This guide has been prepared to assist you in deciding whether to apply to enter MSc (Mathematics and Statistics), Honours or PGDip programs in the area and in designing your course. You are advised that the rules governing the MSc and Honours programs are definitively stated in the official University Handbook. In the event of a disagreement between this Guide and the Handbook, it is the Handbook that is to prevail. The information in this Guide is given in good faith and correct (to the best of our knowledge) at the time of writing (October 2010). It has been carefully checked, but the Department of Mathematics and Statistics accepts no responsibility for the accuracy of the information.
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1 Overview

In 2011 the following advanced level programs will be offered in the Department of Mathematics & Statistics:

- **MC-SCIMAT** Master of Science in Mathematics and Statistics  
  Coordinator: Dr Paul Norbury

- **754AA** Bachelor of Science (Degree with Honours) (Mathematics and Statistics)  
  [See the footnote at the bottom of this page re the limited availability of this program!]  
  Coordinator: Dr Omar Foda

- **290AA** Postgraduate Diploma in Science (Mathematics and Statistics)  
  Coordinator: Dr Omar Foda

The Master of Science (MSc) program (two years full time) and the Honours and Postgraduate Diploma (PGDip) programs (one year full time study each) in Mathematics and Statistics are flexible programs allowing students to study subjects in four broad specializations:

(A) Applied Mathematics and Mathematical Physics,

(B) Discrete Mathematics and Operations Research,

(C) Pure Mathematics, and

(D) Statistics and Stochastic Processes.

The Master of Science program serves as a necessary preparation for research in Mathematics and Statistics, including PhD studies.

Under the New Melbourne Model, the MSc program in Mathematics & Statistics replaces the old one-year long Honours program, which is now available to a special category of students only.\(^1\)

The PGDip program is designed for students who are willing to expand their mathematics and statistics knowledge and skills but have mathematical background insufficient for immediate entry into Masters. For such students, the program can also serve as a stepping stone for the MSc program, and after successful completion of the PGDip program, they will be able to do MSc in one and a half years instead of two.

All three programs have substantial coursework components:

- **MSc:** 200 credit points = 150 points coursework + a 50 points research project;
- **Honours:** 100 credit points = 75 points coursework + a 25 points research project;
- **PGDip:** 100 credit points = 100 points coursework

(recall that the standard full-time student load is 100 credit points per year, which is equivalent to eight standard one-semester subjects).

Each student will be assigned an academic supervisor from a specialisation, who will give individual advice and assist in developing an individual course plan for that student. Students will have to do a prescribed number of MSc level discipline subjects offered by the Department of Mathematics & Statistics (see the table in Section 12, displaying discipline subjects available to MSc and Honours/PGDip students in 2011 and 2012, including their semester allocation), of which a few may be replaced by Mathematics & Statistics undergraduate subjects or by MSc level subjects offered by other departments (subject to their supervisors’ and the program coordinator’s approvals). For more detail, see the program descriptions in the next section.

MSc and Honours students are required to undertake a research project, and MSc students are also required to undertake a professional tools subject.

---

\(^1\)The Honours program in Mathematics & Statistics is available solely to the University of Melbourne students who commenced their undergraduate studies prior to 2008 and apply for the Honours program immediately after completing their undergraduate degree(s).
2 Course Structure

2.1 MSc

The Master of Science in Mathematics and Statistics is one of the research training streams of the Master of Science. The research training streams give students the opportunity to undertake a substantive research project in a field of choice as well as a broad range of coursework subjects including a professional tools component, as a pathway to PhD study or to the workforce.

Students must complete a total of 200 credit points over the two year full-time (or an equivalent part-time) program, comprising:

- Discipline Subjects: 137.5 points
- Professional Tools Subject: 12.5 points
- Research Project: 50 points

On enrolment, students must select one of the four specialisations (A)-(D) listed on p.3. They must complete eleven 12.5 point subjects as indicated in the table below. The list of compulsory and elective MSc level subjects from different specialisations is presented after the table.

<table>
<thead>
<tr>
<th>Number of Subjects</th>
<th>Total Points</th>
<th>Chosen From</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two</td>
<td>25</td>
<td>Compulsory MSc level subjects from student's selected specialisation</td>
</tr>
<tr>
<td>Three</td>
<td>37.5</td>
<td>Elective MSc level subjects from student's selected specialisation</td>
</tr>
<tr>
<td>Two</td>
<td>25</td>
<td>Any MSc level subjects from a single specialisation different to the student's selected specialisation</td>
</tr>
<tr>
<td>Four</td>
<td>50</td>
<td>Any MSc level subjects from any of the specialisations (including up to two approved Masters level subjects from other departments). Up to two of these subjects can be replaced with approved undergraduate subjects. Where it is necessary for the student to acquire the required knowledge for MSc level Mathematics &amp; Statistics discipline subjects, up to two further MSc level subjects can be replaced with approved undergraduate subjects.</td>
</tr>
</tbody>
</table>

**MSc Level Discipline Subjects.** Some of the discipline subjects listed below are offered each year, but others are offered in alternate years. Subjects offered in odd years are labelled with (o), the ones offered in even years are labelled with (e). For semester allocation of the subjects, see the table on p. 13.

(A) Applied Mathematics and Mathematical Physics

**Compulsory Subjects**

- MAST90064 Advanced Methods: Differential Equations (o)
- MAST90067 Advanced Methods: Transforms (e)

**Elective subjects**

- MAST90026 Computational Differential Equations (e)
- MAST90066 Continuum Mechanics and Applications (o)
- MAST90011 Modelling: Mathematical Biology (e)
- MAST90060 Mathematical Statistical Mechanics (o)
- MAST90065 Exactly Solvable Models (o)
- MAST90069 Introduction to String Theory (e)

(B) Discrete Mathematics and Operations Research

**Compulsory Subjects**

- MAST90030 Advanced Discrete Mathematics
- MAST90014 Optimisation for Industry
**Elective subjects**

- MAST90013 Network Optimisation (o)
- MAST90050 Scheduling and Optimisation (e)
- MAST90031 Enumerative Combinatorics (o)
- MAST90053 Experimental Mathematics (e)

**Compulsory Subjects**

- MAST90012 Measure theory (o)
- MAST90023 Algebraic Topology (e)

**Elective subjects**

- MAST90025 Commutative and Multilinear Algebra (e)
- MAST90017 Representation Theory (o)
- MAST90068 Groups, Categories and Homological Algebra (e)
- MAST90029 Differential Topology and Geometry (o)
- MAST90020 Functional Analysis (e)
- MAST90056 Riemann Surfaces and Complex Analysis (o)

**Statistics and Stochastic Processes**

**Compulsory Subjects**

- MAST90062 Probability and Mathematical Statistics I
- MAST90063 Probability and Mathematical Statistics II

**Elective subjects**

- MAST90009 Business Forecasting (o)
- MAST90051 Mathematics of Risk (e)
- MAST90059 Stochastic Calculus with Applications (o)
- MAST90061 Modern Statistical Methods (o)
- MAST90019 Random Processes (e)
- MAST90027 The Practice of Statistics (e)

**Professional Tools.** MSc students must complete MAST90045 Systems Modelling and Simulation. If students have completed the approved equivalent of this subject by way of 620-131 Scientific Programming and Simulation (2007) or another approved equivalent subject, they will be exempt from MAST90045 and will be required to complete an additional 12.5 point MSc level discipline Mathematics and Statistics subject in its place.

**Research Project.** The Research Project (50 points) is an integral part of the MSc program in Mathematics and Statistics, and a thesis is the main requirement for this component. Candidates must pass the Research Project to be awarded the Degree.

For technical reasons, students will have to enrol in one or more “Research Project subjects”, as indicated below, to ensure they have completed a total of 50 points by the end of their course:

- MAST90042 Research Project / 50 points
- MAST90046 Research Project / 37.5 points
- MAST90047 Research Project / 25.0 points
- MAST90048 Research Project / 12.5 points

It is expected that MSc students will enrol in their first “Research Project subject” in the second semester of their (full-time) studies, e.g. enrolling in 37.5 points of discipline subjects and 12.5 points “Research Project subject” in their second and also third semesters (one can enrol in subjects MAST90047 and MAST90048 more than once!), and then in 25 points of discipline subjects and the 25 points “Research Project subject” in their last semester.
2.2 Honours

The total weight of all components of the degree is 100 credit points.

**Discipline Subjects**  Honours students must take six of the MSc level subjects from the list above (12.5 points each, total points 75).

**Research Project**  The Research Project (25 points) is an integral part of the degree, and a thesis is the main requirement for this component. Candidates must pass the Research Project to be awarded the Degree.

2.3 PGDip

Starting from 2011, the PGDip program in Mathematics and Statistics will consist of eight coursework discipline subjects (100 credit points). At least four of them must be MSc level Mathematics and Statistics discipline subjects, three of them normally being within a common specialisation. The remaining subjects can be higher undergraduate (normally third year) level or MSc level Mathematics and Statistics subjects (including MAST90045).

This allows students who have not completed an undergraduate major in Mathematics and Statistics, but have completed first and second year studies in Mathematics and Statistics, to complete a major in the area while doing the PGDip and then start on (MSc level) coursework that can later be credited towards an MSc degree in Mathematics and Statistics. In this way, they will be able to earn the MSc degree in 1.5 years of full-time study after the PGDip.

The PGDip program may also be a suitable stepping stone to the MSc program in Mathematics and Statistics for students coming from overseas.

2.4 Some Common Comments on the Programs

The MSc and PGDip in Mathematics and Statistics are postgraduate degrees, whilst Honours is an undergraduate degree. The aims of these programs are to train students to enable them to proceed to further postgraduate study at the University of Melbourne or other institutions, and equip students with a range of skills demanded by today's employers. The programs are well regarded and recognised both in academia and the industry.

For many students, the advanced courses and project that they do after their undergraduate courses is the most exciting and valuable time in their studies. Following up their special interests enables students to develop their research and analytic skills and substantially extends the knowledge gained in earlier years. In some areas there is a possibility of applying theory to real-world problems. The MSc and Honours programs in Mathematics and Statistics provide an opportunity for students to carry out a research project under the supervision of a staff member who is an expert in the area. They will also learn how to effectively present their findings in print by using document preparation programs such as L\TeX, and how to prepare and deliver a professional oral presentation. Students will have the opportunity to share the findings of their research project with other students and staff in two presentations during the program. They will have the opportunity to acquaint themselves with the Internet and other tools essential in mathematical and statistical research such as MathSciNet (Mathematical Reviews online), to attend seminars that are designed to further extend their specialized knowledge and to inform them about research and job opportunities in Mathematics and Statistics.

MSc, PGDip and Honours students are a part of the Australian mathematical and statistical community and should consider membership in professional organizations. Full-time students in Australian Universities receive their first year of membership in the Australian Mathematical Society free and half-price membership to the Statistical Society of Australia.
3 Entry Requirements

3.1 MSc and PGDip

For the MSc program, the necessary entry requirement comprises a bachelor degree with a major in an appropriate relevant discipline with at least an H3 (65%) in the major, or equivalent. Entry is also subject to the availability of an appropriate research topic and supervisor.

To enter the PGDip program, students should have an undergraduate degree in a relevant discipline. It basically means that they must have completed first and second year studies in Mathematics and Statistics. It is highly desirable that they have also completed some third year level subjects in Mathematics and Statistics or another quantitative discipline.

3.2 Honours

The Honours program in Mathematics & Statistics is available solely to the University of Melbourne students who commenced their undergraduate studies prior to 2008 and apply for the Honours program immediately after completing their undergraduate degree(s).

To be accepted into the Honours program you must satisfy the entry requirements of the Faculty of Science and the Department of Mathematics and Statistics.

- The Faculty of Science requirements:
  - Applicants must hold a Bachelor of Science (BSc) or equivalent qualification recognised by the Faculty of Science. Applicants currently enrolled in a BSc combined course at The University of Melbourne are not required to have completed their combined course to be eligible for Honours. However, these combined course applicants are required to have completed sufficient points to be eligible for the single Bachelor of Science degree.
  - In addition, applicants must also meet the following requirements, depending on their tertiary qualifications:
    - Graduates of the University of Melbourne BSc single degree must normally have a Faculty Honours Score (FHS) of at least 65%. The FHS is a weighted average based on a student’s performance in their best 87.5 points of science study at third year level.
    - For combined course students the Faculty calculates a weighted average mark for the third year level science subjects that have been completed. A weighted average of at least 65% is normally required for entry into Honours.
    - Applicants who have completed their degree at other institutions must demonstrate that they have achieved an average of 65% for the third year science subjects they have studied. The department reserves the right to scale the applicants results to make them comparable to the marks of the University of Melbourne students.

- The Department of Mathematics and Statistics requirement:
  - At least 65% in at least four third year level Mathematics/Statistics subjects.

Students who do not meet this requirement, but who have achieved very good results in other areas, may be considered for entry to Honours on the recommendation of the Head of the Department of Mathematics and Statistics.

3.3 Recommended Third Year Level Subjects for Prospective MSc Students

It is important that prospective MSc (and PGDip) students select suitable third year level Mathematics and Statistics subjects that provide appropriate background for their future study. Students who wish to pursue MSc study in a certain specialization but miss one or more prerequisite courses
should seek advice from their (potential) supervisor(s) and the appropriate lecturer(s) well before the start of their program.

The recommendations below are stated for each of the four broad specialization areas in Mathematics and Statistics.

First of all, it is strongly recommended that all students choose the following second year level subjects: Real Analysis with Applications (or equivalent); Vector Calculus; Probability. Further, they should choose at least two of following the second year level subjects: Group Theory with Linear Algebra; Dynamical Systems and Chaos; Discrete Mathematics and Operations Research; Statistics.

Students commencing the MSc program should have completed a major in one of the four specializations in the Department of Mathematics and Statistics. They are strongly recommended to study at least five third year level Mathematics and Statistics subjects, with four being essential.

Specific third year level recommendations related to the four specializations are listed below.

(A) Pure Mathematics

**Essential:** Group Theory with Linear Algebra; Complex Analysis; Algebra; Metric and Hilbert Spaces.

**Strongly recommended:** at least three of the following, with one being essential (excluding Partial Differential Equations): Graph Theory; Geometry; Discrete Mathematics; Partial Differential Equations.

(B) Applied Mathematics and Mathematical Physics

**Essential:** Dynamical Systems and Chaos; Complex Analysis; Numerical and Symbolic Mathematics; Partial Differential Equations.

**Strongly recommended:** at least two of the following: Graph Theory; Discrete Mathematics; Stochastic Modelling.

(C) Discrete Mathematics and Operations Research

**Essential:** Discrete Mathematics and Operations Research; Complex Analysis; Decision Making and Discrete Mathematics.

**Also essential:** at least two of the following: Techniques in Operations Research; Graph Theory; Stochastic Modelling.

(D) Statistics and Stochastic Processes

**Essential:** Statistics; Linear Statistical Models; Probability and Statistical Inference; Stochastic Modelling.

**Also essential:** Modern Applied Statistics.

**Strongly recommended:** Complex Analysis.

4 How to Apply

Applications to the Master of Science, PGDip and honours programs are made online: please go to

http://graduate.science.unimelb.edu.au/apply

Please refer to the above Melbourne Graduate School of Science Web-site for application deadline(s). If you experience any difficulties with the online application process, please contact the Melbourne Graduate School of Science.

Letters of acceptance are usually sent by the Faculty of Science in mid-December for commencement in Semester 1.
5 How to Find a Supervisor

Both MSc and Honours applicants are strongly encouraged to contact potential supervisors to discuss possible research projects before submitting their applications. Information about the Department, in particular the research activities of various research groups, can be found on the departmental website:

http://www.ms.unimelb.edu.au

Research interests of individual staff members in the Department can be searched online at:

http://www.ms.unimelb.edu.au/Students/supervisorList.php

A supervisor and a second examiner will be appointed for each MSc (or Honours) student. To assist in this, a student is expected to contact a potential supervisor ahead of the beginning of the program. The program Coordinator should be advised after the supervision arrangement is finalized.

- The role of the supervisor is to suggest the content and aim of the project, discuss relevant sources including textbooks, papers, reports, industry materials etc., as well as the timeline for the project and the best strategy for combining the coursework and project. During the year, the supervisor should oversee the student’s progress and provide advice and feedback.

- The second examiner acts as an advisor to the student when the principal supervisor is absent from the department.

The student is expected to provide a draft of the thesis in good time for the supervisor to read and comment on (doing that at least two weeks prior to the thesis submission date would be appropriate) and is responsible for submitting two final (bound hard) copies of the thesis by the deadline specified in this Guide. The supervisor and the second examiner will be responsible for marking the thesis.

6 CSP, HECS and Scholarships

6.1 CSP and HECS

The Master of Science programs will have ‘Commonwealth Supported Places’ (CSP) available for Australian students. BSc (Honours) and PGDip programs are supported by the Commonwealth. For more details, contact the Melbourne Graduate School of Science.

For more detail concerning CSPs, please visit the Commonwealth Government’s Department of Education, Employment and Workplace Relations website ‘Going to Uni’:


For information for future International students (incl. tuition fees) please refer to:

http://www.futurestudents.unimelb.edu.au/int/apply/

For more information on tuition fees for MSc, please visit the following website:

http://graduate.science.unimelb.edu.au/fees

MSc and Honours students may wish to consider undertaking some part-time tutoring in the department in the first half of their programs. For further information please see Dr Deb King (Director of the Mathematics and Statistics Learning Centre) as early as possible to register your interest.
6.2 Scholarships, Studentships, Awards and Prizes

Melbourne Graduate School of Science

The Melbourne Graduate School of Science offers a range of prizes and awards across graduate programs and disciplines to Australian and international students. There are also a number of scholarships available for students undertaking research programs. Students enrolling in the Master of Science in selected streams (including Mathematics and Statistics) in 2011 will be eligible to be considered for one of up to fifty $10,000 Bursaries (paid pro-rata over the time of the degree). Students will need to have a H1 (80+) average in their major (or equivalent) and apply by the closing date. For more information, visit:

http://graduate.science.unimelb.edu.au/support

For Graduate Coursework Scholarships, check

http://www.services.unimelb.edu.au/scholarships/gradcoursework/

and for the Faculty of Science awards, prizes and scholarships, visit

http://www.science.unimelb.edu.au/scholarships

Graduate Access Melbourne provides access to applicants whose personal circumstances have had a sustained adverse effect on their academic achievement at undergraduate level or who are members of a specified group known to be under-represented in higher education. Eligible Graduate Access Melbourne applicants are automatically considered for a Graduate Access Melbourne Bursary or the Maisie Fawcett Scholarship. Both provide a one-off grant of $5000, to help you meet the costs associated with graduate study. For more information, visit:

http://www.futurestudents.unimelb.edu.au/grad/gradaccess

Maurice Belz Scholarships

The department offers up to three scholarships (valued at $7000 each) to students enrolled in our MSc or Honours programs, specialising in Statistics and undertaking a research project in one of these areas: Applied Statistics, Applied Probability and Stochastic Processes, Operations Research. Application deadline is Friday 14 January 2011. For more detail, please contact our Academic Support Officer (contact details are on p.12).

Prizes

The department also awards the following scholarship and prizes for which MSc and Honours students are eligible:

- **Wyselaskie Scholarship**: awarded to the best MSc/Honours student in Mathematics and Statistics.
- **Dwight’s Prize**: awarded to the best MSc/Honours student in Statistics.
- **Urquhart Prize**: awarded to the student with the best overall performance in Mathematics in their Honours year (it is expected that MSc students will also be eligible for this prize in 2011).
- **Nanson/Wilson Prizes**: awarded to the best original memoir by a student within seven years of first enrolment.
7 Research Project

Provisional project titles and supervisors for MSc and Honours should be finalised and communicated to the Academic Support Officer (contact details are on p.12) by 31 January 2011 (for students starting in Semester 1).

It is expected that projects will be prepared to a professional standard using a document preparation program such as \LaTeX. Samples of recent projects can be found in a dedicated section of the Mathematics and Statistics Library.

The final project submission dates are: 2:00pm on Friday 4 November 2011 for end-of-year completion and 2:00pm on Friday 3 June 2011 for mid-year completion (two bound hard copies of the thesis will need to be submitted to the General Office; the requirements apply to all MSc and Honours students who are to complete their degrees in the respective semesters). For students who do not meet the submission deadline, the Examiners will take this into account at the Examiners Meeting. Each student will be required to give a seminar on the subject of their Project on Friday 25 November 2011 (end-of-year completion) or Friday 24 June 2011 (mid-year completion).

The project will be assessed on criteria which will take into account the research areas (pure mathematics, applied mathematics, operations research, probability, applied statistics etc.) and different forms (such as predominantly survey, new research, biological or industrial application, modelling etc.) a thesis may take. These criteria will include:

- clarity of exposition;
- mathematical accuracy;
- mathematical insight displayed;
- coverage of the field and references;

and may be complemented by one or more of the following:

- description of the application and/or business context;
- mathematical modelling;
- presentation and analysis of numerical results.

The weights given to these components will take into account the nature of the project.

Student Seminars

During their candidature, MSc and Honours students should give at least two talks. The first one could be a progress talk on their project or on another related topic and may be given before their research group. The second one will be presented as part of a mini 'conference' which is an all-departmental activity and which will be held at the end of the final semester of their degree (see above for the dates).

8 Pass Requirements

To be awarded an Honours qualification, an Honours student must achieve an overall weighted average of at least 65% in their Honours studies. This rule does not apply to MSc and PGDip students.

MSc and Honours/PGDip students should consider themselves a part of the research strength of the Department and view departmental seminars as a method of broadening their knowledge. It is therefore expected that students will attend all research seminars in the broader area of their chosen field.
9 Contact Details

- Dr Paul Norbury, MSc – Research Training (Coursework) Coordinator; phone: (03) 8344 7163, email: P.Norbury@ms.unimelb.edu.au.
- Dr Omar Foda, Honours and PGDip Coordinator; phone: (03) 8344 9690, email: O.Foda@ms.unimelb.edu.au.
- Ms Kirsten Hoak, Academic Support Officer; phone: (03) 9035 8013, email: khoak@unimelb.edu.au.

10 Key Dates

Application Dates for students to commence their studies in 2011:
- Please see the Faculty Web site referred to in Section 4 above.

Applications may be accepted after these dates. Please contact the Melbourne Graduate School of Science:

http://graduate.science.unimelb.edu.au/contact

MSc/Honours/PGDip Commencement:
- Usually, it is one week before the start of lectures in the respective semester.

MSc/Honours Thesis Submission Deadline:
- 2:00pm, Friday 4 November 2011 (end-of-year completion)
- 2:00pm, Friday 3 June 2011 (mid-year completion)
(For those students who do not meet the submission deadline, the Examiners will take this into account at the Examiners’ Meeting.)

Research Project Seminars:
- Friday 25 November 2011 (end-of-year completion)
- Friday 24 June 2011 (mid-year completion)

11 Useful Web Sites

Department of Mathematics and Statistics:
http://www.ms.unimelb.edu.au

Department Website for prospective MSc, Honours and PGDip students:
http://www.ms.unimelb.edu.au/Students/index_prospect_students.php

Melbourne Graduate School of Science:
http://graduate.science.unimelb.edu.au/

Faculty of Science MSc (Mathematics and Statistics) Website:
http://graduate.science.unimelb.edu.au/programs/msc/ms

Eastern Precinct Student Centre’s Website:
http://www.studentcentre.unimelb.edu.au/eastern

Melbourne Scholarships Office:
http://www.services.unimelb.edu.au/scholarships/

University Career and Employment Website:
http://www.services.unimelb.edu.au/careers/
## MSc Level Discipline Subjects in 2011–12

The table below shows year/semester allocation of MSc level discipline subjects in Mathematics and Statistics in 2011–12. Some subjects are taught each year, some subjects alternate. The ones appearing in the 2011 half of the table will be offered in odd years after 2012 (i.e. in 2013, 2015 etc.), whereas the ones in the 2012 half—in even years. The names of the compulsory subjects within the four specialisations have their names typeset in the **bold font**. The information presented in the table is a draft version of the program, as seen on 1 October 2010.

<table>
<thead>
<tr>
<th>2011 Semester 1</th>
<th>2011 Semester 2</th>
<th>2012 Semester 1</th>
<th>2012 Semester 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pure Mathematics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAST90012 Measure Theory</td>
<td>MAST90017 Representation Theory</td>
<td>MAST90023 Algebraic Topology</td>
<td>MAST90020 Functional Analysis</td>
</tr>
<tr>
<td>MAST90029 Differential Topology and Geometry</td>
<td>MAST90056 Riemann Surfaces &amp; Complex Analysis</td>
<td>MAST90025 Commutative and Multilinear Algebra</td>
<td>MAST90068 Groups, Categories &amp; Homological Algebra</td>
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<td><strong>Applied Mathematics &amp; Mathematical Physics</strong></td>
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<td>MAST90013 Network Optimisation</td>
<td>MAST90053 Experimental Mathematics</td>
<td>MAST90050 Scheduling and Optimisation</td>
</tr>
<tr>
<td><strong>Statistics &amp; Stochastic Processes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAST90059 Stochastic Calculus with Applications</td>
<td>MAST90061 Modern Statistical Methods</td>
<td>MAST90019 Random Processes</td>
<td>MAST90027 The Practice of Statistics</td>
</tr>
</tbody>
</table>
13 Appendix 1: Discipline Subjects

The subjects listed below are offered starting in 2011. Note that some of them are offered in either odd or even years only—which one is the case, is indicated for such subjects by (o) or (e) after the subject code. For semester allocation of the subjects, see the table on p. 13.

**Advanced Discrete Mathematics** MAST90030
**Coordinator:** Peter Forrester
The subject consists of four main topics. These are combinatorial logic by way of Sperner’s lemma and Ramsey theory; combinatorics on words and Sturmian sequences; bijective enumeration with applications to maps, permutations, lattice paths, trees, integer partitions, symmetric functions and tableaux. This subject has relevance to a broad range of specialisations.

**Recommended Pre-requisites:** Third year subjects in graph theory and/or discrete mathematics (equivalent to 620-352 [2009] Graph Theory or 620-353 [2009] Discrete Mathematics)

**Advanced Methods: Differential Equations** MAST90064 (o)
**Coordinator:** Barry Hughes
This subject develops the mathematical methods of applied mathematics and mathematical physics with an emphasis on ordinary differential equations. Both analytical and approximate techniques are used to determine solutions of ordinary differential equations. Exact solutions by localised series expansion techniques of second-order linear ordinary differential equations and Sturm-Liouville boundary value problems are explored. Special functions are introduced here. Regular and singular perturbation expansion techniques, asymptotic series solutions, dominant balance, and WKB theory are used to determine approximate solutions of linear and nonlinear differential equations. Throughout, the theory is set in the context of examples from applied mathematics and mathematical physics such as nonlinear oscillators, boundary layers and dispersive phenomena.

**Recommended Pre-requisites:** It is recommended that students have completed a subject in ordinary differential equations or dynamical systems, and a subject in real analysis. Completion of, or concurrent enrolment in, a subject in complex analysis may also be helpful.

**Advanced Methods: Transforms** MAST90067 (e)
**Coordinator:** Paul Pearce
This subject develops the mathematical methods of applied mathematics and mathematical physics with an emphasis on integral transform and related techniques. An introduction is given to the calculus of variations and the Euler-Lagrange equation. Advanced complex contour integration techniques are used to evaluate and invert Fourier and Laplace transforms. The general theory includes convolutions, Green’s functions and generalized functions. The methods of Laplace, stationary phase, steepest descents and Watson’s lemma are used to asymptotically approximate integrals. Throughout, the theory is set in the context of examples from applied mathematics and mathematical physics such as the brachistochrone problem, Fraunhofer diffraction, Dirac delta function, heat equation and diffusion.

**Recommended Pre-requisites:** It is recommended that students have completed subjects in complex analysis, real analysis and ordinary and partial differential equations.

**Algebraic Topology** MAST90023 (e)
**Coordinator:** Craig Hodgson
This subject studies topological spaces and continuous maps between them. It demonstrates the power of topological methods in dealing with problems involving shape and position of objects and continuous mappings, and shows how topology can be applied to many areas, including geometry, analysis, group theory and physics. The aim is to reduce questions in topology to problems in algebra by introducing algebraic invariants associated to spaces and continuous maps. Important classes of spaces studied are manifolds (locally Euclidean spaces) and CW complexes, built by gluing together cells of various dimensions. Topics include: homotopy of maps and homotopy equivalence of spaces, homotopy groups of spaces, the fundamental group, covering spaces; homology theory, including singular homology theory, the axiomatic approach of Eilenberg and Steenrod, and cellular homology.
**Recommended Pre-requisites:** It is recommended that students have completed third year subjects in algebra (equivalent to 620-321 Algebra) and metric spaces (equivalent to 620-329 Metric and Hilbert Spaces).

**Business Forecasting** MAST90009 (o)  
**Coordinator:** Aihua Xia  
Forecasting is an indispensable part of decision making in business management and government planning. This subject discusses the concept of forecasting and deals with standard forecasting tools. Topics covered include autoregressive, autoregressive moving average and autoregressive integrated moving average time series models and general autoregressive conditional heteroscedasticity, elements of spectral analysis and linear predictors.


**Commutative and Multilinear Algebra** MAST90025 (e)  
**Coordinator:** John Groves  
The subject covers aspects of multilinear and commutative algebra as well as two substantial applications. Within multilinear algebra this includes bilinear forms and ‘multilinear products’ of vector spaces, such as tensor products. Commutative algebra concerns itself with properties of commutative rings, such as polynomial rings and their quotients and to modules over such rings. Both topics have wide application, both to other parts of mathematics and to physics. Much of this theory was developed for applications in geometry and in number theory, and the theorems can be used to cast substantial light on problems from geometry and number theory.

**Recommended Pre-requisites:** It is recommended that students have completed a third year subject in algebra (equivalent to 620-321 Algebra).

**Computational Differential Equations** MAST90026 (e)  
**Coordinator:** Steven Carnie  
This subject discusses techniques to determine numerical solutions to a variety of problems commonly encountered in science and engineering. Understanding the behaviour of the mathematical problem gives insight into the pitfalls for the unwary in using canned packages inappropriately or uncritically. Topics will include boundary value problems for ordinary differential equations and the solution of parabolic, hyperbolic and elliptic partial differential equations.

**Recommended Pre-requisites:** A third year subject in partial differential equations (equivalent to 620-331 [2009] Applied Partial Differential Equations); a basic level of proficiency in computer programming.

**Continuum Mechanics and Applications** MAST90066 (o)  
**Coordinator:** John Elie Sader  
This subject focuses on physical principles and mathematical techniques for modelling the flow and deformation of materials. This finds applications in modern technological advances ranging from nanoelectromechanical systems (NEMS) to processes in the pharmaceutical industry involving microfluidic "lab-on-chip" technologies. It develops vector and tensor methods needed to formulate these principles mathematically; and also introduces the concept of a constitutive equation. Students should develop the ability to select a constitutive equation and correctly pose relevant boundary-value problems; to solve transport and flow problems in simple geometries; to identify valid approximate analyses; and to interpret solutions in physical terms. This subject demonstrates the potential for mathematical modelling of flow and transport processes that arise in a host of industries including manufacturing, mineral exploitation and other areas of science and technology. It also shows the intimate connection between continuum mechanical problems and fundamental mathematical problems.

**Recommended Pre-requisites:** It is recommended that students have completed a second year subject in vector analysis (equivalent of 620-231 [2009] Vector Calculus) and a third year subject in partial differential equations (equivalent of 620-331 [2009] Applied Partial Differential Equations).
**Differential Topology and Geometry** MAST90029 (o)

**Coordinator:** Craig Hodgson

This subject extends the methods of calculus and linear algebra to study the geometry and topology of higher dimensional spaces. The ideas introduced are of great importance throughout mathematics, physics and engineering. This subject will cover basic material on the differential topology of manifolds including integration on manifolds, and give an introduction to Riemannian geometry. Topics include: Differential Topology: smooth manifolds, tangent spaces, inverse and implicit function theorems, differential forms, bundles, transversalitv, integration on manifolds, de Rham cohomology; Riemannian Geometry: connections, geodesics, and curvature of Riemannian metrics; examples coming from Lie groups, hyperbolic geometry, and other homogeneous spaces.

**Recommended Pre-requisites:** It is recommended that students have completed subjects in vector analysis (equivalent to 620-231 Vector Analysis) and metric spaces (equivalent to 620-329 Metric and Hilbert Spaces).

**Enumerative Combinatorics** MAST90031 (o)

**Coordinator:** Aleks Owczarek.

The subject is about the use of generating functions for enumeration of combinatorial structures including partitions of numbers and of sets permutations with restricted cycle structure connected graphs and other types of graphs; solution of recurrence relations; methods of asymptotic enumeration; some applications in statistical mechanics. The methods covered have widespread applicability including areas of pure and applied mathematics and computer science.

**Recommended Pre-requisites:** A subject in real and complex analysis (equivalent to 620-221 [2008] Real and Complex analysis or 620-252 [2008] Analysis).

**Exactly Solvable Models** MAST90065 (o)

**Coordinator:** Jan de Gier

In mathematical physics, a wealth of information comes from the exact, non-perturbative, solution of quantum models in one-dimension and classical models in two-dimensions. This subject is an introduction to this beautiful and deep subject. Yang-Baxter, Bethe Ansatz and matrix product techniques are developed in the context of the critical two-dimensional Ising model, dimers, free fermions, the 6-vertex model, percolation, quantum spin chains and the stochastic asymmetric simple exclusion model. The algebraic setting incorporates the quantum groups, and the Temperley-Lieb and braid-monoid algebras with applications to knot theory. A general treatment of correlation functions includes applications to random polynomials and random matrices.

**Recommended Pre-requisites:** It is recommended that students have completed subjects in linear algebra and real and complex analysis. No prior knowledge of physics is assumed.

**Experimental Mathematics** MAST90053 (e)

**Coordinator:** Jan De Gier

Modern computers have developed far beyond being great devices for numerical simulations or tedious but straightforward algebra; and in 1990 the first mathematical research paper was published whose sole author was a thinking machine known as Shalosh B Ekhad. This course will discuss some of the great advances made in using computers to purely algorithmically discover (and prove) nontrivial mathematical theorems in, for example, Number Theory and Algebraic Combinatorics. Topics include: Automated hypergeometric summation, Groebner basis, Chaos theory, Number guessing, Recurrence relations and BBP formulas.

**Recommended Pre-requisites:** There are no pre-requisites.

**Functional Analysis** MAST90020 (e)

**Coordinator:** Greg Hjorth

Functional analysis is a fundamental area of pure mathematics, with countless applications to the theory of differential equations, engineering, and physics. The students will be exposed to the theory of Banach spaces, the concept of dual spaces, the weak-star topology, the Hahn-Banach theorem, the axiom of choice and Zorn’s lemma, Krein-Milman, operators on Hilbert space, the Peter-Weyl theorem for compact topological groups, the spectral theorem for infinite dimensional normal operators, and connections with harmonic analysis.
Recommended Pre-requisites: Subjects in linear algebra (equivalent to 620-231 Group Theory and Linear Algebra) and metric spaces (equivalent to 620-329 Metric and Hilbert Spaces).

Groups, Categories and Homological Algebra MAST90068 (e)

Coordinator: Craig Westerland

As well as being beautiful in its own right, algebra is used in many areas of mathematics, computer science and physics. This subject provides a grounding in several fundamental areas of modern advanced algebra including Lie groups, combinatorial group theory, category theory and homological algebra. The material complements that covered in the subject Commutative and Multilinear Algebra without assuming it as prerequisite.

Recommended Pre-requisites: It is recommended that students have completed a third year subject in algebra (equivalent to 620-321 Algebra).

Introduction to String Theory MAST90069 (e)

Coordinator: Omar Foda

The first half of the course is a solid introduction to two-dimensional conformal field theory with emphasis on the operator formalism and explicit calculations. The second is an introduction to bosonic string theory based on the first half. Time allowing, one or more of the following topics will be discussed: D-branes, compactification, dualities and matrix models. For concreteness, only bosonic strings in the light-cone gauge with simple world-sheet and target space topologies will be discussed.

Recommended Pre-requisites: It is recommended that students have completed subjects in Vector Analysis and Complex analysis. Prior knowledge of quantum mechanics would be helpful but not essential as the lectures will be self contained in this respect.

Mathematical Statistical Mechanics MAST90060 (o)

Coordinator: Paul Pearce

The goal of statistical mechanics is to describe the behaviour of bulk matter starting from a physical description of the interactions between its microscopic constituents. This subject introduces the Gibbs probability distributions of classical statistical mechanics, the relations to thermodynamics and the modern theory of phase transitions and critical phenomena. The central concepts of critical exponents, universality and scaling are emphasized throughout. Applications include the ideal gases, magnets, fluids, one-dimensional Ising and Potts lattice spin models, random walks and percolation as well as approximate methods of solution.

Recommended Pre-requisites: It is recommended that students have completed subjects in vector analysis and real analysis. No prior knowledge of physics or thermodynamics is assumed.

Mathematics of Risk MAST90051 (e)

Coordinator: Kostya Borovkov

Mathematical modelling of various types of risk has become an important component of the modern financial industry. The subject discusses the key aspects of the mathematics of market risk. Main concepts include loss distributions, risk and dependence measures, copulas, risk aggregation and allocation principles elements of extreme value theory. The main theme is the need to satisfactorily address extreme outcomes and the dependence of key risk drivers. Recommended Pre-requisites: A sound undergraduate probability subject (equivalent to either 620-201 [2009] Probability or 620-205 [2009] Probability for Statistics) and a theoretical statistics subject (equivalent to 620-202 [2009] Statistics.

Measure theory MAST90012 (o)

Coordinator: Greg Hjorth

Measure Theory formalises and generalises the notion of integration. It is fundamental to many areas of mathematics and probability and has applications in other fields such as physics and economics. Students will be introduced to Lebesgue measure and integration, signed measures, the Hahn-Jordan decomposition, the Radon-Nikodým derivative, conditional expectation, Borel sets and standard Borel spaces, product measures, and the Riesz representation theorem.

Recommended Pre-requisites: Subjects in linear algebra (equivalent to 620-231 Group Theory and Linear Algebra) and metric spaces (equivalent to 620-329 Metric and Hilbert Spaces).
Modelling: Mathematical Biology  MAST90011 (e)
Coordinator: Kerry Landman
Modern techniques have revolutionised biology and medicine, but interpretative and predictive tools are needed. Mathematical modelling is such a tool, providing explanations for counter-intuitive results and predictions leading to new experimental directions. The broad flavour of the area and the modelling process will be discussed. Applications will be drawn from many areas including population growth, epidemic modelling, biological invasion, pattern formation, tumour modelling, developmental biology and tissue engineering. A large range of mathematical techniques will be discussed, for example discrete time models, ordinary differential equations, partial differential equations, stochastic models and cellular automata.


Modern Statistical Methods  MAST90061 (o)
Coordinator: Guoqi Qian
Modern statistics is a blend of statistical theory and computational techniques. The understanding and application of modern statistical techniques such as the bootstrap, nonparametric density estimation, nonparametric regression, additive models, tree based methods, the EM algorithm and Markov chain Monte Carlo methods require the development of their theoretical properties, as well as development of suitable algorithms. In this course the emphasis will be on theory behind these techniques, and on how well they perform in both statistical research and applications.

Recommended Pre-requisites: It is recommended that students have completed third year subjects in statistics (equivalent to Linear Statistical Models [620-371 (prior to 2010) or 620-328 (2010)], and Modern Applied Statistics [620-372 (prior to 2010) or 620-330 (2010)].

Network Optimisation  MAST90014 (o)
Coordinators: Sanming Zhou
Many practical problems in management, operations research, telecommunication and computer networking can be modelled as optimisation problems on networks. Here the underlying structure is a graph. This subject is an introduction to optimisation problems on networks with a focus on theoretical results and efficient algorithms. It covers classical problems that can be solved in polynomial time, such as shortest paths, maximum matchings, maximum flows, and minimum cost flows. Other topics include complexity and NP-completeness, matroids and greedy algorithms, approximation algorithms, multicommodity flows, and network design. This course is beneficial for all students of discrete mathematics, operations research, and computer science.

Recommended Pre-requisites: An introductory level subject in operations research (equivalent to 620-290 Discrete Mathematics and Operations Research) or a third year subject in graph theory (equivalent to 620-352 Graph Theory).

Optimisation for Industry  MAST90014
Coordinator: Heng-Soon Gan
The use of mathematical optimisation is widespread in business, where it is a key analytical tool for managing and planning business operations. It is also required in many industrial processes and is useful to government and community organisations. This subject will expose students to operations research techniques as used in industry. A heavy emphasis will be placed on the modelling process that turns an industrial problem into a mathematical formulation. The focus will then be on how to solve the resulting mathematical problem. Mathematical programming and (meta)-heuristic techniques will be reviewed and applied to selected problems.

**Probability and Mathematical Statistics I** MAST90062  
**Coordinator:** Richard Huggins  
This subject first reviews the distributions of univariate and multivariate random variables extending the results encountered in previous probability courses. Principles of data reduction including the sufficiency and likelihood principles are discussed along with methods of finding and evaluating estimators and hypothesis tests. Methods of finding interval estimates are given. Decision theory is introduced and Bayes estimators and tests are discussed.  
**Recommended Pre-requisites:** It is recommended that students have completed a third year subject in probability and statistical inference (equivalent to 620-323 Probability and Statistical Inference).

**Probability and Mathematical Statistics II** MAST90063  
**Coordinator:** Kostya Borovkov  
This is a measure theory based advanced level course on probability theory, with applications to the theory of point estimation. The subject introduces key concepts and presents formal derivations of a number of fundamental results from probability theory. The second part of the course is devoted to the statistical theory of point estimation, where the results presented in the first part play a crucial role.  
**Recommended Pre-requisites:** It is recommended that students have completed a third year subject in probability and statistical inference (equivalent to 620-323 Probability and Statistical Inference).

**Random Processes** MAST90019 (e)  
**Coordinator:** Kostya Borovkov  
The subject covers the key aspects of the theory of stochastic processes that plays the central role in modern probability and has numerous applications in natural sciences and in industry. It begins with a discussion of ways to construct and specify random processes, then proceeds to distributional convergence of processes, covers the functional central limit theorem and its counterpart for empirical processes, and finally discusses Levy processes and more general continuous time Markov processes. Applications to modelling random phenomena evolving in time are discussed throughout the course.  
**Recommended Pre-requisites:** It is recommended that students have completed third year probability and stochastic modelling subjects.

**Representation Theory** MAST90017 (o)  
**Coordinator:** Arun Ram  
Symmetries arise in mathematics as groups and Representation Theory is the study of groups via their actions on vector spaces. It has important applications in many fields: physics, chemistry, economics, biology and others. This subject will provide the basic tools for studying actions on vector spaces. The course will focus on teaching the basics of representation theory through some favourite examples: symmetric groups, diagram algebras, matrix groups, reflection groups. In each case the irreducible characters and irreducible modules for the group (or algebra) will be analysed, developing more and more powerful tools as the course proceeds. Examples that will form the core of the material for the course include SL2, cyclic and dihedral groups, diagram algebras: Temperley-Lieb, symmetric group and Hecke algebras, Brauer and BMW algebras, compact Lie groups. Among the tools and motivation that will play a role in the study are characters and character formulas, Induction, restriction and tensor products, and connections to statistical mechanics, mathematical physics and geometry. If time permits, there may be some treatment of loop groups, affine Lie algebras and Dynkin diagrams.  
**Recommended Pre-requisites:** It is recommended that students have completed a third year subject in algebra (equivalent to 620-321 Algebra).
Riemann Surfaces and Complex Analysis MAST90056 (o)
Coordinator: Paul Norbury

Riemann surfaces arise from complex analysis. They are central in mathematics, appearing in seemingly diverse areas such as differential and algebraic geometry, number theory, integrable systems, statistical mechanics and string theory.

The first part of the course studies complex analysis. It assumes students have completed a first course in complex analysis so begins with a quick review of analytic functions and Cauchy’s theorem, emphasising topological aspects such as the argument principle and Rouche’s theorem. Topics also include: Schwarz’s lemma; limits of analytic functions, normal families, Riemann mapping theorem; multiple-valued functions, differential equations and Riemann surfaces. The second part of the course studies Riemann surfaces and natural objects on them such as holomorphic differentials and quadratic differentials. Topics may also include: divisors, Riemann-Roch theorem; the moduli space of Riemann surfaces, Teichmüller space; integrable systems.

Recommended Pre-requisites: It is recommended that students have completed a subject complex analysis (equivalent to 620-324 Complex Analysis).

Scheduling and Optimisation MAST90050 (e)
Coordinator: Heng-Soon Gan

Scheduling is critical to manufacturing, mining, and logistics, and is of increasing importance in healthcare and service industries. Most automated systems, ranging from elevators to industrial robots, embed some kind of scheduling algorithms. Building on the Optimisation background provided in Optimisation for Industry, this subject teaches students how to solve more advanced problems. A particular focus will be scheduling problems, but other more general assignment problems will be discussed.

Recommended Pre-requisites: None.

Stochastic Calculus with Applications MAST90059 (o)
Coordinator: Aihua Xia

This subject provides an introduction to stochastic calculus and mathematics of financial derivatives. Stochastic calculus is essentially a theory of integration of a stochastic process with respect to another stochastic process, created for situations where conventional integration will not be possible. Apart from being an interesting and deep mathematical theory, stochastic calculus has been used with great success in numerous application areas, from engineering and control theory to mathematical biology, theory of cognition and financial mathematics.

Recommended Pre-requisites: It is recommended that students have completed a sound undergraduate subject in probability (equivalent to 620-201 Probability or 620-205 Probability for Statistics) and a third year subject in stochastic modelling (equivalent to 620-301 Stochastic Modelling).

The Practice of Statistics MAST90027 (e)
Coordinator: Ian Gordon

This subject builds on methods and techniques learned in theoretical subjects by studying the application of statistics in real contexts. Emphasis is on the skills needed for a practising statistician, including the development of mature statistical thinking, organizing the structure of a statistical problem, the contribution to the design of research from a statistical point of view, measurement issues and data processing. The subject deals with thinking about data in a broad context, and skills required in statistical consulting.

Recommended Pre-requisites: It is recommended that students have completed third year subjects in statistics (equivalent to 620-371 [2009] Linear Models and 620-372 [2009] Applied Statistical Inference at the University of Melbourne). In any case, a sound working knowledge of statistical ideas and methods at the second year level (at least) is assumed.