Peter Van Der Kamp
E: P.vanderkamp@latrobe.edu.au

We will start this course with a gentle introduction to number theory, including tantalizing connections to cryptography. If time permits, in the later parts of the unit we may touch on one or more of the recent analytic and algorithmic advances in the areas of Mersenne primes, the Riemann hypothesis, and primality proving. My aim will be to make this course accessible and interesting to a varied audience, including students with interests in applied mathematics, pure mathematics, or computer science.
Prerequisites: MAT1DM and MAT2PDM and MAT1CLA; or 30 credit points of MAT2 units; or any MAT3 unit.

MAT4TD
Topology and Dynamics
Coordinator: Dr John Banks
E: J.Banks@latrobe.edu.au

As well as deepening your knowledge of point set topology, this unit shows how the theory of point set topology may be applied to the study of discrete dynamical systems. We will see that most of the ideas behind the definition of "chaos" are essentially topological and as such can be analysed using point set topological methods.
Prerequisites: MAT3TA

AGR Units

Some of the units that may be available to students in 2010 through the Access Grid Room (AGR) include:

- Advanced Data Analysis
- Advanced Operations Research
- Communicative Algebra
- Cryptography, Computer and Network Security
- Discrete Optimisation
- General Relativity
- Statistical Consulting
- Time Series Analysis
- Topological Groups
- And more

Honours Units in Statistics

Note: STA4 units that may be offered by the Department of Mathematics and Statistics in 2010.

STA4AMD
Analysis of Medical Data
Coordinator: Prof Robert Staudte
E: R.Staudte@latrobe.edu.au

Combining evidence from different studies, using fixed and random effects models in traditional meta-analysis of effects, using inverse variance weights. Strengths and weaknesses. Calibrating evidence in a test and relationship to traditional measures such as p-values. Variance stabilising transformations. The evidence obtained by variance stabilisation will be the basis for confidence intervals for effect sizes. One- and two-sample Binomial models (including risk difference, relative risk and odds ratios). Evaluating and comparing Poisson rates. Evidence in one and two-sample Welch t-tests, and chi-squared tests, including the Cochran Q test for heterogeneity of fixed and random effects. All procedures will be implemented in the software package R.
Recommended Prior Studies: STA3SI

STA4SI
Statistical Inference
Coordinator: Dr Paul Kabaila
E: P.Kabaila@latrobe.edu.au

This unit covers a selection of topics in classical statistical inference at the fourth year level. It consists of a selection of material from the following chapters of Casella and Berger (2002): Chapter 6 (Principles of Data Reduction), Chapter 7 (Point Estimation), Chapter 8 (Hypothesis Testing), Chapter 9 (Interval Estimation) and Chapter 10 (Asymptotic Evaluations). A knowledge of this material is helpful in almost any statistical endeavour.
Recommended Prior Studies: STA3SI
Reference: *Statistical Inference, 2nd Edition*, Duxbury (2002), by G. Casella and R. L. Berger.

STA4RA
Regression Analysis
Coordinator: Dr Luke Prendergast
E: Luke.Prendergast@latrobe.edu.au

The topics for this unit include - multiple linear regression; classical estimation and testing; residual analysis; diagnostics; variable selection; robust regression and some modern dimension reduction techniques.
Recommended Prior Studies: STA3AS and STA3LM

STA4SA
Spatial Analysis
Coordinator: Andriy Olenko
E: A.Olenko@latrobe.edu.au

The unit surveys the theory of random fields, spatial statistics models, and their applications to a wide range of areas, including image analysis and GIS (geographic information system). The course will cover the methodology and modern developments for spatial-temporal modelling, estimation and prediction, and spectral analysis of spatial processes. All the methods presented will be introduced in the context of specific real datasets with GRASS and R software.
Recommended Prior Studies: STA3SI, STA2RSP

KCSS Units

Some of the units that may be available to students in 2010 through the Key Centre of Statistical Science (KCSS) include

- Consulting and Applied Statistics
- Applied Financial Econometrics
- Game Theory and Applications
- Mathematics of Option Pricing
- Time Series Analysis
- Analysis of Hierarchical Data
- And many more (in 2008 there were 13 KCSS units in total)

Thesis Topics

Potential Thesis Topics in 2010

Please be aware that the topics listed below are just some of the possible topics from which students can choose. Most supervisors are happy to discuss other possible topics with you personally. If you have a particular area of research that you wish to pursue and you do not know who to discuss this with, then contact the Honours Coordinator who can arrange a meeting with a potential supervisor.

Mathematics Projects

General Algebra
Not available in 2010
Prof Brian Davey
E: B.Davey@latrobe.edu.au

The ‘classical' kinds of algebras include groups, rings and vector spaces. I am mainly interested in more ‘modern' kinds of algebras, like lattices and Boolean algebras, which arise in logic and theoretical computer science. Possible topics in general algebra include:

1. CSP's. General algebra has recently been used as a tool for improving our understanding of the complexity of Constraint Satisfaction Problems, which frequently arise as practical problems in computer science (for example, in scheduling shift workers). This project would review the background and investigate some recent papers on the topic.

2. Primal and quasi-primal algebras. Primal and quasi-primal algebras are important generalisations of the two-element Boolean algebra, which is familiar from discrete mathematics, and arise in many parts of general algebra. The aim of this project will be to find simple and effective tests for quasi-primality based on some old and some recent tests for primality.

3. Graph algebras. Every graph (in the sense of discrete mathematics) can be converted in a natural way into an algebra with a single binary operation. This project will review the many applications that graph algebras have found and will include some recent papers illustrating their use on the fascinating interface between complexity theory and algebra.

4. NU algebras. Algebras with a near-unanimity term are an important generalisation of lattices. This project will review the various properties that these algebras possess and study some very recent papers, including the proof that it is decidable whether or not a finite algebra actually has a near-unanimity term.

Algebras of programs
Dr Marcel Jackson
E: M.G.Jackson@latrobe.edu.au

There are a number of logical and algebraic approaches to analysing the correctness of computer programs. This project would involve an exposition of some of these approaches and their interrelationships, and lead to an investigation into the relationship between these and algebras of functions and relations. This project is best suited to students with some extra background in logic, or with a strong background in algebra with a computer science interest. No knowledge of programming is necessary, since the focus is on algorithms, rather than actual programming languages.

Algebras of functions and relations
Dr Marcel Jackson,
m.g.jackson@latrobe.edu.au

This topic concerns the problem of classifying various algebras of functions and binary relations. For example: the Cayley representation for groups shows that groups are precisely the algebras arising as systems of permutations of a set under the operations of composition and inverse. What about algebras of binary relations under the operation of composition and intersection? There are a plethora of such questions, many motivated from the kind of issue considered in the previous topic “Algebras of programs”.

Computational complexity in algebra
Dr Marcel Jackson,
m.g.jackson@latrobe.edu.au

How hard is it to decide if two arbitrary finite graphs are isomorphic? What about two finite groups? This project would involve a study of computational questions such as these: the focus would be on general algebraic structures, and connections between computational problems and logical properties of algebras. This project could be directed to computational problems on finite structures (a popular current trend) or for infinite structures (more classical, but still active and important).

Simon's Theorem (automata and semigroups)
Dr Marcel Jackson
E: M.G.Jackson@latrobe.edu.au

Finite state automata (as encountered in, say MAT1DM) and algebraic structures known as "semigroups" have a close relationship: finite semigroups all arise as the algebra of input transitions of a FSA under composition, and every finite semigroup gives rise to a finite automata for which it is the algebra of transitions. Simon's Theorem relates languages recognised by machines that read a fixed multiple number of bits at a time to an elementary structural property of finite semigroups. It has a number of different proofs. This topic is suitable for a student with an algebra background.

Dr Marcel Jackson will also consider other proposals in semigroup theory or universal algebra.

To discover and explain features of integrable systems
Dr Peter Van Der Kamp
E: P.VanDerKamp@latrobe.edu.au

Amongst all differential/difference equations, or mappings/ correspondences, the integrable ones are the nice ones. They always carry special structures. Examples are a Lax -pair, infinitely many symmetries, sufficiently many integrals of motion, and polynomial growth (as opposed to exponential growth) of degrees of iterates and multivaluedness. Often one is able to calculate the first few terms of an infinite series from which one can guess the general form. At this point you want to write down a proof! What does the identity, which makes it happen, look like?

The Inverse Problem in the Calculus of Variations
Prof Geoff Prince
E: G.Prince@latrobe.edu.au

When are the solutions of a system of second order ordinary differential equations (ode's)

$$\frac{d^2x^a}{dt^2} = F^a\left(t, x^b, \frac{dx^b}{dt}\right) \qquad a = 1,\ldots,n$$

the solution of an Euler-Lagrange equation

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{x}^a}\right) = \frac{\partial L}{\partial x^a}$$

This is a famous question in the calculus of variations, important in differential geometry, mechanics and relativity. This project involves an exploration of this inverse problem for some important classes of differential equations using differential geometry and computer algebra.

Numerical integration by arcs
Prof Geoff Prince
E: G.Prince@latrobe.edu.au

Numerical integration of differential equations uses approximation by straight line segments to construct solutions. This project explores what seems to be a completely new idea: approximation by circular arcs. It involves development and implementation of analogues of Euler's method and Runge-Kutta methods and comparison with the traditional algorithms.

Associate Professor Geoff Prince will also consider proposals in differential geometry, differential equations, relativity and mechanics.

Symbolic Dynamics and Formal Languages
Dr John Banks
E: J.Banks@latrobe.edu.au

The branch of dynamical systems theory known as symbolic dynamics interacts in many ways with the theory of formal languages, a theory of fundamental importance in many areas of computer science. This project would explore some of the many connections between the two theories. Some examples of specific areas that might be investigated include the connection between sofic shifts and regular languages, the application of the theory of context free languages to symbolic dynamics, the application of symbolic dynamics to coding problems such as the coding of data for hard disk storage.

Entropy measures for nonlinear partial differential equations
Prof Philip Broadbridge
E: P.Broadbridge@latrobe.edu.au

Just as some dynamical systems have conservation laws, some have monotonicity laws such as dissipation of energy or increase of entropy. In this project, entropy laws will be found systematically for dynamical systems that are governed by practical nonlinear partial differential equations. These will be used to prove stability of states of maximum entropy and to prove stability of solutions that are invariant under some symmetry. A connection will be made between smoothing properties or positivity properties and decrease of Shannon information. Applications might include heat and mass transfer, metal surface evolution and quantum mechanics.

Quantum mechanics of a scalar field in an accelerating universe
Prof Philip Broadbridge
E: P.Broadbridge@latrobe.edu.au

Since the late 1990s, it has been observed that the universe is not only expanding but accelerating, and that most of the energy is in the form of "dark energy" not associated with known types of waves or particles. If we allow a scalar field to be minimally coupled in an invariant way to the simplest consistent expanding accelerating universe, then the field has energy eigenstates that become unstable at discrete times. These non-oscillatory states have a classical analogue in an oscillating spring on an accelerating platform – eventually the spring ceases to oscillate. The quantized non-oscillatory states have a continuous spectrum (like that of an ionized atom), unlike the quantum particle states that have a well defined particle number and discrete spectrum (like the bound states of a neutral atom). This project will predict the partitioning of the scalar field energy into the particle states and the continuous "jelly" states, and will estimate how this non-particulate energy increases in time.

Applying an exactly solvable nonlinear convection-diffusion equation to soil-water flow
Prof Philip Broadbridge
P.Broadbridge@latrobe.edu.au

Recently, a formal series solution in terms of Kummer functions, has been constructed for an integrable nonlinear convection-diffusion equation. Up to 180 series coefficients have been calculated explicitly. The series converges in practical terms but its radius of convergence has not been estimated in any way. This solution leads to an exact infiltration series, a power series in square root time, for the total depth of surface water having infiltrated a soil. The coefficients of this series have been in dispute for some time. These exact results may help to explain pre-existing partial results that seem to be in mutual contradiction. At a practical level, the integrable equation seems to well model water infiltration in soil but the goodness of fit with experimental data needs to be quantified and compared with that of more popular phenomenological models.

Harry Dym equation and its simpler relative
Prof Philip Broadbridge
E: P.Broadbridge@latrobe.edu.au

The Harry Dym equation is a well known integrable nonlinear wave equation. There is another less well known nonlinear water wave equation that appears to be very similar but it can be solved more simply because it becomes linear after a change of variables. This will allow an investigation of how special is the soliton behaviour of the Harry-Dym equation. The Harry Dym equation has a multi-soliton solution for which the finite number of peaks remains constant. What does the other similar integrable equation predict in similar circumstances? Is there a trace of soliton behaviour? If not, how is the soliton energy dissipated?

Graph theory and Number theory
Prof Grant Cairns
E: G.Cairns@latrobe.edu.au

I have a range of possible thesis topics in Graph Theory and Number Theory. Some are classical, some are open problems. For further information, come and see me to discuss topics that might interest you.

Note: Projects supervised by Prof Grant Cairns commence in Semester 2 2010.

Differential equations for orthogonal polynomials
Dr Chris Ormerod

Orthogonal polynomial systems are sequences of polynomials that are orthonormal with respect to some linear form. The study of non-standard orthogonal polynomials have many applications to classically integrable systems such as the Schrödinger wave equation.

The integrable systems that arise are a ubiquitous part of various quantum mechanical models. This project may be directed towards any number of integrable aspects of orthogonal polynomial systems.

Statistics Projects

Dr Siew Pang Chan

For details of Honours topics in the Health Sciences please speak to Siew Pang Chan.

Measures of risk based on financial time series models
Dr Ajay Chandra
E: A.Chandra@latrobe.edu.au

One of the aims of financial risk management is the accurate calculation of the magnitude and probabilities of large potential losses due to extreme events such as stock market crashes, currency crises, trading scandals, or large bond defaults. To get an insight into these problems, we typically evaluate risk measures such as Value at Risk (VaR) and Expected Shortfall (ES) based on financial time series models such as generalised ARCH (GARCH). This project would definitely give students some exposure in time series and would lead to a path of further study at a post graduate level.

Goodnees-of-fit tests for copulas in the context of GARCH models
Dr Ajay Chandra
E: A.Chandra@latrobe.edu.au

Over the last decade, copula modeling has gained popularity notably in finance and insurance because it provides the flexibility in analyzing dependence structures between assets, see, e.g., Embrechts (2002). A copula connects a multivariate distribution to its marginals in such a way that it captures the entire dependence structure in the multivariate distribution. An important property of copulas is their invariance under strictly increasing transformations of the margins. In fact, the use of copulas allows to solve a difficult problem, namely to find a whole multivariate distribution, by performing two easier tasks. The first step is to model every marginal distribution. The step consists of estimating a copula, which summarizes all the dependencies between margins. However, this second task is still in its infancy stage for most of multivariate financial time series. Therefore this topic awaits further research.

The GARCH Method for finding Value-at-Risk
Dr Paul Kabaila
E: P.Kabaila@latrobe.edu.au

Value-at-Risk is a measure of financial risk that is very widely used in the banking sector. The Bank for International Settlements (www.bis.org) provides the regulatory framework for banks by setting minimal capital requirements for banks in terms of a 99% Value-at-Risk. There are a number of different methods of finding a 99% Value-at-Risk. The most important method for finding the Value-at-Risk is to use a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model. The purpose of this Honours project is to apply this method to some exchange rate data and to examine the influence on the computed Value-at-Risk of a commonly-used approximation.

The Coverage Probability of Confidence Intervals in Regression after a Preliminary F-test

We consider a linear regression model. The use of preliminary F-tests to simultaneously test the null hypothesis that several regression coefficients in this model are zero has been suggested, for example, by Milliken, G.A. & Johnson, D.E. (2002) Analysis of Messy Data. Volume III: Analysis of Covariance. Chapman & Hall/CRC. Unfortunately, such tests can lead to confidence intervals with minimum coverage probabilities far below the nominal coverage. The purpose of this Honours project is to examine the coverage properties of these confidence intervals, for a design matrix computed from real-life data, using a sophisticated Monte Carlo simulation method.

WKS sampling reconstructions
Dr Andriy Olenko
E: A.Olenko@latrobe.edu.au

WKS sampling is a process of representing continuous signals by sequences of numbers (called samples). A classical approach to this problem is provided by Shannon's sampling theorem which states that if a signal is band-limited, then it is uniquely determined by its sampled values. This result is one of the basic tools in signal processing. In direct numerical implementations we consider the truncated variant of Shannon's sampling theorem. Restoring continuous signals with given accuracy from discrete samples or assessing the information lost in the sampling process are fundamental problems. This project will analyse truncation errors and the information lost for deterministic and stochastic signals. Applications in signal processing and information compression will be considered.

Wavelets for stochastic processes
Dr Andriy Olenko
E: A.Olenko@latrobe.edu.au

In various statistical, data compression, signal processing applications and simulation, it could be used to convert the problem of analysing a continuous-time random process to that of analysing a random sequence, which is much simpler. Multiresolution analysis provides an efficient framework for the decomposition of random processes. This approach is widely used in statistics to estimate a curve given observations of the curve plus some noise. Various extensions of the standard statistical methodology were proposed recently. These include curve estimation in the presence of correlated noise. For these purposes the wavelet based expansions have numerous advantages over Fourier series, and often lead to stable computations. However, in many cases numerical simulation results need to be confirmed by theoretical analysis. Recently, a considerable attention was given to the properties of the wavelet transform and of the wavelet orthonormal series representation of random processes. This project will analyse uniform convergence of wavelet expansions for Gaussian random processes and fields. Applications in signal processing and information compression will be considered.

Clustering large financial data
Dr Andriy Olenko
E: A.Olenko@latrobe.edu.au

There is a growing need for a more automated system of partitioning data sets into groups, or clusters. Clustering techniques can be used to discover natural groups in data sets and to identify abstract structures that might reside there, without having any background knowledge of the characteristics of the data. Clustering has been used in a variety of areas, including computer vision, data mining, bioinformatics (gene expression analysis), and information retrieval, to name just a few. This project focuses on a few of the most important clustering algorithms. Applications in stocks clustering with actual data will be considered.

Please see Dr Andriy Olenko if you'd like to propose other areas in which to conduct a project. Dr Andriy Olenko would agree to supervise a project in such areas: spatial statistics, limit theorems, actuarial mathematics and approximation theory.

The evidence in non-central chi-squared statistics and applications to goodness-of-fit

Prof Robert Staudte
E: R.Staudte@latrobe.edu.au

For details please speak to Prof Robert Staudte.

Policies Relating to Students

AVAILABILITY OF SUBJECT MATERIAL

Most our subjects have their own web page via LMS, which may include tutorial sheets, assignments, old exams and lecture notes. These sheets and their solutions are provided so that you can prepare before class, and for those students who occasionally miss class or lose their sheets. They are no substitute for participation in the classes. You can connect to the LMS by starting from:

www.latrobe.edu.au/studentlmsinfo

Subject Guides

A subject guide is available for each subject, via its LMS page. Subject Guides provide detailed information regarding lecturers, lecture times/venues, assessment, and policy information. You are assumed to be aware of the contents.

Past Exams

If you can't find past exams on your subject's LMS page, you may be able to access them from the Library Catalogue. This can be found at:

www.lib.latrobe.edu.au/services/students.php

ASSISTANCE

Your tutor will help you with your maths or stats when you have problems. This assistance is available outside tutorial hours: it is part of a tutor's responsibility to make times when they are available to see students. Another source of help should be the other members of your tutorial group. Don't think that it is cheating if you discuss a problem with another student, but it is cheating if you try to deceive your tutor by handing in a copied solution. (See the next section on plagiarism.) A final source of help is the lecturing staff. As with tutors, it is a lecturer's responsibility to spend some time seeing students.

ASSIGNMENTS: First and Second Year

Every week or second week you will be asked to hand in solutions to a set of assignment problems. Each page of your solutions must carry:

1. your name,

2. your tutor's name, and

3. your tutorial day and time.

Statement of Originality: At the top of the first page of each assignment you must write, sign and date the following Statement of Originality: "This is my own work. I have not copied it from anyone else". Further, assessable work (exam papers or assignments) written in pencil will not usually be accepted.

Assignments will be marked by your tutor and returned during your tutorial hour, together with feedback and solutions.

Late submissions will be accepted only in special circumstances and must be handed in personally to your tutor.

For further information about the department's assessment philosophy, you can refer to:

http://www.latrobe.edu.au/mathstats/undergraduates/assessment/index.html

SPECIAL AND SUPPLEMENTARY ASSESSMENT

Forms are available through the Student Centre if you consider that your performance in an exam or during semester is adversely affected by illness or other causes. Whether or not to grant a special exam is a decision of the examiner and is not automatic. The department applies the time limits on applications that are specified in the University policies. The University regulation is available online at:

http://www.latrobe.edu.au/acadserv/current/ans_speccons.html

Special Examinations are scheduled in July and January and are organised by the Admissions, Exams, Graduations and Scholarhips Office (AEGSO). Examination dates are publicised well in advance. It is your responsibility to ensure you are available to sit a special exam at the advertised date.

Supplementary Assessment is also controlled by University policy. The University regulation is available online at:

http://www.latrobe.edu.au/policy

The department uses central scheduling by AEGSO and does not make individual arrangements. Please note that the University policy does not allow for further assessment after the completion of the special/supplementary exam period.

PLAGIARISM and INTEGRITY

While the department encourages collaboration amongst students in learning mathematics, we make a clear distinction between such collaboration and copying. Copying is cheating and will be reported through the subject examiner to the Head of School. Repeated copying will incur serious penalties. The University's policy on plagiarism is available online at:

http://www.latrobe.edu.au/plagiarism

and further information on acting with integrity in your assessment is to be found at:

http://www.latrobe.edu.au/learning/integrity.html

QUALITY ASSURANCE

Response to Student Feedback from Previous Years

A Student Feedback Survey is provided in each subject, to all students, towards the end of semester. Your responses to the surveys are an important factor in assessing the effectiveness of the department's subjects. A web site is available where you can read how we have responded to your survey responses from previous years, through our Quality Assurance process. This site is located at:

www.latrobe.edu.au/mathstats/undergraduates

COMPLAINTS

Any student who feels that they have a serious complaint about one of their lecturers or tutors is advised to discuss this with the Head of Department. Such discussions will be treated as strictly confidential.

For course information updates, visit: www.latrobe.edu.au/coursef nder

CRICOS Provider 00115M