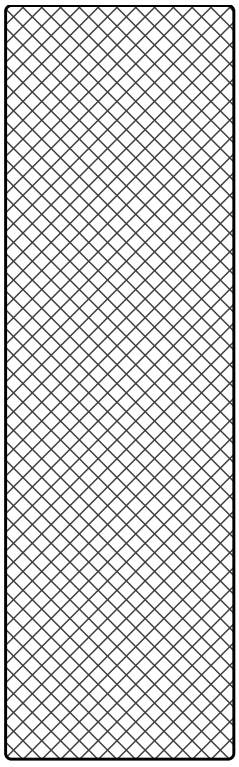
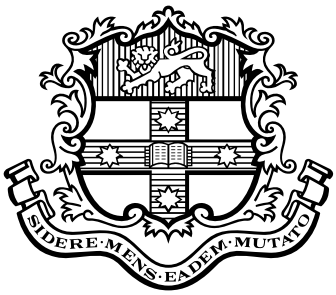


School of Mathematics
and Statistics

Faculties of Arts
Economics, Education,
Engineering and Science

INTERMEDIATE MATHEMATICS and STATISTICS



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THE UNIVERSITY OF SYDNEY

Contents

1. Introduction 1
1.1. Pure Mathematics 2
Normal Level 2
Advanced Level 3
1.2. Applied Mathematics 3
Normal Level 4
Advanced Level 4
1.3. Statistics 4
Normal Level 5
Advanced Level 5
1.4. Financial Mathematics and Statistics 5
1.5. Summary of Enrolment Advice 6
2. Units of Study 7
2.1. Mathematics Units: Semester 1 8
MATH2061 Linear Mathematics and Vector Calculus 8
MATH2063 Mathematical Computing and Nonlinear Systems 8
MATH2067 Differential Equations and Vector Calculus for engineers . 9
MATH2069 Discrete Mathematics and Graph Theory 9
MATH2961 Linear Mathematics and Vector Calculus (Advanced) 10
MATH2962 Real and Complex Analysis (Advanced) 10
MATH2963 Mathematical Computing and Nonlinear Systems (Advanced) 11
MATH2969 Discrete Mathematics and Graph Theory (Advanced) 11
2.2. Mathematics Units: Semester 2 12
MATH2065 Introduction to Partial Differential Equations 12
MATH2068 Number Theory and Cryptography 12
MATH2070 Optimisation and Financial Mathematics 13
MATH2965 Introduction to Partial Differential Equations (Advanced) 13
MATH2968 Algebra (Advanced) 14
MATH2970 Optimisation and Financial Mathematics (Advanced) 14
MATH2988 Number Theory and Cryptography (Advanced) 14
2.3. Mathematical Statistics Units 15
STAT2011 Statistical Models 15
STAT2012 Statistical Tests 15
STAT2911 Probability and Statistical Models (Advanced) 16
STAT2912 Statistical Tests (Advanced) 16

3. Assessment 17
3.1. Semester Examinations 17
3.2. Assignments 17
3.3. Quizzes, participation marks 18
3.4. Illness or misadventure 18
3.5. Special Consideration 19
3.6. Further Assessment 20
3.7. Results 20
3.8. Academic Honesty 20
4. Additional Information 21
4.1. Enrolment, Registration and Timetable 21
4.2. Change of Enrolment 21
4.3. Lectures 21
4.4. Tutorials and Lab Sessions 21
4.5. Webpages, Noticeboards and Pigeonholes 22
4.6. Consultations 22
4.7. Solutions to Tutorials and Assignments 22
4.8. Kopystop and University Copy Centre 22
4.9. Scholarships and Prizes 23
5. Contacts 24

1. Introduction

This handbook contains information about Intermediate Units of Study offered by the School of Mathematics and Statistics, for students in the Faculties of Science, Arts, Engineering, Economics and Education. If you enrol in an intermediate mathematics or statistics unit you will need to refer to this handbook throughout the year.

This introductory section aims to provide you with sufficient information to be able to choose the units which most suit your interests and abilities.

The School offers a variety of one-semester 6-credit point intermediate units in Mathematics and Statistics. There are units at both Advanced and Normal levels. Mathematics units are grouped into two disciplines, Applied Mathematics and Pure Mathematics.

If you are a student in the Science Faculty you are required to complete a major in a recognized subject area (such as Mathematics or Statistics). For this you must complete at least 24 senior credit points in that subject area. You can, if you wish, attempt two majors. You should keep this in mind when planning your intermediate year and consult the Senior Mathematics and Statistics Handbook and Science Faculty handbook, if necessary. The School of Mathematics and Statistics offers majors in the following subject areas: Mathematics, which includes a double major in Mathematics consisting of at least 48 senior credit points; Statistics; and Financial Mathematics and Statistics. Although it is possible for you to do a major in Mathematics with only 12 intermediate level credit points of Mathematics, you are strongly advised to do more than 12 credit points of Intermediate Mathematics. Completing 18 or 24 credit points of intermediate level Mathematics will provide you with a better foundation for your senior year, and open up a wider choice of senior level units to you. If your main interest is Mathematics, you could well choose to do a double major in Mathematics, and the ideal preparation for this would be 36 credit points of intermediate level Mathematics. You may, if you wish, specialize completely in Mathematics and Statistics in your intermediate and senior years.

If you are in a Faculty different from Science consult the relevant Faculty handbook about your degree requirements in Mathematics and Statistics. Engineering students should also consult their department.

The School offers honours units in Applied Mathematics, Pure Mathematics and Mathematical Statistics. If you are considering an honours degree in Mathematics and Statistics, most of your units should be at the advanced level.

A brief description of each of the units of study, and recommended combinations of units, follows. You may, of course, choose any combination of units for which you qualify. Prerequisites for each unit are given in Chapter 2.

However, you should follow the recommendations if you wish to major in, or complete an honours degree in, one of the subject areas described below.

1.1. Pure Mathematics

Pure Mathematics units are designed to provide students with the mathematical knowledge and techniques necessary in all scientific and engineering disciplines, as well as the solid mathematical base necessary for a career in mathematics. Recent developments in pure mathematical research have led to important and exciting applications in various branches of theoretical and applied sciences, and in engineering. Some examples include the application of singularity theory and group theory to symmetry-breaking and bifurcation in engineering; the application of number theory to cryptography; of category theory to computer science; and of complex analysis and algebraic geometry to physics.

Most importantly, units in Pure Mathematics provide invaluable training in logical thinking and problem solving – skills which you will find invaluable no matter what career you subsequently choose. Graduates with a major in Pure Mathematics may choose a career in teaching or research, or in one of the many fields in which mathematical ability and expertise are important, such as finance, operations research, computing and management. Even if your intended career path does not seem to involve much mathematics, you will find that employers, in general, hold mathematical ability in very high regard.

If your interest is in Pure Mathematics, the following units are recommended.

Normal Level There are four 6 credit point intermediate units recommended for students of Pure Mathematics:

MATH2061 *Linear Mathematics and Vector Calculus*.

MATH2065 *Introduction to Partial Differential Equations*.

MATH2068 *Number Theory and Cryptography*.

MATH2069 *Discrete Mathematics and Graph Theory*.

We recommend that students wishing to study at the normal level and complete a Mathematics major in Pure Mathematics do MATH2061 and at least one of MATH2068 or MATH2069. Note that MATH2061 is also recommended for students intending to do a major in applied mathematics.

Note that all students intending to do a mathematics major are strongly advised to more than 12 credit points of intermediate mathematics. Although it is possible to proceed to a major with only 12 credit points of intermediate mathematics, taking 18 or 24 credit points will give you a better background and a wider range of options for your senior year.

Advanced Level If your grades have been a credit average or better in Junior Mathematics units we encourage you to enrol in some advanced units in your intermediate year. There are six 6 credit point advanced level intermediate units recommended for students of Pure Mathematics:

MATH2961 *Linear Mathematics and Vector Calculus (Advanced).*

MATH2962 *Real and Complex Analysis (Advanced).*

MATH2965 *Introduction to Partial Differential Equations (Advanced).*

MATH2968 *Algebra (Advanced).*

MATH2969 *Discrete Mathematics and Graph Theory (Advanced).*

MATH2988 *Number Theory and Cryptography (Advanced).*

MATH2961, which is the advanced level analogue of MATH2061, is considered core material for both pure mathematics and applied mathematics, and so every student intending to do a mathematics major is expected to take either MATH2061 or MATH2961. Students who are considering ultimately proceeding to honours in Pure Mathematics are advised to do MATH2962 and MATH2968 in addition, since the topics introduced in these units are developed further in senior year pure mathematics units. A minimum of 12 credit points of intermediate mathematics is needed if you wish to do a mathematics major, but doing 18 or more provides a much better preparation.

Note that the lectures for MATH2969 are the same as the the lectures for the normal level unit MATH2069; similarly MATH2988 and MATH2068 share common lectures. Despite the similarity of the unit codes there is no close connection between the subject matter of MATH2968 and that of MATH2068, and no preclusion on enrolling in both.

1.2. Applied Mathematics

Applied Mathematics is concerned with the development of mathematical models and techniques, both classical (such as calculus) and modern (such as discrete optimisation), with application to the solution of problems in the physical, biological and social sciences, engineering, medicine and computer science. The School has particular expertise in the general fields of astrophysics, relativity, engineering mathematics, biological sciences and earth sciences. Computer algebra and computational techniques are of considerable interest to Applied Mathematics and units are offered reflecting this.

Units in Applied Mathematics give a student a broad but rigorous training. These qualities are much in demand in the computer industry, engineering, banking and commerce, government organisations and teaching, and thus the study of Applied Mathematics can lead to a rewarding and satisfying career in a wide variety of disciplines. Applied Mathematics is complementary to units in Physics, Marine Sciences and Geophysics. For the mathematically inclined

student the combination of Applied Mathematics with one or both of Pure Mathematics and Mathematical Statistics is an obvious possibility.

If your interest is in Applied Mathematics, the following units are recommended.

Normal Level There are four 6 credit point intermediate units recommended for students of Applied Mathematics:

MATH2061 *Linear Mathematics and Vector Calculus*.

MATH2065 *Introduction to Partial Differential Equations*.

MATH2063 *Mathematical Computing and Nonlinear Systems*.

MATH2070 *Optimisation and Financial Mathematics*.

We recommend that all students wishing to major in Applied Mathematics do MATH2061 and MATH2065. A 12 credit point normal level combination of units will allow you to complete a Mathematics major in Applied Mathematics, but you are strongly advised to do more than 12 credit points of Intermediate Mathematics. You may, if you wish, enrol in some advanced units, provided you qualify.

Advanced Level There are four advanced units of Applied Mathematics. Serious students of Applied Mathematics are strongly encouraged to enrol in the two units:

MATH2961 *Linear Mathematics and Vector Calculus (Advanced)*.

MATH2965 *Introduction to Partial Differential Equations (Advanced)*.

and at least one of the following units:

MATH2963 *Mathematical Computing and Nonlinear Systems (Advanced)*.

MATH2970 *Optimisation and Financial Mathematics (Advanced)*.

This advanced level package of units will allow you to complete a Mathematics major in Applied Mathematics and proceed to an honours year in Applied Mathematics. It is not strictly necessary to take all units at the advanced level in order to do honours, but they do provide a better foundation for senior units and honours.

1.3. Statistics

Mathematical Statistics is concerned with developing the theory necessary for the analysis and modelling of data and the testing of scientific hypotheses. Statistical ideas permeate the whole fabric of scientific investigation. Thus the units are found valuable not just for mathematicians but for students specialising in areas such as psychology and biological sciences.

Statistical expertise is a valued commodity in industry, commerce and government agencies. Thus recent graduates with a major in mathematical statistics have had no difficulty in finding employment either in the private sector (e.g., insurance, banking) or the public sector (e.g., ABS, CSIRO, SRA, Telstra). There is at present an Australia-wide shortage of honours graduates and postgraduates in statistics.

Modern statistics involves considerable use of high-speed computers. Students in the intermediate Statistics units, STAT2011 or STAT2911 and STAT2012 or STAT2912, will have weekly computing sessions using the package R.

Normal Level The standard 12 credit point Statistics intermediate combination of units is as follows:

STAT2011 *Statistical Models*.

STAT2012 *Statistical Tests*.

In order to major in Statistics, it is recommended that you take MATH2061 (or MATH2961).

Advanced Level The standard 12 credit point Statistics intermediate combination of units is as follows:

STAT2911 *Probability and Statistical Models (Advanced)*.

STAT2912 *Statistical Tests (Advanced)*.

In order to major in Statistics at the Advanced level, you must take either MATH2961 or MATH2061.

Science students who do not wish to major in Statistics, but want to learn further statistical techniques, without the mathematical theory, could choose STAT2012, following any Junior Statistics course. These students can then proceed to up to 12 credit points of Senior Statistics if they wish.

1.4. Financial Mathematics and Statistics

Students in the BSc and BSc (Advanced) degrees can choose to major in Financial Mathematics and Statistics. There are three core intermediate units of study that must be completed; in each case you may choose the normal level unit or its advanced level counterpart. The core units are:

MATH2070 or MATH2970 *Optimisation and Financial Mathematics*;

STAT2011 or STAT2911 *Statistical Models*;

STAT2012 or STAT2912 *Statistical Tests*.

It is recommended that you also do the following Intermediate Mathematics units: (MATH2061 or MATH2961), (MATH2063 or MATH2963) and (MATH2065 or MATH2965).

1.5. Summary of Enrolment Advice

- In general, you need 12 credit points of intermediate Mathematics to qualify for a normal level unit of senior Mathematics.
- If your major interest is in Mathematics or Statistics then you are strongly encouraged to enrol in at least 4 units (24 credit points) of Mathematics and Statistics. If you are considering doing honours in Applied Mathematics, the units should include MATH2961 and MATH2965. If you are considering doing honours in Pure Mathematics, the units should include MATH2961, MATH2962 and MATH2968.
- Students intending to specialise in Applied Mathematics should choose at least 3 units (18 credit points) from the units labelled "Applied" or "Pure and Applied". The units should include MATH2061 or MATH2961, and MATH2065 or MATH2965.
- Students intending to specialise in Pure Mathematics should choose at least 3 units (18 credit points) from the units labelled "Pure" or "Pure and Applied". These should include MATH2061 or MATH2961. For advanced students MATH2962 and MATH2968 should be included.
- Students intending to specialise in Statistics should enrol in STAT2011 or STAT2911, and also STAT2012 or STAT2912. Intending honours students should choose the advanced versions.
- Students intending to specialise in Financial Mathematics and Statistics should enrol in MATH2070 or MATH2970, STAT2011 or STAT2911, and STAT2012 or STAT2912.
- Engineering students (excluding chemical engineering) are required to do either MATH2061 or MATH2067, and would be well advised to do MATH2065. (Check with the Engineering Faculty to see which of MATH2061 or MATH2067 specified for your degree program.)
- Information Technology students should normally include MATH2069 as one of their choices, and strongly consider MATH2063, MATH2068 and STAT2012.
- Students whose interest lies in Physics, Chemistry or other sciences would be well-advised to do MATH2061 and MATH2065.
- Prospective teachers of mathematics should basically do as many mathematics and/or statistics units as their degree program will allow: for example, MATH2061, MATH2063, MATH2065, MATH2068, MATH2069, STAT2011 and STAT2012 all contain material that may be of use to a teacher.

In all instances normal level units can be replaced by their advanced level counterparts.

2. Units of Study

- Each unit has a web page, accessed by following the links from

  `http://www.maths.usyd.edu.au/u/UG/IM/`

- Mathematics units are listed, by semester, in numerical order; then Statistics units are listed in numerical order.
- Units are designated *Normal* or *Advanced*. Entry to an Advanced level unit normally requires a Credit or better in a Normal level pre-requisite, or a Pass or better in an Advanced level pre-requisite.
- Mathematics units are also labelled *Applied*, or *Pure*, or both.
- The Unitcode for an Intermediate Unit in the School consists of MATH or STAT followed by 4 digits—for example MATH2063 or STAT2011. The first digit indicates that it is an Intermediate unit. The second digit indicates normal (0 or 1), or advanced (9). In most two units which share the same last two digits are mutually exclusive: for example, MATH2061 may not be counted with MATH2961. The one exception is that MATH2068 and MATH2968 are not mutually exclusive. Instead MATH2068 and MATH2988 are mutually exclusive.
- Text and reference books are yet to be advised. Except for *The Little Blue Book* it is suggested that you do not purchase any books until recommendations are made by lecturers.

  The Little Blue Book is a compact reference book: it contains definitions, formulas and important results from Junior Mathematics which are used in Intermediate Units. It is recommended that all students have access to this book: it is available from the Co-op Bookshop.

2.1. Mathematics Units: Semester 1

MATH2061 Linear Mathematics and Vector Calculus 6 credit points
Semester 1, Pure and Applied, Normal
Prerequisite: (*MATH1001* or *MATH1901* or *MATH1906* or *MATH1111*) and (*MATH1002* or *MATH1014* or *MATH1902*) and (*MATH1003* or *MATH1903* or *MATH1907*)
Prohibition: May not be counted with *MATH2001* or *MATH2901* or *MATH2002* or *MATH2902* or *MATH2961*.
Classes: 3 lectures, 1 tutorial and 1 practice class per week.
Assessment: One 2 hr exam, assignments, quizzes.

This unit starts with an investigation of linearity: linear functions, general principles relating to the solution sets of homogeneous and inhomogeneous linear equations (including differential equations), linear independence and the dimension of a linear space. The study of eigenvalues and eigenvectors, begun in junior level linear algebra, is extended and developed. Linear operators on two dimensional real space are investigated, paying particular attention to the geometrical significance of eigenvalues and eigenvectors. The unit then moves on to topics from vector calculus, including vector-valued functions (parametrised curves and surfaces; vector fields; div, grad and curl; gradient fields and potential functions), line integrals (arc length; work; path- independent integrals and conservative fields; flux across a curve), iterated integrals (double and triple integrals; polar, cylindrical and spherical coordinates; areas, volumes and mass; Green's Theorem), flux integrals (flow through a surface; flux integrals through a surface defined by a function of two variables, though cylinders, spheres and parametrised surfaces), Gauss' Divergence Theorem and Stokes' Theorem.

MATH2063 Mathematical Computing and Nonlinear Systems 6 credit points
Semester 1, Applied, Normal
Prerequisite: (*MATH1001* or *MATH1901* or *MATH1906*) and (*MATH1002* or *MATH1902*) and (*MATH1003* or *MATH1903* or *MATH1907*)
Prohibition: May not be counted with *MATH2003* or *MATH2903* or *MATH2006* or *MATH2906* or *MATH2963*.
Classes: 3 lectures, 1 tutorial and 1 computer lab per week.
Assessment: One 2 hr exam, assignments, quizzes.

This unit will introduce students to techniques of mathematical computation as applied to nonlinear systems, using the numerical programming language MATLAB and, where appropriate, computer algebra. This knowledge will be applied to a number of modelling problems, particularly those involving nonlinear mappings and nonlinear ordinary differential equations (ODEs). Throughout the unit of study the essential nonlinear theory will be developed, and the resulting ideas will be explored computationally. This will allow us to explore the modern concepts of chaos using a variety of examples, including the logistic map, the Henon map and the Lorenz equations. No prior knowledge of programming or of the MATLAB language or computer algebra is required.

MATH2067 Differential Equations and Vector Calculus for engineers

6 credit points

Semester 1, Normal, Available only to students in the Engineering Faculty
Prerequisite: (*MATH1001* or *MATH1901* or *MATH1906*) and (*MATH1002* or *MATH1902*) and (*MATH1003* or *MATH1903* or *MATH1907*)
Prohibition: May not be counted with *MATH2001* or *MATH2901* or *MATH2005* or *MATH2905* or *MATH2061* or *MATH2961*.
Classes: 3 lectures, 1 tutorial and 1 practice class per week.
Assessment: One 2 hr exam, mid-semester test, assignments.

The unit starts by introducing students to solution techniques of ordinary and partial differential equations (ODEs and PDEs) relevant to the engineering disciplines: it provides a basic grounding in these techniques to enable students to build on the concepts in their subsequent engineering classes. The main topics are Fourier series, second order ODEs, including inhomogeneous equations and Laplace transforms, and second order PDEs in rectangular domains (solution by separation of variables).

The unit moves on to topics from vector calculus, including vector-valued functions (parametrised curves and surfaces; vector fields; div, grad and curl; gradient fields and potential functions), line integrals (arc length; work; path-independent integrals and conservative fields; flux across a curve), iterated integrals (double and triple integrals; polar, cylindrical and spherical coordinates; areas, volumes and mass; Green's Theorem), flux integrals (flow through a surface; flux integrals through a surface defined by a function of two variables, though cylinders, spheres and parametrised surfaces), Gauss's Divergence Theorem and Stokes' Theorem.

MATH2069 Discrete Mathematics and Graph Theory

6 credit points

Semester 1, Pure, Normal
Prerequisite: 6 credit points of Junior Mathematics.
Prohibition: May not be counted with *MATH2011* or *MATH2009* or *MATH2969*.
Classes: 3 lectures, 1 tutorial and 1 practice class per week.
Assessment: One 2 hr exam, assignments, quizzes.

We introduce students to several related areas of discrete mathematics, which serve their interests for further study in pure and applied mathematics, computer science and engineering. Topics to be covered in the first part of the unit include recursion and induction, generating functions and recurrences, combinatorics, asymptotics and analysis of algorithms. Topics covered in the second part of the unit include Eulerian and Hamiltonian graphs, the theory of trees (used in the study of data structures), planar graphs, the study of chromatic polynomials (important in scheduling problems), maximal flows in networks, matching theory.

MATH2961 Linear Mathematics and Vector Calculus (Advanced) 6 credit points
Semester 2, Pure and Applied, Advanced
Prerequisite: (*MATH1901* or *MATH1906* or Credit in *MATH1001*) and (*MATH1902* or Credit in *MATH1002*) and (*MATH1903* or *MATH1907* or Credit in *MATH1003*)
Prohibition: May not be counted with *MATH2001* or *MATH2901* or *MATH2002* or *MATH2902* or *MATH2061*.
Classes: 4 lectures and 1 tutorial per week.
Assessment: One 2 hr exam, assignments.

This unit is an advanced version of MATH2061, with more emphasis on the underlying concepts and on mathematical rigour. Topics from linear algebra focus on the theory of vector spaces and linear transformations. The connection between matrices and linear transformations is studied in detail. Determinants, introduced in first year, are revised and investigated further, as are eigenvalues and eigenvectors. The calculus component of the unit includes local maxima and minima, Lagrange multipliers, the inverse function theorem and Jacobians. There is an informal treatment of multiple integrals: double integrals, change of variables, triple integrals, line and surface integrals, Green's theorem and Stokes' theorem.

MATH2962 Real and Complex Analysis (Advanced) 6 credit points
Semester 1, Pure, Advanced
Prerequisite: (*MATH1901* or *MATH1906* or Credit in *MATH1001*) and (*MATH1902* or Credit in *MATH1002*) and (*MATH1903* or *MATH1907* or Credit in *MATH1003*)
Prohibition: May not be counted with *MATH2007* or *MATH2907*.
Classes: 3 lectures, 1 tutorial and 1 practice class per week.
Assessment: One 2 hr exam, assignments.

Analysis is one of the fundamental topics underlying much of mathematics including differential equations, dynamical systems, differential geometry, topology and Fourier analysis. Starting off with an axiomatic description of the real number system, this first course in analysis concentrates on the limiting behaviour of infinite sequences and series on the real line and the complex plane. These concepts are then applied to sequences and series of functions, looking at point-wise and uniform convergence. Particular attention is given to power series leading into the theory of analytic functions and complex analysis. Topics in complex analysis include elementary functions on the complex plane, the Cauchy integral theorem, Cauchy integral formula, residues and related topics with applications to real integrals.

MATH2963 Mathematical Computing and Nonlinear Systems (Advanced) 6 credit points

Semester 1, Applied, Advanced
Prerequisite: (*MATH1901* or *MATH1906* or Credit in *MATH1001*) and (*MATH1902* or Credit in *MATH1002*) and (*MATH1903* or *MATH1907* or Credit in *MATH1003*).
Prohibition: May not be counted with *MATH2003* or *MATH2903* or *MATH2006* or *MATH2906* or *MATH2063*.
Classes: 3 lectures, 1 tutorial and 1 computer lab per week.
Assessment: One 2 hr exam, 2 assignments, quizzes.

The content of this unit of study parallels that of MATH2063, but both computational and theory components will place more emphasis on advanced topics, including Lyapunov exponents, stability, 2- and 3-cycles for mappings and concepts such as strange attractors. No prior knowledge of programming or of the MATLAB language or computer algebra is required.

See the description under MATH2063.

MATH2969 Discrete Mathematics and Graph Theory (Advanced) 6 credit points

Semester 1, Pure, Advanced
Prerequisite: 9 credit points of advanced level Junior Mathematics (or normal level with Credit average).
Prohibition: May not be counted with *MATH2011* or *MATH2009* or *MATH2069*.
Classes: 3 lectures, 1 tutorial and 1 practice class per week.
Assessment: One 2 hr exams, assignments, quizzes.

This unit will cover the same material as MATH2069 with some extensions and additional topics.

2.2. Mathematics Units: Semester 2

MATH2065 Introduction to Partial Differential Equations 6 credit points
Semester 2, Pure and Applied, Normal
Prerequisite: (*MATH1001* or *MATH1901* or *MATH1906*) and (*MATH1002* or *MATH1902*) and (*MATH1003* or *MATH1903* or *MATH1907*).
Prohibition: May not be counted with *MATH2005* or *MATH2905* or *MATH2965* or *MATH2067*.
Classes: 3 lectures, 1 tutorial and 1 practice class per week.
Assessment: One 2 hr exam, mid-semester test, assignments.

This is an introductory course in the analytical solutions of partial differential equations and boundary value problems. The techniques covered include separation of variables, Fourier series, Fourier transforms and Laplace transforms.

MATH2068 Number Theory and Cryptography 6 credit points
Semester 2, Pure, Normal
Prerequisite: 6 credit points of Junior Mathematics.
Assumed Knowledge: MATH1014 or MATH1002 or MATH1902
Prohibition: May not be counted with *MATH3024* or *MATH3009*.
Classes: 3 lectures, 1 tutorial and 1 computer lab per week.
Assessment: One 2 hr exam, assignments, quizzes.

Cryptography is the branch of mathematics that provides the techniques for confidential exchange of information sent via possibly insecure channels. This unit introduces the tools from elementary number theory that are needed to understand the mathematics underlying the most commonly used modern public key cryptosystems. Topics include the Euclidean Algorithm, Fermat's Little Theorem, the Chinese Remainder Theorem, Möbius Inversion, the RSA Cryptosystem, the Elgamal Cryptosystem and the Diffie-Hellman Protocol. Issues of computational complexity are also discussed.

MATH2070 Optimisation and Financial Mathematics 6 credit points

Semester 2, Applied, Normal
Prerequisite: (*MATH1001* or *MATH1901* or *MATH1906*) and (*MATH1002* or *MATH1902*).
Assumed Knowledge: *MATH1003* or *MATH1903* or *MATH1907*.
Prohibition: May not be counted with *MATH2010* or *MATH2033* or *MATH2933* or *ECMT3510 Operations Research A*.
Classes: 3 lectures, 1 tutorial and 1 computer lab per week.
Assessment: One 2 hr exam, assignments, quizzes, project.

Problems in industry and commerce often involve maximising profits or minimising costs subject to constraints arising from resource limitations. The first part of this unit looks at the important class of linear programming problems and their solution using the simplex algorithm, and the minimisation of functions of several variables with constraints, including Lagrange multipliers, Kuhn-Tucker theory and quadratic programming.

The second part of the unit deals with utility theory and modern portfolio theory. Topics covered include: pricing under the principles of expected return and expected utility; mean-variance Markowitz portfolio theory, the Capital Asset Pricing Model, log-optimal portfolios and the Kelly criterion; dynamical programming. Some understanding of probability theory including distributions and expectations is required in this part.

Theory developed in lectures will be complemented by computer laboratory sessions using MATLAB. Minimal computing experience will be required.

MATH2965 Introduction to Partial Differential Equations (Advanced) 6 credit points

Semester 2, Applied, Advanced
Prerequisite: (*MATH2961* or Credit in *MATH2061*) or (*MATH2901* or Credit in *MATH2001*) and (*MATH2902* or Credit in *MATH2002*)).
Prohibition: May not be counted with *MATH2005* or *MATH2905* or *MATH2065*.
Classes: 3 lectures, 1 tutorial and 1 practice class per week.
Assessment: One 2 hr exam, assignments.

This unit of study is essentially an advanced version of MATH2065, the emphasis being on solutions of differential equations in applied mathematics. The theory of ordinary differential equations is developed for second order linear equations, including series solutions, special functions and Laplace transforms. Some use is made of computer programs such as Mathematica. Methods for PDEs (partial differential equations) and boundary-value problems include separation of variables, Fourier series and Fourier transforms.

MATH2968 Algebra (Advanced) 6 credit points

Semester 2, Pure, Advanced
Prerequisite: 9 credit points of Junior Mathematics (advanced level or Credit at normal level) including (*MATH1902* or Credit in *MATH1002*).
Prohibition: May not be counted with *MATH2908* or *MATH2918* or *MATH2008*.
Classes: 3 lectures, 1 tutorial and 1 practice class per week.
Assessment: One 2 hr exam, assignments.

This unit provides an introduction to modern abstract algebra, via linear algebra and group theory. It extends the linear algebra covered in Junior Mathematics and MATH2961, and proceeds to a classification of linear operators on finite dimensional spaces. Permutation groups are used to introduce and motivate the study of abstract group theory. Topics covered include actions of groups on sets, subgroups, homomorphisms, quotient groups and the classification of finite abelian groups.

MATH2970 Optimisation and Financial Mathematics (Advanced) 6 credit points

Semester 2, Applied, Advanced
Prerequisite: (*MATH1901* or *MATH1906* or Credit in *MATH1001*) and (*MATH1902* or Credit in *MATH1002*).
Assumed Knowledge: *MATH1903* or *MATH1907* or Credit in *MATH1003*.
Prohibition: May not be counted with *MATH2010* or *MATH2033* or *MATH2933* or *MATH2070*.
Classes: 3 lectures, 1 tutorial and 1 computer lab per week.
Assessment: One 2 hr exam, assignments, quizzes, project.

The content of this unit parallels MATH2070, but students enrolled at Advanced level will undertake more advanced problem solving and assessment tasks, and some additional topics may be included.

MATH2988 Number Theory and Cryptography (Advanced) 6 credit points

Semester 2, Pure, Advanced
Prerequisite: At least 9 credit points from the following list: MATH1901 or Credit in MATH1001, MATH1902 or Credit in MATH1002, MATH1903 or Credit in MATH1003, MATH1904 or Credit in MATH1004, MATH1905 or Credit in MATH1005, MATH1906, MATH1907, MATH2961 or Credit in MATH2061, MATH2969 or Credit in MATH2069, MATH2962.
Prohibition: May not be counted with *MATH2068* or *MATH3024* or *MATH3009*.
Classes: 3 lectures, 1 tutorial and 1 computer lab per week.
Assessment: One 2 hr exam, assignments, quizzes.

This unit of study is an advanced version of MATH2068, sharing the same lectures but with more advanced topics introduced in the tutorials and computer laboratory sessions.

2.3. Mathematical Statistics Units

STAT2011 Statistical Models introduces both data analysis and ideas of probability and statistical distributions used to explain variability of data. STAT2012 Statistical Tests deals with the methods of statistical analysis of data. Students planning to major in Statistics will need both units. For students who wish an introduction to statistical theory, including some probability, STAT2011 could stand alone and could lead to study of stochastic processes in the Senior year, and so may be suited to students of Financial Mathematics and Physics. For students whose interest is only in applications of statistics, it would be possible to follow a Junior Statistics course with STAT2012 and to proceed to 12 credit points of Senior courses on applied statistics.

The advanced unit corresponding to STAT2011, namely STAT2911 Probability and Statistical Models, gives a more serious introduction to probability and mathematical statistics, while covering the development of statistical models in STAT2011. Similarly, STAT2912 Statistical Tests (Advanced) gives a more mathematically based treatment of classical statistical methods while covering the ideas introduced in STAT2012.

STAT2011 Statistical Models 6 credit points

Semester 1, Normal
Prerequisite: (*MATH1001* or *MATH1901* or *MATH1906* or *MATH1011*) and [(*MATH1005* or *MATH1905* or *MATH1015* or *STAT1021*)].
Prohibition: May not be counted with *STAT2901* or *STAT2001* or *STAT2911*.
Classes: 3 lectures, 1 tutorial and 1 computer lab per week.
Assessment: One 3 hr exam, assignments/quizzes, computer practical reports, one 1 hr computer practical class assessment task.

This unit provides an introduction to univariate techniques in data analysis and the most common statistical distributions that are used to model patterns of variability. Common discrete random variable models, like the binomial, Poisson and geometric, and continuous models, including the normal and exponential, will be studied. The method of moments and maximum likelihood techniques for fitting statistical distributions to data will be explored. The unit will have weekly computer classes where candidates will learn to use a statistical computing package to perform simulations and carry out computer intensive estimation techniques like the bootstrap method.

STAT2012 Statistical Tests 6 credit points

Semester 2, Normal
Prerequisite: *MATH1005* or *MATH1905* or *MATH1015*
Prohibition: May not be counted with *STAT2004* or *STAT2912* or *STAT1022*.
Classes: 3 lectures, 1 tutorial and 1 computer lab per week.
Assessment: One 3 hr exam, assignments/quizzes, computer practical reports, one 1 hr computer practical class assessment task.

The unit provides an introduction to the standard methods of statistical analysis of data: Tests of hypotheses and confidence intervals, including t-tests, analysis of variance, regression - least squares and robust methods, power of tests, non-parametric tests, non-parametric smoothing, tests for count data - goodness of fit, contingency tables. Graphical methods and diagnostics are used throughout with all analyses discussed in the context of computation with real data using an interactive statistical package.

STAT2911 Probability and Statistical Models (Advanced) 6 credit points

Semester 1, Advanced
Prerequisite: (*MATH1903* or *MATH1907* or Credit in *MATH1003*) and (*MATH1905* or Credit in *MATH1005*).
Prohibition: May not be counted with *STAT2001* or *STAT2011* or *STAT2901*.
Classes: 3 lectures, 1 tutorial and 1 computer lab per week.
Assessment: One 3 hr exam, assignments/quizzes, computer practical reports, one 1 hr computer practical class assessment task.

This unit is essentially an advanced version of STAT2011 with an emphasis on the mathematical techniques used to manipulate random variables and probability models. Common random variables including the Poisson, normal, beta and gamma families are introduced. Probability generating functions and convolution methods are used to understand the behaviour of sums of random variables. The method of moments and maximum likelihood techniques for fitting statistical distributions to data will be explored. The unit will have weekly computer classes where students will learn to use a statistical computing package to perform simulations and carry out computer intensive estimation techniques like the bootstrap method.

STAT2912 Statistical Tests (Advanced) 6 credit points

Semester 2, Advanced
Prerequisite: *MATH1905* or credit in *MATH1005* or credit in *MATH1015*.
Assumed Knowledge: *STAT2911* or *STAT2901*
Prohibition: May not be counted with *STAT2004* or *STAT2012* or *STAT1022*.
Classes: 3 lectures, 1 tutorial and 1 computer lab per week.
Assessment: One 3 hr exam, 2 assignments, quizzes, computer practical reports, one 1 hr computer practical class assessment task.

This unit is essentially an advanced version of STAT2012 with an emphasis on both methods and the mathematical derivation of these methods: Tests of hypotheses and confidence intervals, including t-tests, analysis of variance, regression - least squares and robust methods, power of tests, non-parametric methods, non-parametric smoothing, analysis of count data - goodness of fit, contingency tables. Graphical methods and diagnostics are used throughout with all analyses discussed in the context of computation with real data using an interactive statistical package.

3. Assessment

Individual lecturers will have different arrangements for the assessment in each course. During the first week of lectures you will be given an information sheet for each course, which will include details of the precise arrangement for assessment in each course. In some intermediate units the assessment includes tutorial participation marks, and quizzes, as well as assignments and the final exam. In general, the arrangements will NOT be the same as those to which you may have been accustomed in junior Mathematics units.

3.1. Semester Examinations

Each unit will be examined at the end of the semester in which it is offered. The exam does *not* count for 100% of the assessment.

3.2. Assignments

Mathematical skills and understanding cannot be acquired passively – for example, by attendance at lectures alone. On the contrary, it is essential that you attempt, on your own, as many relevant problems as possible. Assignments are set in order to give you extra practice, and to provide you with feedback on how you are handling the material.

The number and assessment status of assignments in each unit will be announced by the lecturer during the first week of lectures. Where it is not possible to collect and mark assignments, voluntary assignments may be made available.

Individual lecturers organise all aspects of assignments, including distribution, marking and return of the assignments for their own unit. They will advise you as to the method of collection, return and distribution of solutions.

For assignments that are to be marked for assessment, you will be asked to adhere to the following guidelines (unless you are told otherwise by your lecturer). Solutions to assignments should be written in pen, not pencil, on lined paper using one side of the paper only, with plenty of space left for corrections by the markers. Work that is untidy or illegibile may not be marked. Your solutions and the appropriately filled out cover sheet (available by following the links from `http://www.maths.usyd.edu.au/u/UG/`) should be *stapled* to a manila folder. Paper clips are unsuitable as they catch on other folders and are pulled off. On the cover of the folder you should write in block letters your name, faculty and SID. To aid the return of assignments, please place the first letter of your family name in the centre of the front of your folder, writing it very large. If there are exceptional circumstances, an application for an extension of time may be made to the lecturer before the submission date. Late submissions without an approved extension of time will not be accepted.

Some collaboration between students on assignments is encouraged, since it can be a real aid to understanding. Thus it is legitimate for students to discuss assignment questions at a general level, provided everybody involved makes some contribution. However, students should produce their own individual written solution. Students should not look at another student's written assignment, nor allow their own assignment to be looked at by someone else. Students submitting identical solutions will be heavily penalised regardless of who copied from whom.

3.3. Quizzes, participation marks

If you are taking a course in which the assessment includes marks for quizzes, or for tutorial participation, you will be given relevant information in the first week of lectures. Make sure you know exactly what the assessment requirements are for each of the courses in which you are enrolled.

3.4. Illness or misadventure

Students who, through serious illness or misadventure, are unable to complete an assessment may be offered special consideration. Students have a right to ask for such consideration, together with an obligation to know the relevant requirements.

It should be noted that only well-attested **serious illness or misadventure during a semester or occurring at the time of an examination will warrant special consideration**. Occasional brief or trivial illness would not normally be regarded as sufficient to explain an absence or a poor performance and students are discouraged from submitting certificates for absences totalling less than one or two weeks, although frequently recurrent short absences would need documentation. While it is important to ask for a medical certificate for illness of longer than a few days duration at the time of the first visit, there is no need to submit it unless the illness becomes prolonged or further frequent absences are required. The exact nature of misadventure will vary, but serious illness or death of a close family member, particularly at the time of the examinations, would clearly warrant consideration.

Students who, because of serious illness or adverse circumstances, are prevented from attending classes for prolonged periods should seek an interview with a member of the department(s) concerned and/ or the relevant Sub-Dean. Even if they do not exceed any specified permitted period of absence, they may need to consider whether their best academic interests are served by discontinuing with permission from the course until they are able to resume their studies effectively.

3.5. Special Consideration

WHAT HAPPENS IF YOU MISS AN EXAM?

- If serious illness or misadventure makes it impossible for you to attend an exam, then you are entitled to apply for special consideration.
- Any application for special consideration must be lodged at the Faculty of Science Office, and submitted to the Mathematics Student Office (Carslaw 520), within seven days of the missed exam.
- If you are unable to attend an exam due to religious beliefs, sporting commitments, compulsory attendance at court, or similar essential commitments, then you may apply for special arrangements to be made.
- Any application for special arrangements must be lodged at the Faculty of Science Office, and submitted to the Mathematics Student Office (Carslaw room 520), at least seven days BEFORE the date of the exam.
- Please note that the Faculty of Science Special Consideration and Special arrangements Policies apply to all mathematics units, regardless of the Faculty in which you are enrolled. Before applying for special consideration or special arrangements you must read the Faculty of Science policies at `http://www.science.usyd.edu.au/cstudent/ug/forms.shtml`
- Application forms can be downloaded from the same website.
- Please do not assume that you will automatically be granted further assessment if you miss an exam. Your application will be assessed in the light of your performance throughout the semester, and your academic record.
- Students who have been granted further assessment will receive notification from the Science Faculty, and a result of 'INC'. A list of students who have been granted further assessment will be posted on the website `http://www.maths.usyd.edu.au/u/UG/IM` for second year subjects.
- All further assessment usually takes place on one specific day. Please note that there is no opportunity for any further assessment after this day. A timetable, and the location of the supplementary exams, will be on the website `http://www.maths.usyd.edu.au/u/UG/IM` for second year subjects.

SPECIAL CONSIDERATION RELATING TO IMPAIRED PERFORMANCE IN EXAMS

- If your application is successful, then your mark may be adjusted (if appropriate) or you may be granted further assessment.
- If the judgement on your special consideration application is 'Decision deferred until semester results available', then it is your responsibility to find out whether or not you have been granted further assessment.

- Students who have been granted further assessment will receive a result of 'INC'. A list of students who have been granted further assessment will be posted on the website `http://www.maths.usyd.edu.au/u/UG/IM` for second year subjects.
- All further assessment usually takes place on one specific day. Please note that there is no opportunity for any further assessment after this day. A timetable, and the location of the supplementary exams, will be posted on the website `http://www.maths.usyd.edu.au/u/UG/IM` for second year subjects.

3.6. Further Assessment

Further assessment is a privilege, not a right. Students who have been prevented by duly certified illness or misadventure from completing an examination or assessment task **may** be given the opportunity to be further assessed. Additionally, further assessment does not necessarily take the form of a written supplementary examination. It may involve an oral exam, or some other form of assessment. **You will not automatically be granted further assessment if you miss an exam. Your application will be assessed in the light of all circumstances, including your performance and participation throughout the semester, and your academic record.**

3.7. Results

At the end of each semester, examination results are posted on the web, as well as being mailed to students. Any marks which are released prior to this are provisional only.

3.8. Academic Honesty

Academic Board guidelines on academic honesty may be found by following the link from `http://www.maths.usyd.edu.au/u/UG/`.

4. Additional Information

4.1. Enrolment, Registration and Timetable

Students do not need to register separately with the School of Mathematics and Statistics. This will be done automatically at re-enrolment.

Before Semester 1 begins, you will be given an individual timetable with lecture times, tutorial times and locations for any intermediate mathematics or statistics unit in which you are enrolled.

4.2. Change of Enrolment

Any change of enrolment must be made before the HECS cut-off date in each semester. (These dates are usually within a month or so of the beginning of semester.) After the cut-off dates it is not possible to enrol in additional units, nor to withdraw from a unit without incurring HECS fees. Note that some faculties may have earlier dates after which it is not possible to enrol in additional units.

It is your responsibility to make any desired changes to your enrolment before the relevant dates. All changes must be made at your faculty office.

4.3. Lectures

You are expected to attend lectures. If you do not attend lectures, you should be aware that important announcements relating to all aspects of the unit of study are often made in lectures. It is **your responsibility** to find out the content of any such announcements in the event that you were absent when they were made.

4.4. Tutorials and Lab Sessions

The number of tutorials and lab sessions you attend depends on the units you are taking. Details for each unit are given in Chapter 2.

Tutorial exercise sheets are usually posted on the unit website by the preceding week. In some units they are printed in the back of the book of lecture notes. They may also be given out during the lectures of the preceding week. Tutors and lecturers do not have extra copies of tutorial and assignment sheets. You will gain maximum benefit from a tutorial if you have attempted the tutorial exercises before the actual tutorial. The tutorial hour is for discussion of the exercises, and for you to ask the tutor for help with any exercises that cause you difficulties.

Tutorial classes will usually begin in the second week of each semester, unless otherwise specified on the web page for the unit.

4.5. Webpages, Noticeboards and Pigeonholes

Important notices will be displayed on the Intermediate Mathematics webpage and on the unit of study webpages.

Noticeboards and pigeonholes may still be used by some lecturers. There are noticeboards for Intermediate Mathematics located on Level 3 of Carslaw (near the pyramids) and on Level 6 of Carslaw outside room 624. The noticeboard for Statistics is located on Level 8 of Carslaw, outside room 817. There are also assignment hand-in boxes, and pigeonholes for return of mathematics assignments located on Level 3 of Carslaw (near the noticeboards), and on Level 6 of Carslaw outside room 623.

4.6. Consultations

Students should take general questions about course organisation to the appropriate coordinator. Questions about content of a course should be discussed with the lecturer or tutors for that course, during tutorials or scheduled consultation hours. Consultation hours will be announced in lectures and unit of study webpages early in the semester.

4.7. Solutions to Tutorials and Assignments

At the discretion of the lecturer, solutions to assignments and tutorials may be made available. If so, they will usually be posted on the website.

4.8. Kopystop and University Copy Centre

In some units of study material may be made available from either

KOPYSTOP, 55 Mountain Street, Broadway

or

University Copy Centre, Ground Floor

Noel Martin Recreation Centre.

4.9. Scholarships and Prizes

Science students should be aware that the ranking for post-graduate scholarships in the Science Faculty is determined by combining the Science weighted average mark (SCIWAM) and the Honours mark in the ratio 35:65. The SCIWAM is calculated from all Intermediate and Senior units undertaken with a weighting of 2 for Intermediate units and 3 for Senior units.

A number of prizes are awarded to outstanding achievers. These are listed in the University Calendar.

Sydney University Mathematical Society

SUMS is an informal group that aims to promote interest in mathematics. It is run by students, and every mathematics student is automatically a member. SUMS organises talks on mathematical topics as well as a variety of social events. See `http://www.maths.usyd.edu.au/u/PS/SUMS.html` for more information.

5. Contacts

If you wish to discuss the information in this handbook, or need general advice about mathematics or statistics in second year, you should consult the appropriate coordinator.

The coordinators are also the people you should consult whenever you have enquiries, or problems of an administrative nature, relating to intermediate mathematics or statistics courses.

Pure Mathematics	Dr Bob Howlett Carslaw room number: 709 Phone: 9351 2976 email: pm2coord@maths.usyd.edu.au
Applied Mathematics	Dr Rosemary Thompson Carslaw room number: 624 Phone: 9351 5782 email: am2coord@maths.usyd.edu.au
Statistics	Dr Jennifer Chan Carslaw room number: 817 Phone: 9351 4873 email: st2coord@maths.usyd.edu.au

For information about the content of a particular unit approach a unit lecturer: each unit has an email address of the form

`UnitCode@maths.usyd.edu.au`

(e.g. `MATH2001@maths.usyd.edu.au`).