THE UNIVERSITY OF
SYDNEY

JUNIOR MATHEMATICS AND STATISTICS

2020 Handbook

Web: http://www.maths.usyd.edu.au/u/UG/JM

Contents

1   Introduction

This handbook contains information relating to various aspects of studying mathematics at junior level at the University of Sydney. It includes a brief description of the content of each junior unit, and some advice on which units to choose. It also contains some information on assessment and administrative matters. If you have a question about junior mathematics, and cannot find the answer in this book, there are other sources of information.

1.1   Where to find out more:

- The Junior Mathematics website:

  http://www.maths.usyd.edu.au/u/UG/JM

- The Frequently Asked Questions webpage:

  http://www.maths.usyd.edu.au/u/UG/JM/FAQ.html

  If there is something you want to know, please check this page before you contact us.

- The Student Services Office:

  - Carslaw Room 520 (Helpdesk on Level 5)
  - Phone: 9351 5787
  - Email: fy.maths@sydney.edu.au

  We expect that any emails written to us will be courteous, and will include your name and SID. Emails need to be sent from your official university of Sydney email account. We will not respond to anonymous emails.

- The First Year Director: Daniel Daners (acting for 2020), Carslaw Room 715.

  Deputy First Year Director: Garth Tarr, Carslaw Room 828.

1.2   How we communicate with you

There are over 4000 students doing a first year mathematics unit. When we have something to tell you we clearly cannot do so on an individual basis. You will have to take far more responsibility for seeking out information than you may have been used to doing at school. Here are the ways in which we communicate with you:

Announcements in Lectures Important announcements relating to all aspects of a unit of study are often made in lectures. You should listen carefully to all such announcements. If you do not attend lectures regularly then it is your responsibility to find out the content of any such announcements in the event that you were absent when they were made.

Canvas Announcements Usually, important announcements are also posted through the Learning Management System (Canvas). You can configure yourself how you want to receive such announcements (through email, app or other option).

Web pages The main page for Junior Mathematics is given above. Each unit has its own web page, linked to the main page. Many important announcements are made on these pages. These are accessible from the Learning Management System (Canvas). It is essential that you check the main page, and the pages relevant to your enrolment, at least once a week.

Email We will sometimes email you at your Unikey email address, either as an individual student, or as a member of a particular class. You should check for email sent to your Unikey address on a regular basis.

Some units of study may also make announcements through the discussion forum (Edstem).

1.3   Junior units of study

Junior units are offered at four different levels: advanced, mainstream, fundamental and introductory. The level at which you study mathematics should be determined by your mathematical background and your ability, as well as the degree program and major you intend to complete.

As a general rule, if you have done HSC Mathematics Extension 2 then you should take advanced units; if you have done HSC Mathematics Extension 1 then you should take mainstream units; if you have done HSC Mathematics then you should take fundamental units. Later chapters in this book give more detailed advice as to which level you should choose.

Advanced, mainstream and fundamental units are all worth 3 credit points, with the exception of DATA1001 and DATA1901, which is worth 6 credit points.

Advanced Units of Study in Semester 1.

- MATH1921 *Calculus of One Variable (Advanced)*
- MATH1902 *Linear Algebra (Advanced)*
- MATH1931 *Calculus of One Variable (Special Studies Program)*
- DATA1901 *Foundations of Data Science (advanced)*

Advanced Units of Study in Semester 2.

- MATH1923 *Multivariable Calculus and Modelling (Advanced)*

- MATH1904 *Discrete Matematics (Advanced)*
- MATH1905 *Statistical Thinking about Data (Advanced)*
- MATH1933 *Multivariable Calculus and Modelling (Special Studies Program)*

Mainstream Units of Study in Semester 1.

- MATH1021 *Calculus of One Variable*
- MATH1023 *Multivariable Calculus and Modelling*
- MATH1002 *Linear Algebra*
- MATH1005 *Statistical Thinking about Data*
- DATA1001 *Foundations of Data Science*

Mainstream Units of Study in Semester 2.

- MATH1021 *Calculus of One Variable*
- MATH1023 *Multivariable Calculus and Modelling*
- MATH1004 *Discrete Mathematics*
- MATH1064 *Discrete Mathematics for Computation*
- MATH1005 *Statistical Thinking about Data*
- MATH1115 *Interrogating Data*
- DATA1001 *Foundations of Data Science*

Fundamental Units of Study in Semester 1.

- MATH1011: *Applications of Calculus*

Fundamental Units of Study in Semester 2.

- MATH1013: *Mathematical Modelling*
- MATH1014: *Introduction to Linear Algebra*

Introduction to Calculus. MATH1111: *Introduction to Calculus* is a 6 credit point unit of study and is available only to students who have not done HSC Mathematics, HSC Mathematics Ext 1 or HSC Mathematics Ext 2 (or equivalent).

Students in the Faculty of Science

Science students are required to complete at least 12 credit points of mathematics and/or statistics. The choice depends on whether students are doing a major in Mathematics, Statistics, Financial Mathematics or Data Science, or taking mathematical units to satisfy a Science Degree Mathematics core requirement. The definitive rules for the Degree Core units of study can be found at

> sydney.edu.au/handbooks/science/subject_areas_ae/tableA_core.shtml

The level is usually determined by background and partly by the major/minor. Some streams or degree programs (in particular the Mathematical Sciences Program) have specific requirements. Check the handbook at

`sydney.edu.au/handbooks/science/subject_areas_ae/tableA_overview.shtml`

For the Mathematical Sciences program see

`sydney.edu.au/handbooks/science/subject_areas_fm/mathematical_sciences.`
`shtml`

Here are recommendations that apply to most students:

Students with HSC Mathematics Extension 2 (or equivalent).   Generally take MATH1921, MATH1902, MATH1923 and MATH1905. If there is space for electives MATH1905 can be substituted by DATA1901 and MATH1904.

Students with HSC Mathematics Extension 1 (or equivalent).   Generally take MATH1021, MATH1002, MATH1023 and MATH1005. Students intending to complete a Data Science major will generally take (MATH1021 or MATH1023) and (MATH1002 and DATA1001).

Students with HSC Mathematics (or equivalent).   Generally take MATH1011, MATH1005, MATH1013 and MATH1014. Students who are weak in calculus could consider substituting MATH1004 for MATH1013 in second semester. If DATA1001 is taken in place of MATH1X05 students will generally take (MATH1011 or MATH1013) and MATH1014. **Note:** If you do a major or minor in mathematics, financial mathematics and statistics, statistics or data science, you need to take the mainstream units assuming HSC Mathematics Extension 1 (except for statistics which allows MATH1011 and MATH1014).

Students who have not successfully completed calculus at school.   There is a possibility to enrol in MATH1111 in first semester, but that requires special permission. In second semester, students who successfully complete MATH1111 generally take two of MATH1013, MATH1014, MATH1004 and MATH1005. However, MATH1013 is only recommended if students achieve a credit or higher in MATH1111.

Students in the Faculty of Engineering

Engineering students are required to study mathematics in both first and second year. Different engineering degrees and majors have different requirement. These requirements can be found in the Engineering Handbook at

<p style="text-align:center"><code>https://sydney.edu.au/handbooks/engineering/</code>.</p>

Most first year engineering students will take MATH1021, MATH1002, MATH1023 and MATH1005.

Engineering students with HSC Mathematics Extension 2 (or equivalent) are encouraged to choose the advanced units MATH1921, MATH1902, MATH1923 and MATH1905.

Engineering students who do not have Mathematics Extension 1 (or equivalent) are strongly advised to do a Bridging Course before semester starts. Details of Bridging Courses are available from the Student Services Office (Carslaw room 520), or at `http://www.maths.usyd.edu.au/u/BC/`.

Students in the Faculties of Arts, Economics and Education

Junior mathematics units may be taken by students in these faculties. Consult the relevant Faculty Handbook at `http://sydney.edu.au/handbooks/` for details.

1.4 Advice on choice of junior mathematics units

Students doing a major in the School of Mathematics and Statistics

If you are a Science student the units you enrol in for a major in Mathematics, Statistics, Financial Mathematics and Statistics, or Data Science will also count towards the "Science Mathematics Degree Core" requirements. So do not enrol in the separate "Science Mathematics Degree core".

Students intending to specialise Mathematics (Pure or Applied) should take four or five junior units. Students with the appropriate background should take advanced units, or Special Studies Units if invited to do so. It is important that one of the units MATH1923, MATH1933 or MATH1023 be selected: seek the advice of the Mathematics Student Services Office if you do not wish to do this.

Students intending to specialise in Statistics or in Financial Mathematics and Statistics should take the following units:

- (MATH1021 or MATH1921 or MATH1931) and (MATH1002 or MATH1902 or MATH1014)

and

- (MATH1023 or MATH1923 or MATH1933) and (MATH1005 or MATH1905)

If there is enough room for electives, MATH1X05 can be substituted by DATA1001 or DATA1901. To fill the shortfall of three credit points it is recommended to take MATH1004 or MATH1904.

Students not in the *Mathematical Sciences program* have the option of only taking one calculus unit when taking DATA1X01 instead of MATH1X05.

Students who wish to specialise in Data Science should take

- (DATA1001 or DATA1901) or (MATH1905 and (MATH1002 or MATH1902

The second option is a requirement if you are in the Mathematical Sciences Program.

To fulfill the requirements of your degree you may need to take some mathematics units. A recommendation is to take one of the calculus units at the appropriate level (see Section 1.3).

If for some reason you have taken MATH1005 and want to do a data science major you can take MATH1115 as together they are equivalent to DATA1001.

Students in other Degree Programs and Majors/Minors

Students who want Mathematics as a support for a major in another area   have a wide range of choices. Some faculties, schools and departments prescribe and/or recommend mathematics units: refer to the appropriate handbooks or advisers. In general, take as many mathematics units as you can fit in; if you satisfy prerequisites, take advanced units rather than mainstream units and mainstream units rather than fundamental units. If you intend to take intermediate units in mathematics, take MATH1923 or MATH1023 or seek the advice of the Mathematics Student Services Office if you do not wish to do this.

Students who want Statistics as a support for a major in another area   should take MATH1905 or MATH1005 or DATA1001. Students who wish (at a later stage) to take DATA2002, DATA2902, STAT3022 or STAT3922 should also take MATH1902 or MATH1002 or MATH1014.

1.5   Intermediate, Senior and Honours Units of Study

It is possible to proceed as far as Honours in any of five disciplines: Pure Mathematics, Applied Mathematics , Financial Mathematics and Statistic, Mathematical Statistics or Data Science. The School's intermediate and senior units of study are offered at two levels, advanced and mainstream. Intending Honours students are strongly encouraged to select advanced units of study.

There are intermediate and senior units of study offered by the School of Mathematics and Statistics which complement specialised studies in other discipline areas. In particular, students who seek to specialise in certain other Science discipline areas such as Physics and Computer Science, should bear in mind the requirement to complete intermediate mathematics units in their degree.

1.6   What to do before semester starts

Once you have your timetable, check whether classes start in week 1 or 2. All lectures start in week 1, and tutorials start in week 1 or 2.

It is not essential to buy textbooks for mathematics units of study before semester starts, but you may do so if you wish. For several junior units of study the text is a set of course notes written by lecturers within the School of Mathematics and Statistics. All such notes may be purchased from KOPYSTOP, 55 Mountain St Broadway. They are *not* available from the University Copy Centre. Textbooks which are not published by the School of Mathematics and Statistics will generally be available from the Co-op Bookshop on campus.

2 Advanced Units

2.1 Who should take advanced units?

Advanced units of study are designed for students who have both a strong background and a keen interest in mathematics, and who wish to study mathematics at a higher level. Advanced units are challenging but rewarding. They treat topics at a greater depth and with more mathematical rigour than do mainstream units.

2.2 Assumed knowledge

The assumed knowledge for advanced units is the NSW Mathematics Extension 2 HSC course (or equivalent). The depth of study required for that HSC course is similar to that needed for advanced units here. Students who achieved Band E4 in the NSW Extension 1 HSC course (or equivalent) and who are enthusiastic about mathematics may also consider advanced units, although they will be missing some background knowledge. All students who wish to enrol in advanced units must apply for Departmental Permission through Sydney Student.

2.3 Objectives of advanced units

In addition to extending and deepening students' knowledge in key areas of mathematics and statistics, and preparing students for later units in mathematics and statistics, the advanced units are designed to

- provide challenging and stimulating material for students with an interest in, and aptitude for, mathematics;

- give students an appreciation of the power and beauty of mathematics;

- provide an insight into the way in which professional mathematicians think about mathematics;

- develop a student's ability to reason mathematically;

- give students an appreciation of the need for rigour in mathematics.

Outcomes for individual units are listed on the unit information sheets.

2.4   Special Studies Program (SSP) units

These units are offered to a relatively small group of talented and committed students. The two SSP units are MATH1931 and MATH1933. MATH1931 includes all the material in MATH1921 as well as special topics which are not available elsewhere in the Mathematics and Statistics programs. Students attend the MATH1921 lectures and complete all MATH1921 assessment tasks, but have their own seminar and tutorial. The special topics will be assessed by means of assignments.

Special Studies Program   Similarly MATH1933 has the same lectures as MATH1923 plus seminars on special topics. For the purposes of Science Faculty regulations, SSP units count as Advanced units.

Selection into MATH1931 and/or MATH1933 is based on interest in and commitment to mathematics, and on HSC (or equivalent) results. A NSW ATAR score of at least 98.5 and a score of 95% in Mathematics Extension 2 is generally expected, although students with lower scores and a serious commitment to mathematics may apply for selection. Students interested in obtaining entry to the Special Studies Program should enrol in MATH1921 (unless informed otherwise) and subsequently apply for entry into MATH1931. Details of how to apply will be available on the MATH1931 website `http://www.maths.usyd.edu.au/u/UG/JM/math1931/` by late January or early February.

2.5   List of Advanced Units

MATH1902: Linear Algebra (Advanced)

This unit is designed to provide a thorough preparation for further study in mathematics and statistics. It is a core unit of study providing three of the twelve credit points required by the Faculty of Science as well as a Junior level requirement in the Faculty of Engineering. It parallels the normal unit MATH1002 but goes more deeply into the subject matter and requires more mathematical sophistication.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: (HSC Mathematics Extension 2) OR (90 or above in HSC Mathematics Extension 1) or equivalent

Prohibitions: MATH1002 or MATH1014

Offered: Semester 1

Credit points: 3.0

Note: Faculty/department permission required

MATH1921: Calculus Of One Variable (Advanced)

Calculus is a discipline of mathematics that finds profound applications in science, engineering, and economics. This unit investigates differential calculus and integral calculus of one variable and the diverse applications of this theory. Emphasis is given both to the theoretical and foundational aspects of the subject, as well as developing the valuable skill of applying the mathematical theory to solve practical problems. Topics covered in this unit of study include complex numbers, functions of a single variable, limits and continuity, differentiation, optimisation, Taylor polynomials, Taylor's Theorem, Taylor series, Riemann sums, and Riemann integrals. Additional theoretical topics included in this advanced unit include the Intermediate Value Theorem, Rolle's Theorem, and the Mean Value Theorem.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: (HSC Mathematics Extension 2) OR (Band E4 in HSC Mathematics Extension 1) or equivalent.

Prohibitions: MATH1001 or MATH1011 or MATH1906 or ENVX1001 or MATH1901 or MATH1021 or MATH1931

Offered: Semester 1

Credit points: 3.0

Note: Faculty/department permission required

MATH1931: Calculus Of One Variable (SSP)

The Mathematics Special Studies Program is for students with exceptional mathematical aptitude, and requires outstanding performance in past mathematical studies. Students will cover the material of MATH1921 Calculus of One Variable (Adv), and attend a weekly seminar covering special topics on available elsewhere in the Mathematics and Statistics program.

Classes: 2x1-hr lectures; and 1x1-hr tutorial/wk

Assumed knowledge: (HSC Mathematics Extension 2) OR (Band E4 in HSC Mathematics Extension 1) or equivalent.

Prohibitions: MATH1001 or MATH1011 or MATH1901 or ENVX1001 or MATH1906 or MATH1021 or MATH1921

Offered: Semester 1

Credit points: 3.0

Note: Faculty/department permission required

MATH1923: Multivariable Calculus and Modelling (Adv)

Calculus is a discipline of mathematics that finds profound applications in science, engineering, and economics. This unit investigates multivariable differential calculus and modelling. Emphasis is given both to the theoretical and foundational aspects of the subject, as well as developing the valuable skill of applying the mathematical theory to solve practical problems. Topics covered in this unit of study include mathematical modelling, first order differential equations, second order differential equations, systems of linear equations, visualisation in 2 and 3 dimensions, partial derivatives, directional derivatives, the gradient vector, and optimisation for functions of more than one variable. Additional topics covered in this advanced unit of study include the use of diagonalisation of matrices to study systems of linear equation and optimisation problems, limits of functions of two or more variables, and the derivative of a function of two or more variables.

Classes: 2x1-hr lectures; and 1x1-hr tutorial/wk

Assumed knowledge: (HSC Mathematics Extension 2) OR (Band E4 in HSC Mathematics Extension 1) or equivalent.

Prohibitions: MATH1003 or MATH1013 or MATH1907 or MATH1903 or MATH1023 or MATH1933

Offered: Semester 2

Credit points: 3.0

Note: Faculty/department permission required

MATH1933: Multivariable Calculus and Modelling (SSP)

The Mathematics Special Studies Program is for students with exceptional mathematical aptitude, and requires outstanding performance in past mathematical studies. Students will cover the material of MATH1923 Multivariable Calculus and Modelling (Adv), and attend a weekly seminar covering special topics on available elsewhere in the Mathematics and Statistics program.

Classes: 2x1-hr lectures; and 1x1-hr tutorial/wk

Assumed knowledge: (HSC Mathematics Extension 2) OR (Band E4 in HSC Mathematics Extension 1) or equivalent.

Prohibitions: MATH1003 or MATH1903 or MATH1013 or MATH1907 or MATH1023 or MATH1923

Offered: Semester 2

Credit points: 3.0

Note: Faculty/department permission required

MATH1904: Discrete Mathematics (Advanced)

This unit is designed to provide a thorough preparation for further study in mathematics. It parallels the normal unit MATH1004 but goes more deeply into the subject matter and requires more mathematical sophistication.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: Strong skills in mathematical problem solving and theory, including coordinate geometry, integral and differential calculus, and solution of polynomial equations equivalent to HSC Mathematics Extension 2 or a Band E4 in HSC Mathematics Extension 1

Prohibitions: MATH1004 or MATH1064

Offered: Semester 2

Credit points: 3.0

Note: Faculty/department permission required

MATH1905: Statistical Thinking with Data (Advanced)

This unit is designed to provide a thorough preparation for further study in mathematics and statistics. It is a core unit of study providing three of the twelve credit points required by the Faculty of Science as well as a Junior level requirement in the Faculty of Engineering. This Advanced level unit of study parallels the normal unit MATH1005 but goes more deeply into the subject matter and requires more mathematical sophistication.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: (HSC Mathematics Extension 2) OR (90 or above in HSC Mathematics Extension 1) or equivalent

Prohibitions: MATH1005 or MATH1015 or STAT1021 or ECMT1010 or ENVX1001 or ENVX1002 or BUSS1020 or DATA1001 or DATA1901

Offered: Semester 2

Credit points: 3.0

Note: Faculty/department permission required

DATA1901: Foundations of Data Science (Adv)

DATA1901 is an advanced level unit (matching DATA1001) that is foundational to the new major in Data Science. The unit focuses on developing critical and statistical thinking skills for all students. Does mobile phone usage increase the incidence of brain tumours? What is the public's attitude to shark baiting following a fatal attack? Statistics is the science of decision making, essential in every industry and undergirds all research which relies on data. Students will use problems and data from the physical, health, life and social sciences to develop adaptive problem solving skills in a team setting. Taught interactively with embedded technology and masterclasses, DATA1901 develops critical thinking and skills to problem-solve with data at an advanced level. By completing this unit you will have an excellent foundation for pursuing data science, whether directly through the data science major, or indirectly in whatever field you major in. The advanced unit has the same overall concepts as the regular unit but material is discussed in a manner that offers a greater level of challenge and academic rigour.

Classes: Lecture 3 hrs/week + Computer lab 2 hr/week

Assumed knowledge: An ATAR of 95 or more

Prohibitions: MATH1905 or ECMT1010 or ENVX1002 or BUSS1020 or DATA1001 or MATH1115 or MATH1015

Offered: Semester 1, Semester 2

Credit points: 6.0

3 Mainstream Units

3.1 Who should take mainstream units?

Mainstream Units of Study are designed for students who have both the necessary background and interest in mathematics, and who want to study mathematics beyond junior units, or need to do so in order to satisfy degree requirements. Mainstream units cover much the same material as advanced units, but less rigourously.

3.2 Assumed knowledge

The assumed knowledge for MATH1021 is NSW HSC Mathematics Extension 1 (or equivalent). Students who have done well in the HSC Mathematics(or equivalent) may consider enrolling in MATH1021. Before doing so it is highly recommended to discuss the option a mathematics adviser during enrolment.

The assumed knowledge for MATH1002, MATH1004, MATH1005 and DATA1001 is NSW HSC Mathematics.

The assumed knowledge for MATH1023 is MATH1021 or NSW HSC Mathematics Extension 2.

Students who have only completed NSW HSC Mathematics but are required to enrol in MATH1021 should complete a bridging course in February. Details of Bridging Courses are available from the Student Services Office, or from mathematics advisers at enrolment.

Students with a Distinction or High Distinction in MATH1021 or MATH1002 are encouraged to discuss the possibility of enrolling in one of the second semester advanced units with the First Year Director.

3.3 Objectives of mainstream units

In addition to extending students' knowledge in key areas of mathematics and statistics, and preparing students for later units in mathematics and statistics, the mainstream units are designed to

- give students an appreciation of the power and beauty of mathematics;

- demonstrate the application of mathematics to a wide variety of physical problems;

- develop a student's ability to reason mathematically;

- give students an appreciation of the need for rigour in mathematics.

Outcomes for individual units are listed on the unit information sheets.

3.4   List of Mainstream Units

Note that MATH1115 is not normally chosen. The unit is only useful for those who need DATA1001 for their major but have already taken MATH1005 (for instance when changing to a Data Science major).

MATH1002: Linear Algebra

MATH1002 is designed to provide a thorough preparation for further study in mathematics and statistics. It is a core unit of study providing three of the twelve credit points required by the Faculty of Science as well as a Junior level requirement in the Faculty of Engineering. This unit of study introduces vectors and vector algebra, linear algebra including solutions of linear systems, matrices, determinants, eigenvalues and eigenvectors.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: HSC Mathematics or MATH1111. Students who have not completed HSC Mathematics (or equivalent) are strongly advised to take the Mathematics Bridging Course (offered in February).

Prohibitions: MATH1012 or MATH1014 or MATH1902

Offered: Intensive January, Semester 1

Credit points: 3.0

MATH1004: Discrete Mathematics

This unit provides an introduction to fundamental aspects of discrete mathematics, which deals with 'things that come in chunks that can be counted'. It focuses on the enumeration of a set of numbers, viz. Catalan numbers. Topics include sets and functions, counting principles, discrete probability, Boolean expressions, mathematical induction, linear recurrence relations, graphs and trees.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: HSC Mathematics or MATH1111. Students who have not completed HSC Mathematics (or equivalent) are strongly advised to take the Mathematics Bridging Course (offered in February).

Prohibitions: MATH1904 or MATH1064

Offered: Semester 2

Credit points: 3.0

MATH1021: Calculus Of One Variable

Calculus is a discipline of mathematics that finds profound applications in science, engineering, and economics. This unit investigates differential calculus and integral calculus of one variable and the diverse applications of this theory. Emphasis is given both to the theoretical and foundational aspects of the subject, as well as developing the valuable skill of applying the mathematical theory to solve practical problems. Topics covered in this unit of study include complex numbers, functions of a single variable, limits and continuity, differentiation, optimisation, Taylor polynomials, Taylor's Theorem, Taylor series, Riemann sums, and Riemann integrals.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: HSC Mathematics Extension 1 or equivalent.

Prohibitions: MATH1011 or MATH1901 or MATH1906 or ENVX1001 or MATH1001 or MATH1921 or MATH1931

Offered: Intensive January, Semester 1, Semester 2

Credit points: 3.0

MATH1023: Multivariable Calculus and Modelling

Calculus is a discipline of mathematics that finds profound applications in science, engineering, and economics. This unit investigates multivariable differential calculus and modelling. Emphasis is given both to the theoretical and foundational aspects of the subject, as well as developing the valuable skill of applying the mathematical theory to solve practical problems. Topics covered in this unit of study include mathematical modelling, first order differential equations, second order differential equations, systems of linear equations, visualisation in 2 and 3 dimensions, partial derivatives, directional derivatives, the gradient vector, and optimisation for functions of more than one variable.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: Knowledge of complex numbers and methods of differential and integral calculus including integration by partial fractions and integration by parts as for example in MATH1021 or MATH1921 or MATH1931 or HSC Mathematics Extension 2

Prohibitions: MATH1013 or MATH1903 or MATH1907 or MATH1003 or MATH1923 or MATH1933

Offered: Intensive January, Semester 1, Semester 2

Credit points: 3.0

MATH1064: Discrete Mathematics for Computation

This unit introduces students to the language and key methods of the area of Discrete Mathematics. The focus is on mathematical concepts in discrete mathematics and their applications, with an emphasis on computation. For instance, to specify a computational problem precisely one needs to give an abstract formulation using mathematical objects such as sets, functions, relations, orders, and sequences. In order to prove that a proposed solution is correct, one needs to apply the principles of mathematical logic, and to use proof techniques such as induction. To reason about the efficiency of an algorithm, one often needs to estimate the growth of functions or count the size of complex mathematical objects. This unit provides the necessary mathematical background for such applications of discrete mathematics. Students will be introduced to mathematical logic and proof techniques; sets, functions, relations, orders, and sequences; counting and discrete probability; asymptotic growth; and basic graph theory.

Classes: 3x1-hr lecture/wk for 13 weeks; 1x1-hr practice class/wk for 13 weeks; 1x1-hr tutorial/wk for 12 wks.

Assumed knowledge: Coordinate geometry, basic integral and differential calculus, polynomial equations and algebraic manipulations, equivalent to HSC Mathematics

Prohibitions: MATH1004 or MATH1904

Offered: Semester 2

Credit points: 6.0

MATH1005: Statistical Thinking with Data

In a data-rich world, global citizens need to problem solve with data, and evidence based decision-making is essential is every field of research and work. This unit equips you with the foundational statistical thinking to become a critical consumer of data. You will learn to think analytically about data and to evaluate the validity and accuracy of any conclusions drawn. Focusing on statistical literacy, the unit covers foundational statistical concepts, including the design of experiments, exploratory data analysis, sampling and tests of significance.

Classes: 2x1-hr lectures; 1x1-hr lab/wk

Assumed knowledge: HSC Mathematics. Students who have not completed HSC Mathematics (or equivalent) are strongly advised to take the Mathematics Bridging Course (offered in February).

Prohibitions: MATH1015 or MATH1905 or STAT1021 or ECMT1010 or ENVX1001 or ENVX1002 or BUSS1020 or DATA1001 or DATA1901

Offered: Intensive January, Semester 1, Semester 2

Credit points: 3.0

MATH1115: Interrogating Data

In a data-rich world, global citizens need to problem solve with data, and evidence based decision-making is essential is every field of research and work. This unit equips you with foundational statistical thinking to interrogate data. Focusing on statistical literacy, the unit covers foundational statistical concepts such as visualising data, the linear regression model, and testing significance using the t and chi-square tests. Based on a flipped learning approach, you will experience most of your learning in weekly collaborative 2 hour labs, supplemented by readings and lectures. Working in teams, you will explore three real data stories across different domains, with associated literature. The combination of MATH1005/1015 and MATH1115 is equivalent to DATA1001, allowing you to pathway to the Data Science, Statistics, or Quantitative Life Sciences majors.

Classes: 2-hr lab/wk

Prohibitions: STAT1021 or ENVX1001 or ENVX1002 or BUSS1020 or ECMT1010 or DATA1001 or DATA1901

Pre-requisites: MATH1005 or MATH1015

Offered: Intensive January, Semester 2

Credit points: 3.0

DATA1001: Foundations of Data Science

DATA1001 is a foundational unit in the Data Science major. The unit focuses on developing critical and statistical thinking skills for all students. Does mobile phone usage increase the incidence of brain tumours? What is the public's attitude to shark baiting following a fatal attack? Statistics is the science of decision making, essential in every industry and undergirds all research which relies on data. Students will use problems and data from the physical, health, life and social sciences to develop adaptive problem solving skills in a team setting. Taught interactively with embedded technology, DATA1001 develops critical thinking and skills to problem-solve with data. It is the prerequisite for DATA2002.

Classes: 3x1-hr lectures; 1x2-hr lab/wk

Prohibitions: DATA1901 or MATH1005 or MATH1905 or MATH1015 or MATH1115 or ENVX1001 or ENVX1002 or ECMT1010 or BUSS1020 or STAT1021

Offered: Semester 1, Semester 2

Credit points: 6.0

4 Fundamental Units

4.1 Who should take fundamental units?

Fundamental units are designed for students whose major interest lies outside mathematics, but who require mathematics and statistics to support the study of other scientific disciplines. In general, students who take fundamental units will not be interested in studying mathematics after first year. Students who wish to continue studying mathematics after first year, or who are enrolled in a degree program which requires intermediate mathematics, should aim for at least credits in fundamental junior units or choose mainstream junior units.

4.2 Assumed knowledge

HSC Mathematics (or equivalent) is the assumed knowledge for all fundamental units. Students who wish to enrol in fundamental units without the assumed knowledge should complete a Bridging Course in February. Details of Bridging Courses are available from the Student Services Office, or from mathematics advisers at enrolment.

4.3 Objectives of fundamental units

The fundamental units are designed to:

- illustrate ways in which students' existing mathematical knowledge can be applied to problems that arise in the life sciences;

- demonstrate applications of mathematics and statistics;

- give students an appreciation of mathematics as vital to all scientific disciplines.

Outcomes for individual units are listed on the unit information sheets.

4.4 List of Fundamental Units

MATH1011: Applications of Calculus

This unit is designed for science students who do not intend to undertake higher year mathematics and statistics. It establishes and reinforces the fundamentals of calculus, illustrated

where possible with context and applications. Specifically, it demonstrates the use of (differential) calculus in solving optimisation problems and of (integral) calculus in measuring how a system accumulates over time. Topics studied include the fitting of data to various functions, the interpretation and manipulation of periodic functions and the evaluation of commonly occurring summations. Differential calculus is extended to functions of two variables and integration techniques include integration by substitution and the evaluation of integrals of infinite type.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: HSC Mathematics. Students who have not completed HSC Mathematics (or equivalent) are strongly advised to take the Mathematics Bridging Course (offered in February). Please note: this unit does not normally lead to a major in Mathematics or Statistics or Financial Mathematics and Statistics.

Prohibitions: MATH1001 or MATH1901 or MATH1906 or BIOM1003 or ENVX1001 or MATH1021 or MATH1921 or MATH1931

Offered: Intensive January, Semester 1

Credit points: 3.0

MATH1013: Mathematical Modelling

MATH1013 is designed for science students who do not intend to undertake higher year mathematics and statistics. In this unit of study students learn how to construct, interpret and solve simple differential equations and recurrence relations. Specific techniques include separation of variables, partial fractions and first and second order linear equations with constant coefficients. Students are also shown how to iteratively improve approximate numerical solutions to equations.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: HSC Mathematics or a credit or higher in MATH1111. Students who have not completed HSC Mathematics (or equivalent) are strongly advised to take the Mathematics Bridging Course (offered in February). Please note: this unit does not normally lead to a major in Mathematics or Statistics or Financial Mathematics and Statistics.

Prohibitions: MATH1003 or MATH1903 or MATH1907 or MATH1023 or MATH1923 or MATH1933

Offered: Intensive January, Semester 2

Credit points: 3.0

MATH1014: Introduction to Linear Algebra

This unit is an introduction to Linear Algebra. Topics covered include vectors, systems of linear equations, matrices, eigenvalues and eigenvectors. Applications in life and technological sciences are emphasised.

Classes: 2x1-hr lectures; 1x1-hr tutorial/wk

Assumed knowledge: Coordinate geometry, basic integral and differential calculus, polynomial equations and algebraic manipulations, equivalent to HSC Mathematics

Prohibitions: MATH1002 or MATH1902

Offered: Intensive January, Semester 2

Credit points: 3.0

5   MATH1111 Introduction to Calculus

5.1   Who should take this unit?

This unit of study is available only to those students who have not successfully completed a calculus course at school. Students with HSC General Mathematics or only Year 10 Mathematics are eligible to enrol in this unit. Permission must be sought from the School of Mathematics and Statistics in order to enrol. The unit is offered only in semester 1.

5.2   Objectives

This unit is designed to:

- provide students with a clear understanding of the ideas of calculus;

- build a solid foundation for subsequent courses in mathematics;

- demonstrate the power of the calculus as a tool for solving problems in science and engineering.

Outcomes are listed on the unit information sheet.

5.3   Description

MATH1111: Introduction to Calculus

This unit is an introduction to the calculus of one variable. Topics covered include elementary functions, differentiation, basic integration techniques and coordinate geometry in three dimensions. Applications in science and engineering are emphasised.

Classes: 3x1-hr lectures; 2x1-hr tutorials/wk

Assumed knowledge: Knowledge of algebra and trigonometry equivalent to NSW Year 10

Prohibitions: MATH1011 or MATH1901 or MATH1906 or MATH1001 or HSC Mathematics Extension 1 or HSC Mathematics Extension 2 or ENVX1001 or MATH1021 or MATH1921 or MATH1931

Offered: Semester 1

Credit points: 6.0

Note: Faculty/department permission required

Additional Resources.

- Online Resource

  – MOOC: Introduction to Calculus
    (https://www.coursera.org/learn/introduction-to-calculus)

- Reference Book (available from the Co-op Bookshop):

  – Anton, H., Biven, I. and Davis, S., *Calculus: Early Transcendentals Single Variable.* Wiley (Library 515/77C).

6 Classes

All junior units of study require attendance at both lectures and tutorials or computer lab sessions. The number of classes in any particular unit is given in previous sections.

6.1 Lectures

Most content of a unit of study is delivered via lectures. Generally junior units have very large class sizes. The pace at which material is delivered is usually quicker than you will have encountered at school, and you are required to work much more independently. Lecturers may provide you with text references during lectures. It is important to listen, and to try to follow the material being presented, and take abbreviated notes rather than comprehensively write down everything.

You are expected to attend lectures. If you do not attend lectures you should at least follow the lecture recordings available through Canvas. Remember lectures may contain important announcements and that it is your responsibility to find out the content of any such announcements.

6.2 Tutorials

Mathematical skills and understanding cannot be acquired passively, for example by attendance at lectures and reading solutions to problems alone. On the contrary, it is essential that you work through as many relevant problems as possible by yourself.

Tutorials are small classes in which you are expected to work through some set exercises. Most units run board tutorials, in which you collaroratively solve problems in small groups on the white board. The role of the tutor is to provide support and to some extent give feedback on your solutions written on the board.

Problem sheets and solutions will be available from the unit of study website. Problem sheets will also be provided by the tutor. When available, you will gain maximum benefit from a tutorial if you have attempted the pre-tutorial exercises.

A record of your tutorial attendance is kept. You should attend the tutorial to which you have been assigned on your timetable. When you attend your first tutorial you should check that your name is *typed* onto your tutor's roll. Timetable changes can be requested during the first week of semester through MyUni.

6.3   Computer Laboratory

Statistics and Data Science units have computer labs. Similar to tutorials they provide opportunity to practice problem solving and coding. You may need to download and install required software to use at home or during lab classes. Some classes require to bring your own device. Please look at the information provided for the relevant units of study.

6.4   Discussion Forum and Consultations

Every unit will offer a discussion forum (Edstem). You should be invited to participate. If not, for instance because you enrolled late, you can go to the Canvas site and click onto the Edstem link. That gets you enrolled and you can participate immediately.

Use the discussion forum to ask any questions relevant to content or organisation of the unit. If you know answers you can post responses to questions. That way others can benefit from questions and answers.

If the discussion forum does not answer your questions, you can consult your lecturer. All lecturers in junior mathematics units will have a scheduled consultation hour. Consultation hours will be announced early in the semester.

7 Assessment

In general, assessment in junior mathematics units will be based on tasks to be completed during the semester as well as the end of semester exam. Precise details of the assessment procedures in each unit will be included in a "Unit Information Sheet" which will be made available online through the Learning Management System. For all assessments please note the University's "Academic Dishonesty and Plagiarism in Coursework". For more detail see

https://sydney.edu.au/students/academic-dishonesty.html.

You must complete the *Academic honesty education module* available from within Canvas.

7.1 Grades

Final grades in mathematics units of study are returned within one of the following bands:

Grade	Mark Range	Standard
High Distinction (HD)	85–100	representing complete or close to complete mastery of the material;
Distinction (D)	75–84	representing excellence, but substantially less than complete mastery;
Credit (CR)	65–74	representing a creditable performance that goes beyond routine knowledge and understanding, but less than excellence;
Pass (P)	50–64	representing at least routine knowledge and understanding over a spectrum of topics and important ideas and concepts in the course.
Fail (F)	0-49	does not meet the minimal requirements for the course.

A student with a passing or higher grade should be well prepared to undertake further studies in mathematics. Students hoping to continue with advanced units of study should be aiming for credits or higher grades.

7.2   Examinations

Each junior mathematics unit has an examination during the University examination period at the end of the semester in which the unit is offered. The dates of the exam period, and information concerning the exam timetable, can be found at:

https://sydney.edu.au/students/exams.html

7.3   In Semester Assessments

Assignments

Assignments are set and marked in order to give you extra practice, and to provide you with feedback on how you are handling the material.

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 a contribution. However, if an assignment is to count as part of the assessment, then you must produce your own individual written solution. Copying someone else's assignment, or allowing your assignment to be copied by someone else, is academic dishonesty and will be dealt with as such, see above.

Submission and return of assignments. The assignments must be submitted electronically via the Learning Management System (Canvas) site by the deadline. It is passed through a text matching software (Turnitin) to check for plagiarism. Your submission should include your SID, tutorial day, time, room and Tutor's name. Your assignment will be marked anonymously with useful comments and feedback, which you can view online from the Learning Management System (Canvas) site after the Feedback date, given on the Unit Information Sheet.

Quizzes

Many junior units of study may have written quizzes as part of the assessment. These will usually be conducted in a regular tutorial period by the tutor. You should attempt any quiz in the tutorial in which you are officially enrolled. You are enrolled in a tutorial class if and only if your name is *typed* onto the roll for that class.

If you have a legitimate reason for being unable to sit the quiz in the tutorial in which you are enrolled then you may apply, at the Mathematics Student Services Office, to sit the quiz at a different time.

Note: Your quiz mark may not be recorded if you sit a quiz in a tutorial in which you are not enrolled, unless you have been given written permission to do so by the Student Services Office.

Online Quizzes

Some units have weekly online quizzes that count towards the final mark. Precise instructions vary. Please take note of the instructions provided on the Learning Management System and/or the School's unit of study web page.

Projects and Presentations

Some units (statistics and data) have groupwork projects and presentations. Similar to assignments, groupwork projects are submitted electronically through the Learning Management System (Canvas).

Final Results

Your final result in each unit will be posted on MyUni and later you will receive notice of examination results by mail. If you have a concern about your results, contact the Student Services Office. We will not generally release any marks inofficially.

8 Special consideration and special arrangements

8.1 General Information

While studying at the University of Sydney, a student may need to apply for special consideration or special arrangements as follows:

Special Consideration may be granted where well-documented illness, injury or misadventure occurs to the student (or someone the student has carer's responsibility for) during semester or the exam period.

Longer term health or emotional issues are best managed with adjustments to course assessments as part of an Academic Plan developed in discussion between the student and Disabilities Service.

Special Arrangements may be granted for certain personal circumstances - for example the birth of a child, or religious or cultural commitments - or for essential community commitments - for example compulsory legal absence (e.g. Jury duty), elite sporting or cultural commitments (representing the University, state or country), or Australian Defence Force or Emergency Service commitments (e.g. Army Reserve).

Further information on deadlines, eligibility, document requirements and how to apply is available at

https://sydney.edu.au/students/special-consideration.html.

When completing the online application, ensure you choose an Assessment Category and Type that matches the description of the assessment given in the Unit Outline.

Students should not submit an application of either type if

- there is no assessment associated with a missed class, or

- there is a reasonable opportunity to make up any work you missed.

Note that occasional brief or trivial illness will not generally warrant special consideration. Also, an application for special consideration or special arrangements is a request only, and not a guarantee that special consideration will be granted or special arrangements made.

8.2   Special consideration relating to assignments.

If you encounter a problem submitting an assignment or project on time, you need to apply for special considerations. Extensions longer than one week are generally not possible. See the link given above for more information and details on how to apply. Simple extension requests will generally not be granted, rather students will be directed to apply for special consideration.

Written assignments or projects submitted late without permission will incur a late penalty equal to 5% of the maximum awardable mark per day. These deductions begin immediately after the time the assignment is due and continue for 10 calendar days or until a solution for the assignment is released or marked assignments are returned to other students. At that point the mark awarded will be zero.

8.3   Special consideration relating to quizzes.

If you miss a quiz due to illness or misadventure, then you should go to the Mathematics Student Services Office as soon as possible afterwards. Arrangements may be made for you to sit the quiz at another time. If that is not possible then you may be eligible to apply for Special Consideration if the *bettermark principle* does not apply.

If your application for Special Consideration relating to missing a quiz is successful then you gain exemption from the quiz and the credit is transferred to the final examination.

Bettermark principle.   Most units of study use a *bettermark principle*, which means that credit for a missed quiz is automatically transferred to the exam. Please consult the unit information sheet for the precise rules applying to your unit.

Special consideration relating to end-of-semester examinations.

If you believe that your performance on an exam was impaired due to illness or misadventure during the week preceding the exam, then you should apply for Special Consideration. If your application is successful you may be offered the opportunity to sit a replacement exam. Please note that illness or misadventure during the week preceding the exam is not usually an acceptable reason for missing an exam.

If you miss an exam due to illness or misadventure on the day of the exam then you should apply for Special Consideration. If your application is successful you will be granted the opportunity to sit a supplementary examination.

8.4   Special consideration relating to attendance.

The University policy is that all students should attend at least 80 per cent of timetabled classes in their respective units of study. Attendance is monitored in tutorials, but generally no marks are allocated for attendance, except where it is incorporated in some scheduled assessed activity. Applications for Special Consideration or for Special Arrangements for absences that do not involve a scheduled assessed activity should not be made.

8.5 Jury duty, military service, national sporting and religious or cultural commitments.

Students who will miss an assessment due to commitments such as these may apply for special arrangements to be made, as detailed above.

9 Additional information

9.1 Variation of enrolment

Any variation to enrolment must be made before the relevant HECS cut-off date in each semester (some time in March for first semester, and some time in August for second semester).

After the cut-off dates it may not be possible to enrol in additional units, nor to withdraw from a unit without incurring HECS fees. Note that it is generally not possible to enrol in additional units of study after the end of the second week of each semester.

It is your responsibility to make any desired changes to your enrolment before the relevant dates. This includes changing the level at which you are studying mathematics, for example from advanced to mainstream, or vice versa. You are strongly advised to consult the Director of First Year Studies if you wish to make such a change. Even though advanced and mainstream units have similar syllabuses, changing from one to the other may be disruptive. If it is necessary to make such a change, try to change earlier rather than later. Because advanced and mainstream units have completely different syllabuses from fundamental units, changes to and from fundamental units may be even more disruptive. In general, such changes should not be made after the end of the second week of each semester.

9.2 Mathematics Learning Centre

Students who have difficulties with current course work as a result of inadequate understanding of the assumed knowledge for the unit of study may find that the Mathematics Learning Centre can help.

The Mathematics Learning Centre can be of particular assistance if you:

- You have not studied the mathematics which is assumed knowledge for your course.

- You are a mature age student who has not studied mathematics in several years.

- You are from overseas and find you have gaps in your knowledge, or are not familiar with mathematical terms in English.

- Your studies have been interrupted by either illness or accident or some other cause.

The Mathematics Learning Centre offers advice about supplementary work needed and has self-study materials, in a variety of forms, which students can use. Small classes or one-to-one assistance are provided where needed. The Mathematics Learning Centre also helps students to improve their study skills. More information is at

> https://sydney.edu.au/students/mathematics-learning-centre.html

You can make use of the online resources regardless of your background and eligibility.

The Mathematics Learning Centre is in Room N293 in the Quadrangle.

9.3   Sydney University Mathematical Society

ΣUMS (pronounced sums) is an informal group, organised by students, that aims to promote interest in mathematics. Every mathematics student is automatically a member. ΣUMS organises talks by mathematicians, an annual problem solving competition and various other events such as the ΣUMS musical. Everybody is very welcome to attend and be involved. Contributions to the ΣUMS newsletter (ΣUMS+Plus) are also welcome. Websites:

- https://usydsums.wordpress.com/

- https://www.facebook.com/usydsums

9.4   Sydney University Science Association

The University of Sydney Science Society, SciSoc, is the undergraduate society for students in the Science Faculty at the University of Sydney. All students enrolled in Science at the University of Sydney are automatically members of SciSoc. Part of the mission of SciSoc is to provide a form of social support for Science students.

9.5   Fire alarms and evacuation procedures

If you are in a building and the fire alarm sounds, then you must evacuate the building immediately. You should familiarise yourself with the evacuation procedures from any rooms in which you have classes.

9.6   Timetables

Once semester has started you find timetables for all units offered by the School of Mathematics and Statistics at

> https://www.maths.usyd.edu.au/u/UG/mathstattimetable.html.

How to get your personal timetable, enter preferences etc you find at

> https://sydney.edu.au/students/timetables.html