Table of Contents

Course Regulations for Year 1

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/)

To create a printable version of this section of the Handbook click on the "pages to go" link at the bottom right.

MATHEMATICS BSC. G100, MASTER OF MATHEMATICS MMATH G103, MATHEMATICS WITH BUSINESS STUDIES G1NC.

Normal Load = 120 CATS. Maximum Load = 150 CATS.

Students must take the 8 core modules (total 90 CATS), plus options. List A modules have a high mathematical content. The Core modules are: MA106 Linear Algebra, MA131 Analysis, MA132 Foundations, MA133 Differential Equations, MA134 Geometry and Motion, MA136 Introduction to Abstract Algebra, MA124 Maths by Computer, ST111 Probability A.

MATHEMATICS AND ECONOMICS GL11

The first year is in common with the BSc Mathematics degree course G100, with the addition of EC107 Economics I and ST112 Probability B as additional core modules (total core of 126 CATS).

Note. The Mathematics Department does not make first year List A modules compulsory, in order to give students (including those on joint degree courses) freedom of choice in building their options. However, the List A modules are important for many subsequent pure and applied maths modules, and we recommend that first year students take as many as possible to maintain flexibility for future maths modules. Choosing options is discussed here, and the first year List A options are discussed below.

Of the core, the modules MA131 Analysis, MA133 Differential Equations, MA106 Linear Algebra and MA134 Geometry and Motion are designated as being "required cores". This means that all first years **must** pass these modules (at 40%) either in the Summer exams or the resit exams the following September, in order to progress in to the second year, alongside getting an overall 40% for the year and passing at least 90 CATS of modules.

GL11 students must in addition pass EC107.

Additional advice to first year students

Maths Modules

Term	Code	Module	CATS	List
Pre-Term	MA1K2	Refresher Mathematics	0	Core
Term 1	MA132	Foundations	12	Core
	MA133	Differential Equations	12	Core
	MA136	Introduction to Abstract Algebra	6	Core
Term 1 & 2	MA131	Analysis I and II	24	Core
Term 2	MA106	Linear Algebra	12	Core
	MA124	Maths by Computer	6	Core
	MA134	Geometry and Motion	12	Core
	MA117	Programming for Scientists	12	List B

Maths Modules for External Students

These modules are not available to Maths students.

Term	Code	Module	CATS
Term 1	MA138	Sets and Numbers	12
Term 1 & 2	MA137	Mathematical Analysis I and II	24
Term 2	MA113	Differential Equations A	6

Statistics Modules

First year mathematics students interested in transferring to MORSE (Mathematics, Operational Research, Statistics and Economics) should include the following modules among their options

EC106 Introduction to Quantitative Economics(24 CATS, Terms 1-2);
IB104 Mathematical Programming I (12 CATS version, Term 3);
ST112 Probability B (6 CATS, Term 2)
ST104 Statisitcal Laboratory I (12 CATS, Terms 2-3)

This would allow transfer into the second year of MORSE, which consists of roughly equal proportions from the four participating departments (Statistics, Economics, Business Studies and Mathematics). Further details of MORSE can be obtained from the Statistics Department.

For transfer into Mathematics and Statistics students should take

ST112 Probability B (6 CATS, Term 2)
ST104 Statisitcal Laboratory I (12 CATS, Terms 2-3)

Transfer into any Statistics course will depend on available capacity and is likely to be restricted to only the strongest students.

Both Probability A (core) and Probability B are also essential for any further Statistics options in later years.

Term	Code	Module	CATS	List
Terms 2 and 3	ST104	ST104 Statistical Laboratory I	12	List B
Term 2	ST111	Probability A	6	Core

	ST112	Probability B	6	List A Core (GL11)

Economics Modules

Mathematics & Economics (GL11) students should refer to the Economics Undergraduate handbook and to the section on joint degree courses in this handbook.

Other mathematics students (G100 or G103, BSc or MMath) may take EC106 Introduction to Qualitative Economics as an option. [Note: Maths & Economics students do NOT take EC106.] It is designed to be suitable for Mathematics students, and a good performance in this module >55% is a prerequisite for some optional second and third year Economics modules. See the Economics Department Undergraduate handbook, which also contains details of other more specialized first year economics options. **If you wish to take second year Economics modules next year then you MUST take EC106 or EC107 this year,**

Term	Code	Module	CATS	List
Terms 1 & 2	EC106	Introduction to Quantitative Economics	24	List B (not GL11)
	EC107	Economics I	30	Core (GL11 only)

Computer Science

Mathematics students should note that *at least one 1st year programming module*, or the ability to program in a high level language, *is a prerequisite* for most Computer Science modules in Years 2 and 3. There are two roughly equivalent high level programming modules. CS118 Programming for Computer Scientists which is taken by Computer Science students, and MA117 Programming for Scientists which is available to all Mathematics students as an option. MA117 satisfies the programming prerequisite for Computer Science options.

Students considering transferring to the Discrete Mathematics G4G1 degree should take the modules Discrete Mathematics & its Applications 2 as well as MA117 Programming for Scientists.

Term	Code	Module	CATS	List
Term 2	CS137	Discrete Mathematics & its Applications 2	12	List B

Physics

Physics options for Mathematics students: Weekly problem sheets are issued for all the first year Physics modules. Any combination of Physics options may be taken. However, the Physics Department recommends the following modules and combinations, especially for students who may wish to transfer to the Maths and Physics degree at the end of the first year.

- PX101 Quantum Phenomena. This module deals from first principles with one of the major components of modern Physics. It leads on to several options in 2nd year Physics (see the second year options for details).
- PX148 Classical Mechanics and Special Relativity
- PX120 Electricity and Magnetism. These lectures treat the classical description of the behaviour of particles, waves and matter.

Term	Code	Module	CATS	List
Term 1	PX148	Classical Mechanics and Special Relativity	12	List B
Term 2	PX120	Electricity and Magnetism	12	List B
	PX144	Introduction to Astronomy	6	List B
	PX147	Introduction to Particle Physics	6	List B
Term 3	PX101	Quantum Phenomena	6	List B

Philosophy Modules

Students wishing to follow modules in Philosophy should register for these modules at the start of Term 1, using the online registration system.

In order to follow 2nd or 3rd year Philosophy honours modules students must normally first have completed a total of 30 CATS of Philosophy modules at the first year level. Those in doubt should consult the module tutor of the relevant module.

Students on the Mathematics and Philosophy joint degree take the following two modules in their first year: PH142 Central Themes in Philosophy (term 2); PH136 Logic I: Introduction to Symbolic Logic (term 2). Mathematics students are also eligible for a transfer to Mathematics and Philosophy if they take the same module combination in their first year. See the Philosophy Department's website

Term	Code	Module	CATS	List
Term 1	PH144	Mind and Reality	15	List B
	PH146	Reason, Argument and Analysis	15	List B
Term 2	PH136	Logic I: Introduction to Symbolic Logic	15	List B

Warwick Business School

See Information for all WBS modules.

Note that for any WBS module you MUST register on both the University registration system (eVision) and the WBS system (MyWBS), **with the same CATS weighting**. Failure to do this may mean that you will not be permitted to continue on the module and be removed from it.

Term	Code	Module	CATS	List
Term 3	IB104	Mathematical Programming I	12	List B

Languages

The Language Centre offers academic modules in Arabic, Chinese, French, German, Japanese, Russian and Spanish at a wide range of levels. These modules are available for exam credit as unusual options to mathematicians in all years. Pick up a leaflet listing the modules from the Language Centre, on the ground floor of the Humanities Building by the Central Library. Full descriptions are available on request. Note that you may only take one language module (as an Unusual Option) for credit in each year. Language modules are available as whole year modules, or smaller term long modules; both options are available to maths students. These modules may carry 24 (12) or 30 (15) CATS and that is the credit you get. We used to restrict maths students to 24 (12) if there was a choice, but we no longer do this.

Plan ahead! Note that 3rd and 4th year students cannot take beginners level (level 1) Language modules.

There is also an extensive and very popular programme of lifelong learning language classes provided by the centre to the local community, with discounted fees for Warwick students. Enrolment is from 9am on Wednesday of week 1. These classes do not count as credit towards your degree.

The Language Centre also offers audiovisual and computer self-access facilities, with appropriate material for individual study at various levels in Arabic, Chinese, Dutch, English, French, German, Greek, Italian, Portuguese, Russian and Spanish. (This kind of study may improve your mind, but it does not count for exam credit.)

Important note for students who pre-register for Language Centre modules

It is essential that you confirm your module pre-registration by coming to the Language Centre as soon as you can during week one of the new academic year. If you do not confirm your registration, your place on the module cannot be guaranteed. If you decide, during the summer, NOT to study a language module and to change your registration details, please have the courtesy to inform the Language Centre of the amendment.

Information on modules can be found at

http://www2.warwick.ac.uk/fac/arts/languagecentre/academic/

Engineering

Mathematics students interested in taking Engineering modules in later years should see the page for year 2 and 3 modules for any prerequisites. Details of all engineering modules can be found on the Engineering web pages.

Objectives

After completing the first year students will have

- made the transition in learning style and pace from school to university mathematics;
- been introduced to the basic concepts in university mathematics, in particular proof, rigour and calculations;
- begun the study of the foundational core;
- acquired knowledge, understanding and techniques necessary to proceed to the second year.

General Advice to First Year Students

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/yr1advice/)
As described in the "General" section, first-year Mathematics students get regular supervisions in groups in Terms 1 and 2, and the first 6 weeks of Term 3, in groups (normally of five) which are assigned at the start of the year. Personal tutors are available to answer questions about the course, individual modules, or anything else within reason.

Your A level background. There are many different A level syllabuses, with wide variations from one exam board to another, and from one selection of modules to another; in addition, not all schools teach the entire syllabus. Thus, some students may have missed out on some material which is needed for degree work, or may only have covered some topics skimpily and without adequate practice.

For the success of your career at Warwick, it is most important that you know these topics inside out, and are able to work with them fluently, confidently, and rapidly, even in the new and sometimes unexpected contexts of university maths. In the middle of a complicated argument, a lecturer may well simply assume that you can handle this kind of stuff easily and transparently, and lack of this ability may be a serious impediment to getting the most out of the course. Before you arrive you should have attempted the Refresher Mathematics module, MA1K2, to make sure that you are up to date and proficient in the material that you need to know. This module will appear on your registrations, but does not count for any credit towards your degree.

Tutorials. Every student has a personal tutor, with whom they will (where possible) remain throughout their degree. Tutors usually see their first-year students in groups of five once every two weeks, though students can see their tutors individually, in principle, as often as they want. The aim of the regular meetings is to find out how the students are getting on, and to provide extra help where needed. At the start of the year, your tutor can also help you to choose your optional modules.

The relationship between student and tutor is an important one. Your tutor is there to help you not only with mathematical difficulties, but also with other problems that may arise: difficulties in settling down to a steady programme of study, noisy neighbours in the Halls of Residence, how to catch up after an absence through illness, etc. etc. He or she also plays an important role after examinations at the end of each year. For example, if your marks are lower than they should be because you were unwell during your exams, they can give you advice and in teh case of mitigating circumstances provide secondary evidence for the exam board (you must always provide primary evidence from third party professionals such as doctors or counsellors). Of course, this can only happen if he or she knows you and has a good idea of your ability. See also the section on Mitigation.

First year Core and List A options

The Warwick course regulations and our options scheme is listed elsewhere, but the 8 core modules (shared by all students in the Mathematics Department) add up to 90 CATS:

Core

MA106 Linear Algebra	12 CATS
MA133 Differential Equations	12 CATS
MA124 Mathematics by Computer	6 CATS
MA134 Geometry and Motion	12 CATS
MA132 Foundations	12 CATS
MA136 Introduction to Abstract Algebra	6 CATS
MA131 Analysis	24 CATS

ST111 Probability A 6 CATS

List A

ST112 Probability B 6 CATS

We recommend students to take as many of the List A options as possible during their degrees, for the sake of flexibility with maths modules in future years. ST112 Probability B is a prerequisite for most second and third year Statistics options, and is either a prerequisite or recommended for many courses in Economics and Business Studies. Students on joint degree courses have additional core modules.

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

MA106 Linear Algebra

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ma106/)
Lecturer: Diane Maclagan and Marco Schlichting

Term(s): Term 2

Status for Mathematics students: Core for Maths

Commitment: 30 one-hour lectures

Assessment: 15% from weekly assignments, 85% from a 2 hour examination

Formal registration prerequisites: None

Assumed knowledge: A-level Mathematics and Further Mathematics

Useful background: A-level Mathematics and Further Mathematics

Synergies: All parts of mathematics, and more generally, all parts of quantitative science, use linear algebra

Leads to: The following modules have this module listed as **assumed knowledge** or **useful background:**

- MA241 Combinatorics
- MA243 Geometry
- MA251 Algebra I: Advanced Linear Algebra
- MA254 Theory of ODEs
- MA258 Mathematical Analysis III
- MA259 Multivariable Calculus
- MA3D5 Galois Theory
- MA3E1 Groups and Representations
- MA398 Matrix Analysis and Algorithms
- MA3K1 Mathematics of Machine Learning

- MA3H7 Control Theory
- MA427 Ergodic Theory
- MA4J1 Continuum Mechanics

Content: Many problems in maths and science are solved by reduction to a system of simultaneous linear equations in a number of variables. Even for problems which cannot be solved in this way, it is often possible to obtain an approximate solution by solving a system of simultaneous linear equations, giving the "best possible linear approximation".

The branch of maths treating simultaneous linear equations is called linear algebra. The module contains a theoretical algebraic core, whose main idea is that of a vector space and of a linear map from one vector space to another. It discusses the concepts of a basis in a vector space, the dimension of a vector space, the image and kernel of a linear map, the rank and nullity of a linear map, and the representation of a linear map by means of a matrix.

These theoretical ideas have many applications, which will be discussed in the module. These applications include:

- Solutions of simultaneous linear equations
- Properties of vectors
- Properties of matrices, such as rank, row reduction, eigenvalues and eigenvectors
- Properties of determinants and ways of calculating them

Aims: To provide a working understanding of matrices and vector spaces for later modules to build on and to teach students practical techniques and algorithms for fundamental matrix operations and solving linear equations.

Objectives: Students must understand the ideas of linearly independent vectors, spanning sets and bases of vector spaces. They must also understand the equivalence of linear maps between vector spaces and matrices and be able to row reduce a matrix, compute its rank and solve systems of linear equations. The definition of a determinant in all dimensions will be given in detail, together with applications and techniques for calculating determinants. Students must know the definition of the eigenvalues and eigenvectors of a linear map or matrix, and know how to calculate them.

Books:

David Towers, *Guide to Linear Algebra*, Macmillan 1988.

Howard Anton, *Elementary Linear Algebra*, John Wiley and Sons, 1994.

Paul Halmos, *Linear Algebra Problem Book*, MAA, 1995.

G Strang, *Linear Algebra and its Applications*, 3rd ed, Harcourt Brace, 1988.

Recommended Syllabus

Additional Resources

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

MA112 Experimental Maths

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ma112/)
Lecturers: Andrew Brendon-Penn and Mark Cummings

Term(s): Not running 2020/21

Status for Mathematics students: List A for Maths

Commitment: One 3 hour lab session per week for 4 weeks (during weeks 1-5 of term 3)

Assessment: 100% by written reports on each of the projects

Prerequisites: Most core 1st year mathematics modules, especially MA133 Differential Equations, MA131 Analysis, MA136 Abstract Algebra, MA124 Maths by Computer, and MA134 Geometry & Motion.

Leads To: MA259 Multivariable Calculus, MA209 Variational Principles, MA250 Partial Differential Equations, MA3J3 Bifurcation, Catastrophes and Symmetry

Content:
This module consists of a series of 4 laboratory projects which combine physical or computer experiments with mathematical modelling and analysis. The projects will include work on symmetry breaking, catastrophe theory, nonlinear oscillators, period doubling, and coupled pendula.

Much more information is provided on the Additional Resources page, linked below. Due to deregistration dates being before the start of the module, we strongly advise all students who are seriously considering taking the module to read this.

Aims:
To demonstrate that mathematical ideas and techniques can be used to predict and explain `real life' phenomena and that, conversely, physical intuition can lead to mathematical insights.

Objectives:

1. To show how various aspects of mathematics seen in earlier modules can be applied to real-world situations, such as the application of differential equations to the study of coupled and nonlinear oscillators.
2. To illustrate the use of simple group theoretical ideas in problems with symmetries.
3. To provide an opportunity for students to learn the thought process used to solve long and complicated problems, by breaking them down into smaller, more manageable pieces.
4. To provide an opportunity for students to develop report writing skills.
5. To provide an opportunity for students to develop the ability to work in groups.

Books:
As this module follows on from several core first year modules, you are recommended to check the recommended texts for those modules.

Additional Resources

Archived Pages: 2012 2014 2015

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

MA117 Programming for Scientists

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ma117/)
Lecturer: Andrew Hague (DCS)

Term(s): Term 2

Status for Mathematics students: List B for Maths

Commitment: 10 lectures plus lab sessions/tutorials

Assessment: Three programming assignments.

Prerequisites: No previous computing experience will be assumed, but students should have obtained a code to use the IT Services work area systems prior to this module. Information and assistance is available in the Student Computer Centre in the Library Road.

Leads to:

- MA4M1 Epidemiology by Example

Content: Aspects of software specification, design, implementation and testing will be introduced in the context of the Java language. The description of basic elements of Java will include data types, expressions, assignment and compound, alternative and repetitive statements. Program structuring and object oriented development will be introduced and illustrated in terms of Java's method, class and interface. This will enable the development of software that reads data in a variety of contexts, performs computations on that data and displays results in text and graphical form. Examples of iterative and recursive algorithms will be given. The importance of Java and Java Virtual Machine in networked computing will be described. The majority of examples will be standard applications but the development of Java Applets to be delivered by web browsers will also be covered.

Aims: To provide an understanding of the process of scientific software development and an appreciation of the importance of data vetting, sound algorithms and informative presentation of results.

Objectives: To enable the student to become confident in the use of the Java language for scientific programming.

Books:

Books are not essential for this module as use will be made of on-line tutorial and reference material. An informative, optional text is

H M Deitel & P J Deitel, *Java How to Program* (2nd or 3rd Ed), Prentice Hall.

Additional Resources

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

MA124 Mathematics by Computer

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ma124/)
Lecturer: Richard Lissaman and Marya Bazzi

Term(s): Term 1 and 2

Status for Mathematics students: Core for Maths

Commitment: One lecture per week with one 1-hour help class per week

Assessment: The material learnt in the contact sessions will be assessed through five assignments, counting for 100% of the total mark

Formal registration prerequisites: None

Assumed knowledge: None, other than that already covered in core first-year mathematics modules

Useful background: Prior experience with Python or other programming languages will be useful

Synergies: The assignments will make contact with material from other first-year mathematics modules, in particular:

- MA133 Differential Equations
- MA131 Analysis
- MA106 Linear Algebra
- MA134 Geometry and Motion

Leads to: The following modules have this module listed as **assumed knowledge** or **useful background:**

- MA261 Differential Equations: Modelling and Numerics
- MA398 Matrix Analysis and Algorithms
- MA4M1 Epidemiology by Example

By the end of the module you will find the computer to be a tool that can aid you throughout your life as a mathematician and, in particular, in many modules you will take at Warwick. Specific modules which might use Matlab include: MA261 Differential Equations: Modelling and Numerics, MA398 Matrix Analysis and Algorithms, MA3H7 Control Theory. But you should think of your computing skills as a powerful resource to be used, potentially, at any time.

Aims: The first aim is to show how the computer may be used, throughout all of mathematics, to enhance understanding, make predictions, test hypotheses. This will be achieved primarily through eight hours of computer-based contact sessions.

Objectives: The module will be taught using Python (please note the recent change from Matlab). Through using this language you will be introduced to the rudiments of computer programming.

You will learn how to graph functions, study vectors and matrices graphically and numerically, how to iterate and use iteration to study sequences and series, how to solve algebraic and differential equations numerically and how to study statistical properties of sets of numbers.

Books:

- M Lutz, *Learning Python*, O'Reilly Media Inc., 3rd edition, 2007, ebook here
- JV Guttag, *Introduction to Computation and Programming Using Python*, MIT Press, 2nd edition, 2016, ebook here

Additional Resources

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

MA125 Introduction to Geometry

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ma125/)
Lecturer: Meritxell Saez

Term(s): Not running 2021/22

Status for Mathematics students: List A for Maths

Commitment: Fifteen one-hour lectures

Assessment: One-hour exam taken in the summer term

Prerequisites:

Leads To: MA243 Geometry

Content: This module begins with a quick tour through elementary plane Euclidean geometry. We emphasise proof, and the careful use of diagrams as an aid to understanding problems and finding proofs. Plane geometry then provides the setting for an introduction to the geometry of the sphere and of polyhedra.

Aims:

- To learn and enjoy Euclidean geometry of the plane, the sphere and of three-dimensional space.
- To learn to visualise geometrical problems, and to draw diagrams which represent them accurately.
- To learn to reason from diagrams, and use them as an aid to writing rigorous proofs.
- To learn to construct proofs, and to set them out clearly and convincingly.

Objectives: You will gain familiarity with

- Plane Euclidean geometry: isometries, congruence and similarity; theorems on triangles, circles, tangents and angles; ruler and compass constructions.
- Polyhedra: the Euler characteristic; classification and construction of regular polyhedra.
- Spherical geometry: the angle-sum formula for spherical triangles; stereographic projection and its relation with inversion; conformal (angle-preserving) maps.

Books:

Notes for the module will be available at cost price from the departmental office.

Also relevant: G.A. Jennings, *Modern geometry with applications*, Springer-Verlag (a fine book with many challenging exercises, but useful only as a complement to the course).

Additional Resources

Archived Pages Pre-2011 2012 2016 2017

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

MA131 Analysis I and II

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ma131/)
Lecturer:
Term 1: Daniel Ueltschi

Term 2: Keith Ball

Term(s): Terms 1 & 2

Status for Mathematics students: Core for Maths

CAUTION: This entry refers to arrangements for students based in the Mathematics Department (those who entered through the Mathematics Department and have a Personal Tutor there). All other students should be registered on MA137 Mathematical Analysis.

Commitment: One lecture per week, two 1-hour classes per week

Assessment: Weekly assignments (15%), January exam (25%), June exam (60%)

Formal registration prerequisites: None

Assumed knowledge: None

Useful background: None

Synergies: Analysis is one of the two most fundamental parts of pure mathematics with the other being algebra. This module forms the foundation on which many other modules will be built. Amongst the first year modules, the ones most closely related are: MA133 Differential Equations and MA134 Geometry and Motion. Analysis also has close connections to applied mathematics, probability theory and physics.

Leads to: The following modules have this module listed as **assumed knowledge** or **useful background:**

- MA222 Metric Spaces
- MA260 Norms, Metrics and Topologies
- MA254 Theory of ODEs
- MA259 Multivariable Calculus
- MA4J1 Continuum Mechanics

Content: At the beginning of the nineteenth century, the familiar tools of calculus, differentiation and integration, began to run into problems. Mathematicians were unsure of how to apply these tools to sums of infinitely many functions. The origins of Analysis lie in their attempt to formalize the ideas of calculus purely in the the language of arithmetic and to resolve these problems.

You will study ideas of the mathematicians: Cauchy, Dirichlet, Weierstrass, Bolzano, D'Alembert, Riemann and others, concerning sequences and series in term one, continuity and differentiability in term two and integration in term one of your second year.

By the end of the year you will be able to answer many interesting questions: What do we mean by `infinity'? How can you accurately compute the value of π or e or $\sqrt{2}$? How can you add up infinitely many numbers, or infinitely many functions? Can all functions be approximated by polynomials?

There will be considerable emphasis throughout the module on the need to argue with much greater precision and care than you had to at school. With the support of your fellow students, lecturers and other helpers, you will be encouraged to move on from the situation where the teacher shows you how to solve each kind of problem, to the point where you can develop your own methods for solving problems. You will also be expected to question the concepts underlying your solutions, and understand why a particular method is meaningful and another not so. In other words, your mathematical focus should shift from problem solving methods to concepts and clarity of thought.

Books:
M. Hart, *Guide to Analysis*, Macmillan. (A good traditional text with theory and many exercises.)
K.G. Binmore, *Mathematical Analysis: A Straightforward Approach*, CUP (1982)

R.G Bartle and D.R Sherbert, *Introduction to Real Analysis,* (4th Edition), Wiley (2011)

L. Alcock, *How To Think About Analysis*, Oxford University Press (2014)

Recommended Syllabus

[Additional Resources Analysis I (Term 1)](#)
[Additional Resources Analysis II (Term 2)](#)

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

MA132 Foundations

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ma132/)
Lecturer: Dave Wood

Term(s): Term 1

Status for Mathematics students: Core

Commitment: 30 lectures, 10 weekly assignments with 4 or 5 fortnightly tests based on them

Assessment: 15% from fortnightly tests and 85% from January exam

Formal registration prerequisites: None

Assumed knowledge: Grade A in A-level Maths or equivalent.

Useful background: Some elementary knowledge of modular arithmetic, induction principle, set notation.

Synergies: Most later pure mathematics modules specifically:

- MA136 Introduction to Abstract Algebra
- MA131 Analysis
- MA106 Linear Algebra
- MA251 Algebra I: Advanced Linear Algebra

Leads to: The following modules have this module listed as **assumed knowledge** or **useful background:**

- MA222 Metric Spaces
- MA260 Norms, Metrics and Topologies
- MA257 Introduction to Number Theory
- MA249 Algebra II: Groups and Rings
- MA3E1 Groups and Representations
- MA3A6 Algebraic Number Theory
- MA3D5 Galois Theory
- MA3H3 Set Theory

Aims: University mathematics introduces progressively more and more abstract ideas and structures, and demands more and more in the way of proof, until by the end of a mathematics degree most of the student's time is occupied with understanding proofs and creating his or her own. This is not because university mathematicians are more pedantic than schoolteachers, but because proof is how one knows things in mathematics, and it is in its proofs that the strength and richness of mathematics is to be found.

Learning to deal with abstraction and with proofs takes time. This module aims to bridge the gap between school and university mathematics, by beginning with some rather concrete techniques where the emphasis is on calculation, and gradually moving towards abstraction and proof.

Content:

- **Number Systems:**
  Number systems: Natural numbers, integers. Rationals and real numbers. Existence of irrational numbers. Complex Numbers.
  Polar and exponential form of complex numbers. De Moivre's Theorem, n'th roots and roots of unity.
  Euclidean algorithm; greatest common divisor and least common multiple.
  Prime numbers, existence and uniqueness of prime factorisation. Infiniteness of the set of primes.
  Modular arithmetic. Congruence, addition and multiplication modulo n.
- **Language and Proof:**
  Proof by induction.
  Well-ordering Principle.
  Proof by contradiction.
  Basic set theory:$\cap$, $\cup$, Venn diagrams and de Morgan's Laws. Cartesian product of sets, power set.
  Logical connectives$\wedge$, $\vee$, $\Rightarrow$ and their relation with $\cap$, $\cup$ and $\subseteq$. Quantifiers $\forall$ and $\exists$.
- **Sets, Functions and Relations:**
  Injective, surjective and bijective functions.
  Inverse functions.
  Relations: equivalence relations, order relations.
- **Polynomials:**
  Multiplication and long division of polynomials.
  Euclidean algorithm for polynomials.
  Remainder theorem; a degree n polynomial has at most n roots.
  Algebraic and transcendental numbers. Fundamental theorem of
  Algebra (statement only).
- **Counting:**
  Cardinalities, including infinite cardinalities.
  Cardinality of the power set of X is greater than cardinality of X.
  Russell's paradox.
  Countability of the rational numbers, uncountability of the reals.
  Transcendental numbers exist!

Objectives: Students will work with number systems and develop fluency with their properties; they will learn the language of sets and quantifiers, of functions and relations and will become familiar with various methods and styles of proof.

Books:
None of these is the course text, but each would be useful, especially the first:
A.F.Beardon, *Algebra and Geometry*, CUP, 2005.
I.N. Stewart and D.O. Tall, *Foundations of Mathematics*, OUP, 1977.
J. A. Green, *Sets and Groups; First Course in Algebra*, Chapman and Hall, 1995.

Recommended Syllabus

Additional Resources

Year 1 regs and modules
G100 G103 GL11 G1NC

MA133 Differential Equations

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ma133/)
Lecturer: Dwight Barkley

Term: Term 2

Status for Mathematics students: Core

Commitment: 30 lectures

Assessment: 15% from fortnightly assignments, 85% from a 2 hour examination

Formal registration prerequisites: None

Assumed knowledge: A-level mathematics or equivalent, in particular Calculus topics from Pure

Useful background: Proficiency with Mechanics from Maths A-level, or having taken Physics A-level, useful but not essential, we will cover necessary topics from first principles

Synergies: This module leads on to any module using differential or partial differential equations, most immediately MA134 Geometry and Motion in Term 2

Leads to: The following modules have this module listed as **assumed knowledge** or **useful background:**

- MA254 Theory of ODEs
- MA261 Differential Equations: Modelling and Numerics
- MA250 Introduction to Partial Differential Equations
- MA269 Asymptotics and Integral Transforms
- MA256 Introduction to Mathematical Biology
- MA258 Mathematical Analysis III
- MA209 Variational Principles
- MA390 Topics in Mathematical Biology
- MA3J3 Bifurcations, Catastrophes and Symmetry
- MA3H7 Control Theory
- MA4J1 Continuum Mechanics

Content: How do you reconstruct a curve given its slope at every point? Can you predict the trajectory of a tennis ball? The basic theory of ordinary differential equations (ODEs) as covered in this module is the cornerstone of all applied mathematics. Indeed, modern applied mathematics essentially began when Newton developed the calculus in order to solve (and to state precisely) the differential equations that followed from his laws of motion.

However, this theory is not only of interest to the applied mathematician: indeed, it is an integral part of any rigorous mathematical training, and is developed here in a systematic way. Just as a `pure' subject like group theory can be part of the daily armoury of the `applied' mathematician , so ideas from the theory of ODEs prove invaluable in various branches of pure mathematics, such as geometry and topology.

In this module we will cover relatively simple examples, first order equations

$dy/dx = f(x, y)$,

linear second order equations

$\ddot{x}(t) + p(t)\dot{x} + q(t)x = g(t)$

and coupled first order linear systems with constant coefficients, for most of which we can find an explicit solution. However, even when we can write the solution down it is important to understand what the solution means, i.e. its `qualitative' properties. This approach is invaluable for equations for which we cannot find an explicit solution.

We also show how the techniques we learned for second order differential equations have natural analogues that can be used to solve difference equations.

The course looks at solutions to differential equations in the cases where we are concerned with one- and two-dimensional systems, where the increase in complexity will be followed during the lectures. At the end of the module, in preparation for more advanced modules in this subject, we will discuss why in three-dimensions we see new phenomena, and have a first glimpse of chaotic solutions.

Aims: To introduce simple differential and difference equations and methods for their solution, to illustrate the importance of a qualitative understanding of these solutions and to understand the techniques of phase-plane analysis.

Objectives: You should be able to solve various simple differential equations (first order, linear second order and coupled systems of first order equations) and to interpret their qualitative behaviour; and to do the same for simple difference equations.

Books:

The primary text will be:
J. C. Robinson *An Introduction to Ordinary Differential Equations*, Cambridge University Press 2003.

Additional references are:
W. Boyce and R. Di Prima, *Elementary Differential Equations and Boundary Value Problems*, Wiley 1997.
C. H. Edwards and D. E. Penney, *Differential Equations and Boundary Value Problems*, Prentice Hall 2000.
K. R. Nagle, E. Saff, and D. A. Snider, *Fundamentals of Differential Equations and Boundary Value Problems*, Addison Wesley 1999.

Recommended Syllabus

Additional Resources

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

MA134 Geometry and Motion

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ma134/)
Lecturer: Siri Chongchitnan and Thomas Hudson

Term(s): Term 2

Status for Mathematics students: Core for Maths

Commitment: 30 lectures

Assessment: 85% Examination, 15% Assessment

Formal registration prerequisites: None

Assumed knowledge: Vector identities involving dot and cross products, equations of circles, ellipses and hyperbolae in $\mathbb{R}^2$, polar coordinates and sketching polar curves, equations of lines and planes in $\mathbb{R}^3$, differentiation and integration techniques, Taylor expansion.

Useful background: Parametric curves in $\mathbb{R}^2$, Cartesian equations of simple surfaces (e.g. a sphere), plotting curves and surfaces in $\mathbb{R}^2$ and $\mathbb{R}^3$ online (e.g. math3d.org) or using Python

Synergies: MA133 Differential Equations and all Term 2 MA modules

Leads To: The following modules have this module listed as **assumed knowledge** or **useful background:**

- MA254 Theory of ODEs
- MA243 Geometry
- MA250 Introduction to Partial Differential Equations
- MA259 Multivariable Calculus
- MA269 Asymptotics and Integral Transforms
- MA4J1 Continuum Mechanics

This module leads on directly to MA259 Multivariable Calculus and, together with MA133 Differential Equations, provides the foundations for most future applied mathematics modules including MA250 Partial Differential Equations, MA209 Variational Principles. The geometric aspects of the module also lead on to MA3D9 Geometry of Curves and Surfaces. The proper theory of integration of functions of several variables is done in MA359 Measure Theory.

Content: When a particle moves in space, it traces out a curve as a function of time. This parametric description of a curve gives us an important connection between geometry and motion.

We will study parametric curves using the tools of *vector calculus*. We will also see how surfaces can be described parametrically using 2 parameters. The properties of curves, surfaces and volumes will be studied using partial differentiation and multiple integrals.

Aims: This module aims to indicate to students how intuitive geometric and physical concepts such as length, area, volume, curvature, mass, circulation and flux can be translated into mathematical formulas. It also aims to teach the practical calculation of these formulas and their application to elementary problems in particle/fluid mechanics.

Objectives: On successful completion of this module students should be able to:

- Parametrise simple curves and surfaces in cartesian and other coordinates, including polar, cylindrical and spherical coordinates
- Calculate lengths and curvatures of curves in R^3 and demonstrate that length is independent of parametrisation
- Understand and be able to calculate line, surface and volume integrals with respect to various coordinate systems. This includes change of variables and change of order of integration in repeated integrals
- Understand and prove simple properties of a conservative vector field
- State the Divergence and Stokes' Theorems and use them to aid calculations
- Apply all these techniques to problems in mechanics (mass, work, circulation and flux) and geometry (area, volume, centre of mass).

Books:

See the reading list on Talis.

Additional Resources

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

MA136 Introduction to Abstract Algebra

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ma136/)
Lecturer: Richard Lissaman

Term(s): Term 1

Status for Mathematics students: Core for Maths

Commitment: 15 one hour lectures

Assessment: Assignments (15%), Written exam (85%)

Formal registration prerequisites: None

Assumed knowledge: A-level Mathematics and Further Mathematics

Useful background: Some elementary knowledge of matrices, functions, modular arithmetic

Synergies:

- MA106 Linear Algebra
- MA132 Foundations or MA138 Sets and Numbers

Leads To: The following modules have this module listed as **assumed knowledge** or **useful background:**

- MA249 Algebra II
- MA251 Algebra I: Advanced Linear Algebra
- MA257 Introduction to Number Theory
- MA3F1 Introduction to Topology
- MA3E1 Groups and Representations
- MA4H4 Geometric Group Theory

Content:

Section 1 Group Theory:

- Motivating examples: numbers, symmetry groups
- Definitions, elementary properties
- Subgroups, including subgroups of Z
- Arithmetic modulo n and the group Z_n
- Lagrange's Theorem
- Permutation groups, odd and even permutations (proof optional)
- Normal subgroups and quotient groups

Section 2 Ring Theory:

- Definitions: Commutative and non-commutative rings, integral domains, fields
- Examples: Z, Q, R, C, Z_n, matrices, polynomials, Gaussian integers

Aims:

To introduce First Year Mathematics students to abstract Algebra, covering Group Theory and Ring Theory.

Objectives:

By the end of the module students should be able to understand:

- the abstract definition of a group, and be familiar with the basic types of examples, including numbers, symmetry groups and groups of permutations and matrices.
- what subgroups are, and be familiar with the proof of Lagrange's Theorem.
- the definition of various types of ring, and be familiar with a number of examples, including numbers, polynomials, and matrices.
- unit groups of rings, and be able to calculate the unit groups of the integers modulo n.

Books:

Any library book with Abstract Algebra in the title would be useful.

Additional Resources

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

ST114 Games and Decisions

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/st114/)

uk.ac.warwick.sbr.content.LinkedContentNotFoundException: The source page does not contain HTML, or has been deleted.

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

EC106 Introduction to Quantitative Economics

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ec106/)

 

325 total students

40 total lecture hours

5 total seminars

45 total contact hours

24 CATS - Department of Economics

Principal Aims

To introduce quantitative economics to students with a relatively strong mathematical background and to extend this

analysis through the use of mathematics. The focus is mainly on economic theory but "real world" applications of relevant theories may also be examined.

Play

00:00 / 02:51

Principal Learning Outcomes

Demonstrate knowledge of economic behaviours, outcomes, trends, developments, phenomena, institutions and policies

To demonstrate the capacity for abstract reasoning and to simplify economic problems through the application of theoretical models

Syllabus

The focus is mainly on economic theory but "real world" applications of relevant theories will also be examined, subject to time limitations. The module will typically cover the following topics:

Term 1: microeconomics, which is concerned with the economic behaviour of individual consumers and producing firms, and their interaction in markets for goods, services and factors of production, strategic interaction and the analysis of externalities and public goods.

Topic-1: Introduction: What is Economics? (Parkin: Chapter 1&2)

Topic-2: Demand and Supply (Parkin: Chapter 3)

Topic-3: Consumer Choices (N&S: Chapter 3&4 and Parkin: Chapter 9)

Topic-4: Uncertainty and Information (Parkin: Chapter 20)

Topic-5: The Firm: Production (N&S: Chapter 9 and Parkin: Chapter 11)

Topic-6: The Firm: Cost (Parkin: Chapter 11)

Topic-7: The Market: Perfect Competition (Parkin: Chapter 12)

Topic-8: The Market: Monopoly (Parkin: Chapter 13 and N&S: Chapter 14)

Topic-9: The Market: Oligopoly and Game Theory (N&S: Chapter 8 &15)

Topic-10: Public Goods and Externality (Parkin: Chapter 16&17)

Term 2: macroeconomics, which is concerned with aggregate economic variables or the workings of the national economy as a whole: aggregate output (Gross Domestic Product or GDP), employment and unemployment, inflation, interest rates, the balance of payments, exchange rates, etc., and with government economic policies to influence these variables.

Topic-1: Introduction to Macroeconomics: (Lecture notes + Rochon & Rossi Ch.1 & 2, + Gandolfo Ch.1)

Topic-2: National Accounts, Alternative Measurements (Lecture notes + Miles, Scott & Breedon Ch.2 + Rochon & Rossi Ch. 7 & 8 + Mankiw Ch.3)

Topic-3: Income Distribution, Demand Side & Supply Side of Economy (AD/AS) (Lecture notes, Blanchard, Amighini and Giavazzi Ch. 8 + Rochon & Rossi Ch.7 + Mankiw Ch. 3 & 10 & 11 & 12)

Topic-4: Money, Banking & Financial System (Lecture notes + Rochon & Rossi Ch.4 & 5 & 6 & 15 + Mankiw Ch. 4 & 11 & 12 + Blanchard, Amighini and Giavazzi Ch.5 & 6 & 14)

Topic-5: Shocks & Fluctuations Using IS-LM model, The Great Depression, Economic & Financial Crises (Lecture notes + Mankiw Ch.12 + Blanchard, Amighini and Giavazzi Ch.20)

Topic -6: Inflation, Unemployment and Phillips Curve (Lecture notes + Mankiw Ch. 5 & 7 & 14 + Rochon & Rossi Ch.8 + Blanchard, Amighini and Giavazzi Ch.7 & 9 & 10, Carlin & Soskice Ch.2)

Topic -7: The 3-Equation Model and Macroeconomic Policy (Lecture notes + Carlin & Soskice Ch.3)

Topic -8: Economic Growth, Capital Accumulation, Population Growth, Technological Advancement (lecture notes + Mankiw Ch.8 & 9 + Rochon & Rossi Ch.10 + Blanchard, Amighini and Giavazzi Ch.11 & 12 & 13)

Topic -9: Open Economy Model (Lecture notes + Mankiw Ch.6 & 13 + Amighini and Giavazzi Ch.6)

Context

Core Module	G300 - Year 1, Y602 - Year 1
Optional Module	G100 - Year 1, G103 - Year 1
Pre or Co-requisites	A-level Mathematics or the equivalent

Assessment

Assessment Method	Coursework (20%) + 2 hour exam (summer) (80%)
Coursework Details	2 hour exam (summer) (80%) ℹ, Test 1 (10%) ℹ, Test 2 (10%) ℹ
Exam Timing	Summer

Reading Lists

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

EC107 Economics 1

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/ec107/)

  

374 total students

40 total lecture hours

16 total seminars

56 total contact hours

30 CATS - Department of Economics

Principal Aims

This module allows students to develop an understanding of fundamental and intermediate concepts in micro and macroeconomic analysis by equipping them with a range of appropriate analytical skills, including descriptive, graphical and mathematical methods. This allows students to develop the capacity to apply analytical techniques to real world problems.

Play

00:00 / 02:54

Principal Learning Outcomes

Subject Knowledge and Understanding:... demonstrate knowledge of economic behaviours, outcomes, trends, developments, phenomena, institutions and policies.

Subject Knowledge and Understanding:...demonstrate an understanding of key concepts, principles, theories and models in Economics.

Subject Specific/Professional Skills:...demonstrate the capacity for abstract reasoning and to simplify economic problems through the application of theoretical models.

Subject Specific/Professional Skills:...demonstrate the capacity to interpret economic data and to use data to inform the selection and application of appropriate economic tools of analysis.

Syllabus

Typically, topics covered will include those such as:

Micro (term 1)

• The Capitalist Revolution

• Technology, Population and Growth

• Scarcity, Work and Choice

• Social Interactions

• Property and Power

• The Firm: Owners, managers and employees

• The Firm and its Customers

• Supply and Demand

• Markets, Efficiency and Public Policy

Macro (Term 2)

• Consumption, saving and investment.

• Aggregate demand, the multiplier and the IS curve

• The labour discipline model of equilibrium unemployment

• Wage setting, inflation and the Phillips Curve

• Social Preferences over inflation and unemployment, the central bank

• Monetary policy stabilisation: central bank responses to economic shocks

• Fiscal policy stabilisation

• Economic growth in historical and global perspective

• The Solow model of economic growth

Context

Core Module	LM1D (LLD2) - Year 1, V7ML - Year 1, GL11 - Year 1, GL12 - Year 1, L1L8 - Year 1, R9L1 - Year 1, R3L4 - Year 1, R4L1 - Year 1, R1L4 - Year 1, R2L4 - Year 1, L1CA - Year 1
Pre or Co-requisites	This module is available as an optional module for all students outside the Economics Department (except for WBS students) who have achieved a Grade B or better in Mathematics at A-level, or the equivalent. It is a pre-requisite for EC204: Economics 2 and EC238/EC239.
Part-year Availability for Visiting Students	Not available on a part-year basis

Assessment

Assessment Method	Coursework (30%) + Online Examination (70%)
Coursework Details	Assessment 1: Problem set (group work) Micro (5%), Assessment 2: MCQ Test (10%), Assessment 3: Problem set (group work) Macro (5%), Assessment 4: MCQ Test (10%), Online Examination (70%)
Exam Timing	Summer

Exam Rubric

Time Allowed: 3 Hours

Read all instructions carefully- and read through the entire paper at least once before you start entering your answers.

There are THREE Sections in this paper. Answer ALL questions in Section A (40 marks total). Answer TWO questions in Section B (30 marks total); and TWO questions in Section C (30 marks total).

Approved pocket calculators are allowed.

You should not submit answers to more than the required number of questions. If you do, we will mark the questions in the order that they appear, up to the required number of questions in each section.

Previous exam papers can be found in the University's past papers archive. Please note that previous exam papers may not have operated under the same exam rubric or assessment weightings as those for the current academic year. The content of past papers may also be different.

Reading Lists

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

CS126 Design of Information Structures

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/cs126/)

CS126-15 Design of Information Structures

Academic year	**21/22**
Department	**Computer Science**
Level	**Undergraduate Level 1**
Module leader	**Charilaos Efthymiou**
Credit value	**15**
Module duration	**10 weeks**
Assessment	**Multiple**
Study location	**University of Warwick main campus, Coventry**

Download as PDF

Description | Study | Assessment | Availability

Introductory description

CS126 is all about data structures and how to program them.

We are interested in: what common data structures exist; how we can program those data structures; how we can represent them efficiently; how we can reason about them (in a formal manner).
We are also interested in common algorithms that use data structures, including: searching for data; sorting data.

Module aims

The module aims for students to:

- gain familiarity with the specification, implementation and use of some standard abstract data types (ADTs) such as linked-lists, stacks, queues, graphs etc.
- learn some standard algorithms for common tasks (such as searching and sorting) and some elementary methods of measuring the complexity, and of showing the correctness, of algorithms;
- learn how to program with non-standard ADTs using an object-oriented language.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

- Types and their properties: simple types in programming languages; relationship between familiar mathematical and program objects of given type. Using predicate logic to state properties of types and their operations in terms of pre- and post-conditions.
- Abstract data types: specification of familiar abstract objects (eg complex numbers, sets, sequences, matrices) and their operations, comparison with their implementation using a typical programming language. Specification and implementation of some important standard types (eg strings, stacks and queues).
- Algorithms: relationship between data structures and algorithms; some standard algorithms for searching, sorting and pattern matching. Elementary analysis of complexity. Reasoning about the correctness of the implementation of simple algorithms.

Learning outcomes

By the end of the module, students should be able to:

- After completing CS126 Design of Information Structures, a student should be familiar with a range of standard ADTs and how they can be used to accomplish common programming tasks.
- After completing CS126 Design of Information Structures, a student should be able to assess the complexity and correctness of simple algorithms, and choose appropriate algorithms for simple tasks.
- After completing CS126 Design of Information Structures, a student should have practical experience of designing user-defined ADTs, and associated algorithms, for a non-standard application.

Indicative reading list

Please see Talis Aspire link for most up to date list.

View reading list on Talis Aspire

Subject specific skills

- Specifying abstract data types and implementing them in an object-oriented programming language
- Estimating the asymptotic running time of simple algorithms
- Using basic data structures to implement efficient algorithms

Transferable skills

- Creative problem solving

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

CS137 Discrete Mathematics and its Applications 2

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/cs137/)

CS137-12 Discrete Mathematics & its Applications 2

Academic year	**21/22**
Department	**Computer Science**
Level	**Undergraduate Level 1**
Module leader	**Ramanujan Maadapuzhi Sridharan**
Credit value	**12**
Module duration	**10 weeks**
Assessment	**Multiple**
Study location	**University of Warwick main campus, Coventry**

Download as PDF

Description | Study | Assessment | Availability

Introductory description

This module is designed to introduce students to language and methods of the area of Discrete Mathematics.

Module aims

The focus of the module is on basic mathematical concepts in discrete maths and on applications of discrete mathematics in algorithms and data structures. One of the aims will be to show students how discrete mathematics can be used in modem computer science (with the focus on algorithmic applications).

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Introduction to combinatorics: counting techniques, pigeonhole principle, inclusion-exclusion.
Recurrence relations, solving recurrences using generating functions.
Master Theorem for solving recurrences.

Graphs. Basic graph algorithms. Trees. Applications of graphs.
Applications of linear algebra and matrix algebra in algorithms (e.g., in web searching).
Algorithmic applications of random processes and Markov chains, for example, cover time in graphs and card shuffling.
Partitions, enumerations with symmetries.

Learning outcomes

By the end of the module, students should be able to:

- - Understand the notion of mathematical thinking, mathematical proofs, and algorithmic thinking, and be able to apply them in problem solving.
- - Understand the basics of discrete probability and number theory, and be able to apply the methods from these subjects in problem solving.
- - Use effectively algebraic techniques to analyse basic discrete structures and algorithms.
- - Understand asymptotic notation, its significance, and be able to use it to analyse asymptotic performance for some basic algorithmic examples.
- - Understand some basic properties of graphs and related discrete structures, and be able to relate these to practical examples.

Indicative reading list

Please see Talis Aspire link for most up to date list.

View reading list on Talis Aspire

Subject specific skills

Basic knowledge of graph theory and its applications in algorithms
Basic knowledge of discrete probability and its applications in algorithms
Understanding and using asymptotic notations in design and analysis of algorithms

Transferable skills

Communication - Reading and writing mathematical proofs
Critical thinking - problem solving
Technical - Technological competence and staying current with knowledge

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

PX101 Quantum Phenomena

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/px101/)
uk.ac.warwick.sbr.content.ContentDeniedException: Access denied for the source page.

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

PX120 Electricity & Magnetism

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/px120/)
uk.ac.warwick.sbr.content.ContentDeniedException: Access denied for the source page.

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

PX121 Thermal Physics I

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/px121/)
uk.ac.warwick.sbr.content.LinkedContentNotFoundException: The source page does not contain HTML, or has been deleted.

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

PX144 Introduction to Astronomy

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/px144/)
uk.ac.warwick.sbr.content.ContentDeniedException: Access denied for the source page.

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

PX147 Introduction to Particle Physics

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/px147/)
uk.ac.warwick.sbr.content.ContentDeniedException: Access denied for the source page.

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages

PX148 Classical Mechanics & Relativity

(https://warwick.ac.uk/fac/sci/maths/currentstudents/ughandbook/year1/px148/)
uk.ac.warwick.sbr.content.ContentDeniedException: Access denied for the source page.

Year 1 regs and modules
G100 G103 GL11 G1NC

Year 2 regs and modules
G100 G103 GL11 G1NC

Year 3 regs and modules
G100 G103

Year 4 regs and modules
G103

Exam information
Core module averages