Mathematics MMath

COURSE DETAILS

- A level requirements: ABB
- UCAS code: G101
- Study mode: Full-time
- Length: 4 years

KEY DATES

- Apply by: 29 January 2025
- Starts: 22 September 2025

Course overview

This four-year programme is ideal for ambitious students who want to study mathematics in depth. Graduates gain a master's qualification, which provides a competitive edge in the employment market and opens the door to careers in research.

INTRODUCTION

Mathematics is a beautiful and diverse subject. It underpins a wide range of disciplines, from physical sciences to social science, from biology to business and finance. The further your study of mathematics progresses, the more fascinating it becomes.

The University of Liverpool has a large Mathematical Sciences department with highly qualified staff, a first class reputation in teaching and research, and a friendly, supportive environment. We use mixed approaches to teaching and assessment, taking the best from traditional lectures, tutorials and assignments, and modern methods such as interactive learning sessions, video content and online assessment. Our programmes are designed with the needs of employers in mind, to give you a solid foundation from which you may take your career in whatever direction you choose.

The first two years of the MMath programme are the same as the Mathematics BSc. You will have the opportunity to learn about a range of fundamental topics, building on the mathematics you already know and providing the background for the more advanced modules in years three and four. No assumptions are made about whether you have previously studied mechanics, statistics or computer programming. In years three and four, we offer a wide range of advanced modules in pure mathematics, applied mathematics and statistics, enabling you to specialise in the areas of mathematics that interest you most. In the final year, students on this programme complete a substantial project on a mathematical topic of their own choice, supervised by an expert in the relevant field.

Graduates completing the programme have experience of mathematics research and independent working skills that are highly valued by employers.

This programme also has a year abroad option, an incredible opportunity to spend an academic year at one of our partner universities. On the four-year integrated master's programme, you can go abroad either between years two and three (apply in year two), or between years three and four (apply in year three).

WHAT YOU'LL LEARN

- Fundamentals of pure and applied mathematics, probability and statistics
- Advanced material from the branches of mathematics that interest you most
- Teamwork
- Digital fluency
- Sophisticated problem solving skills
- How to communicate complex ideas

ACCREDITATION

Liverpool's MMath degree is accredited by the Institute of Mathematics and its Applications (IMA) and the Royal Statistical Society (RSS)

Course content

Discover what you'll learn, what you'll study, and how you'll be taught and assessed.

YEAR ONE

All students on the programme take the same modules in year one. These build on the mathematics you already know, and lay the foundations for the more advanced material introduced later.

In year one you will study a range of compulsory modules.

COMPULSORY MODULES

CALCULUS I (MATH101)

Credits: 15 / Semester: semester 1

At its heart, calculus is the study of limits. Many quantities can be expressed as the limiting value of a sequence of approximations, for example the slope of a tangent to a curve, the rate of change of a function, the area under a curve, and so on. Calculus provides us with tools for studying all of these, and more. Many of the ideas can be traced back to the ancient Greeks, but calculus as we now understand it was first developed in the 17th Century, independently by Newton and Leibniz. The modern form presented in this module was fully worked out in the late 19th Century. MATH101 lays the foundation for the use of calculus in more advanced modules on differential equations, differential geometry, theoretical physics, stochastic analysis, and many other topics. It begins from the very basics – the notions of real number, sequence, limit, real function, and continuity – and uses these to give a rigorous treatment of derivatives and integrals for real functions of one real variable.

CALCULUS II (MATH102)

Credits: 15 / Semester: semester 2

This module, the last one of the core modules in Year 1, is built upon the knowledge you gain from MATH101 (Calculus I) in the first semester. The syllabus is conceptually divided into three parts: Part I, relying on your knowledge of infinite series, presents a thorough study of power series (Taylor expansions, binomial theorem); part II begins with a discussion of functions of several variables and then establishes the idea of partial differentiation together with its various applications, including chain rule, total differential, directional derivative, tangent planes, extrema of functions and Taylor expansions; finally, part III is on double integrals and their applications, such as finding centres of mass of thin bodies. Undoubtedly, this module, together with the other two core modules from Semester 1 (MATH101 Calculus I and MATH103 Introduction to linear algebra), forms an integral part of your ability to better understand modules you will be taking in further years of your studies.

INTRODUCTION TO LINEAR ALGEBRA (MATH103)

Credits: 15 / Semester: semester 1

Linear algebra is the branch of mathematics concerning vector spaces and linear mappings between such spaces. It is the study of lines, planes, and subspaces and their intersections using algebra.

Linear algebra first emerged from the study of determinants, which were used to solve systems of linear equations. Determinants were used by Leibniz in 1693, and subsequently, Cramer's Rule for solving linear systems was devised in 1750. Later, Gauss further developed the theory of solving linear systems by using Gaussian elimination. All these classical themes, in their modern interpretation, are included in the module, which culminates in a detailed study of eigenproblems. A part of the module is devoted to complex numbers which are basically just planar vectors. Linear algebra is central to both pure and applied mathematics. This module is an essential pre-requisite for nearly all modules taught in the Department of Mathematical Sciences.

INTRODUCTION TO STATISTICS USING R (MATH163)

Credits: 15 / Semester: semester 2

Students will learn fundamental concepts from statistics and probability using the R programming language and will learn how to use R to some degree of proficiency in certain contexts. Students will become aware of possible career paths using statistics.

MATHEMATICAL IT SKILLS (MATH111)

Credits: 15 / Semester: semester 1

This module introduces students to powerful mathematical software packages such as Maple and Matlab which can be used to carry out numerical computations or to produce a more complicated sequence of computations using their programming features. We can also do symbolic or algebraic computations in Maple. These software packages have built-in functions for solving many kinds of equations, for working with matrices and vectors, for differentiation and integration. They also contain functions which allow us to create visual representations of curves and surfaces from their mathematical descriptions, to work interactively, generate graphics and create mathematical documents. This module will teach students many of the above-mentioned features of mathematical software packages. This knowledge will be helpful in Years 2, 3 and 4 when working on different projects, for example in the modules MATH266 and MATH371.

INTRODUCTION TO STUDY AND RESEARCH IN MATHEMATICS (MATH107)

Credits: 15 / Semester: semester 1

This module looks at what it means to be a mathematician as an undergraduate and beyond. The module covers the discussion of mathematics at university, research mathematics and careers for mathematicians as well as core elements of mathematical language and writing such as logic, proofs, numbers, sets and functions. The activities include sessions delivered by staff on their research areas, sessions by alumni and other mathematicians working outside academia on careers for mathematicians and sessions by careers services. The module also provides key tools needed for studying mathematics at university level. You will explore the core mathematical concepts in more detail in groups and individually and practice communicating mathematics in speech and writing.

NEWTONIAN MECHANICS (MATH122)

Credits: 15 / Semester: semester 2

This module is an introduction to classical (Newtonian) mechanics. It introduces the basic principles like conservation of momentum and energy, and leads to the quantitative description of motions of bodies under simple force systems. It includes angular momentum, rigid body dynamics and moments of inertia.

NUMBERS, GROUPS AND CODES (MATH142)

Credits: 15 / Semester: semester 2

A group is a formal mathematical structure that, on a conceptual level, encapsulates the symmetries present in many structures. Group homomorphisms allow us to recognise and manipulate complicated objects by identifying their core properties with a simpler object that is easier to work with. The abstract study of groups helps us to understand fundamental problems arising in many areas of mathematics. It is moreover an extremely elegant and interesting part of pure mathematics. Motivated by examples in number theory, combinatorics and geometry, as well as applications in data encryption and data retrieval, this module is an introduction to group theory. We also develop the idea of mathematical rigour, formulating our theorems and proofs precisely using formal logic.

Any optional modules listed above are illustrative only and may vary from year to year. Modules may be subject to minimum student numbers being achieved and staff availability. This means that the availability of specific optional modules cannot be guaranteed.

YEAR TWO

In year two, all students take five core modules that are important to all branches of mathematics. Our range of optional modules also allows you to begin to specialise in the areas that interest you most.

COMPULSORY MODULES

DIFFERENTIAL EQUATIONS (MATH221)

Credits: 15 / Semester: semester 2

Differential equations play a central role in mathematical sciences because they allow us to describe a wide variety of real-world systems and the mathematical techniques encountered in this module are useful to a number of later modules; this is why MATH201 is compulsory for a number of degree programmes. The module will aim to stress the importance of both theory and applications of ordinary differential equations (ODEs) and partial differential equations (PDEs), putting a strong emphasis on problem solving and examples. It has broadly 5 parts and each part contains two types of equations: those that can be solved by specific methods and others that cannot be solved but can only be studied to understand some properties of the underlying equations and their solutions. The main topics are first order ODEs, second order ODEs, systems of ODEs, first-order PDEs and some of the most well-known second-order PDEs, namely the wave, heat and Laplace equations.

VECTOR CALCULUS WITH APPLICATIONS IN FLUID MECHANICS (MATH225)

Credits: 15 / Semester: semester 1

This module provides an introduction to the subjects of fluid mechanics and electromagnetism, to the various vector integrals, the operators div, grad and curl and the relations between them and to the many applications of vector calculus to physical situations.

LINEAR ALGEBRA AND GEOMETRY (MATH244)

Credits: 15 / Semester: semester 1

Linear algebra provides a toolbox for analysing phenomena ubiquitous in many areas of mathematics: linear maps, or linearity in general. In all of these situations it is essential to first identify the kind of objects which are mapped or behave in a linear way. To cover the many different possibilities the concept of an abstract vector space is introduced. It generalizes the real vector spaces introduced in MATH103 (Introduction to Linear Algebra) and the calculational techniques developed there can still be used. Applications of ideas from Linear Algebra appear in Geometry, in Algebra, in solving Differential Equations, which in turn model many physical systems, in Physics, especially Quantum Mechanics, in Biology and in Statistics.

STATISTICS AND PROBABILITY I (MATH253)

Credits: 15 / Semester: semester 1

Analysis of data has become an essential part of current research in many fields including medicine, pharmacology, and biology. It is also an important part of many jobs in e.g. finance, consultancy and the public sector. This module provides an introduction to statistical methods with a strong emphasis on applying and interpreting standard statistical techniques. Since modern statistical analysis of real data sets is performed using computer power, a statistical software package is introduced and employed throughout.

COMPLEX FUNCTIONS (MATH243)

Credits: 15 / Semester: semester 1

This module introduces students to a surprising, very beautiful theory having intimate connections with other areas of mathematics and physical sciences, for instance ordinary and partial differential equations and potential theory.

OPTIONAL MODULES

CLASSICAL MECHANICS (MATH228)

Credits: 15 / Semester: semester 2

This module is concerned with the motion of physical bodies both in everyday situations and in the solar system. To describe motion, acceleration and forces you will need background knowledge of calculus, differentiation, integration and partial derivatives from MATH101 (Calculus I), MATH102 (Calculus II) and MATH103 (Introduction to Linear Algebra). Classical mechanics is important for learning about modern developments such as relativity (MATH326), quantum mechanics (MATH325) and chaos and dynamical systems (MATH322). This module will make you familiar with notions such as energy, force, momentum and angular momentum which lie at the foundations of applied mathematics problems.

METRIC SPACES AND CALCULUS (MATH242)

Credits: 15 / Semester: semester 2

This is a foundational module aimed at providing the students with the basic concepts and techniques of modern real Analysis. The guiding idea will be to start using the powerful tools of analysis, familiar to the students from the first year module MATH101 (Calculus I) in the context of the real numbers, to vectors (multivariable analysis) and to functions (functional analysis). The notions of convergence and continuity will be reinterpreted in the more general setting of metric spaces. This will provide the language to prove several fundamental results that are in the basic toolkit of a mathematician, like the Picard Theorem on the existence and uniqueness of solutions to first order differential equations with an initial datum, and the implicit function theorem. The module is central for a curriculum in pure and applied mathematics, as familiarity with these notions will help students who want to take several other subsequent modules as well as many projects. This module is also a useful preparation (although not a formal prerequisite) for MATH365 Measure theory and probability, a very useful module for a deep understanding of financial mathematics.

COMMUTATIVE ALGEBRA (MATH247)

Credits: 15 / Semester: semester 2

The module provides an introduction to the theory and methods of the modern commutative algebra (commutative groups, commutative rings, fields and modules) with some applications to number theory, algebraic geometry and linear algebra.

STATISTICS AND PROBABILITY II (MATH254)

Credits: 15 / Semester: semester 2

This module provides an introduction to probabilistic methods that are used not only in actuarial science, financial mathematics and statistics but also in all physical sciences. It focuses on discrete and continuous random variables with values in one and several dimensions, properties of the most useful distributions (e.g. geometric, exponential, and normal), their transformations, moment and probability generating functions and limit theorems. This module will help students doing MATH260 and MATH262 (Financial mathematics). This module complements MATH365 (Measure theory and probability) in the sense that MATH365 provides the contradiction-free measure theoretic foundation on which this module rests.

FINANCIAL MATHEMATICS (MATH260)

Credits: 15 / Semester: semester 2

Mathematical Finance uses mathematical methods to solve problems arising in finance. A common problem in Mathematical Finance is that of derivative pricing. In this module, after introducing the basic concepts in Financial Mathematics, we use some particular models for the dynamic of stock price to solve problems of pricing and hedging derivatives. This module is fundamental for students intending to work in financial institutions and/or doing an MSc in Financial Mathematics or related areas.

OPERATIONAL RESEARCH (MATH269)

Credits: 15 / Semester: semester 2

The term "Operational Research" came in the 20th century from military operations. It describes mathematical methods to achieve the goal (or to find the best possible decision) having limited resources. This branch of applied mathematics makes use of and has stimulated the development of optimisation methods, typically for problems with constraints. This module can be interesting for any student doing mathematics because it concentrates on real-life problems.

STEM EDUCATION AND COMMUNICATION (MATH291)

Credits: 15 / Semester: whole session

This module is designed to give students experience of communicating in a variety of media and in a variety of contexts. It will also introduce students to contemporary issues in education, and educational practice. This will be achieved by seminars, interactions with educational professionals, and the design and delivery of enrichment materials, utilising the existing and highly successful outreach activity within the school.

NUMERICAL METHODS FOR APPLIED MATHEMATICS (MATH226)

Credits: 15 / Semester: semester 2

Most problems in modern applied mathematics require the use of suitably designed numerical methods. Working exactly, we can often reduce a complicated problem to something more elementary, but this will often lead to integrals that cannot be evaluated using analytical methods or equations that are too complex to be solved by hand. Other problems involve the use of 'real world' data, which don't fit neatly into simple mathematical models. In both cases, we can make further progress using approximate methods. These usually require lengthy iterative processes that are tedious and error prone for humans (even with a calculator), but ideally suited to computers. The first few lectures of this module demonstrate how computer programs can be written to handle calculations of this type automatically. These ideas will be used throughout the module. We then investigate how errors propagate through numerical computations. The focus then shifts to numerical methods for finding roots, approximating integrals and interpolating data. In each case, we will examine the advantages and disadvantages of different approaches, in terms of accuracy and efficiency.

Any optional modules listed above are illustrative only and may vary from year to year. Modules may be subject to minimum student numbers being achieved and staff availability. This means that the availability of specific optional modules cannot be guaranteed.

YEAR THREE

Students in year three choose six modules with codes beginning MATH3. These honours level modules contain the most advanced material that is usually taught on the Mathematics BSc. Students also choose two modules with codes beginning MATH4. These are master's level modules, taught by experts in the relevant fields, with the most sophisticated content to be found anywhere on our mathematics degrees. There are no compulsory modules in year three, but the options available to individual students will vary depending on choices made in year two.

OPTIONAL MODULES

FURTHER METHODS OF APPLIED MATHEMATICS (MATH323)

Credits: 15 / Semester: semester 1

Ordinary and partial differential equations (ODEs and PDEs) are crucial to many areas of science, engineering and finance. This module addresses methods for, or related to, their solution. It starts with a section on inhomogeneous linear second-order ODEs which are often required for the solution of higher-level problems. We then generalize basic calculus by considering the optimization of functionals, e.g., integrals involving an unknown function and its derivatives, which leads to a wide variety of ODEs and PDEs. After those systems of two linear first-order PDEs and second-order PDES are classified and reduced to ODEs where possible. In certain cases, e.g., `elliptic' PDEs like the Laplace equation, such a reduction is impossible. The last third of the module is devoted to two approaches, conformal mappings and Fourier transforms, which can be used to obtain solutions of the Laplace equation and other irreducible PDEs.

CARTESIAN TENSORS AND MATHEMATICAL MODELS OF SOLIDS AND VISCOUS FLUIDS (MATH324)

Credits: 15 / Semester: semester 1

This module provides an introduction to basic concepts and principles of continuum mechanics. Cartesian tensors are introduced at the beginning of the module, bringing simplicity and versatility to the analysis. The module places emphasis on the importance of conservation laws in integral form, and on the fundamental role integral conservation laws play in the derivation of partial differential equations used to model different physical phenomena in problems of solid and fluid mechanics.

QUANTUM MECHANICS (MATH325)

Credits: 15 / Semester: semester 1

The development of Quantum Mechanics, requiring as it did revolutionary changes in our understanding of the nature of reality, was arguably the greatest conceptual achievement of all time. The aim of the module is to lead the student to an understanding of the way that relatively simple mathemactics (in modern terms) led Bohr, Einstein, Heisenberg and others to a radical change and improvement in our understanding of the microscopic world.

RELATIVITY (MATH326)

Credits: 15 / Semester: semester 1

Einstein's theories of special and general relativity have introduced a new concept of space and time, which underlies modern particle physics, astrophysics and cosmology. It makes use of, and has stimulated the development of modern differential geometry. This module develops the required mathematics (tensors, differential geometry) together with applications of the theory to particle physics, black holes and cosmology. It is an essential part of a programme in theoretical physics.

NUMBER THEORY (MATH342)

Credits: 15 / Semester: semester 1

Number theory begins with, and is mainly concerned with, the study of the integers. Because of the fundamental role which integers play in mathematics, many of the greatest mathematicians, from antiquity to the modern day, have made contributions to number theory. In this module you will study results due to Euclid, Euler, Gauss, Riemann, and other greats: you will also see many results from the last 10 or 20 years.Several of the topics you will study will be familiar from MATH142 (Numbers, groups, and codes). We will go into them in greater depth, and the module will be self-contained from the point of view of number theory. However, some background in group theory (no more than is in MATH142) will be assumed.

GROUP THEORY (MATH343)

Credits: 15 / Semester: semester 1

The module provides an introduction to the modern theory of finite non-commutative groups. Group Theory is one of the central areas of Pure Mathematics. Being part of Algebra, it has innumerable applications in Geometry, Number Theory, Combinatorics and Analysis, but also plays a very important role in Theoretical Physics, Mechanics and Chemistry. The module starts with basic definitions and some well-known examples (the symmetric group of permutations and the groups of congruence classes modulo an integer) and builds up to some very interesting and non-trivial constructions, such as the semi-direct product, which makes it possible to construct more complicated groups from simpler ones. In the final part of the course, the Sylow theory and its applications to the classification of groups are considered.

DIFFERENTIAL GEOMETRY (MATH349)

Credits: 15 / Semester: semester 1

Differential geometry studies distances and curvatures on manifolds through differentiation and integration. This module introduces the methods of differential geometry on the concrete examples of curves and surfaces in 3-dimensional Euclidean space. The module MATH248 (Geometry of curves) develops methods of differential geometry on examples of plane curves. This material will be discussed in the first weeks of the course, but previous familiarity with these methods is helpful. Students following a pathway in theoretical physics might find this module interesting as it discusses a different aspect of differential geometry, and might take it together with MATH326 (Relativity). MATH410 (Manifolds, homology and Morse theory) and MATH446 (Lie groups and Lie algebras).

APPLIED PROBABILITY (MATH362)

Credits: 15 / Semester: semester 1

This module studies discrete-time Markov chains, as well as introducing the most basic continuous-time processes. The basic theory for these stochastic processes is considered in detail. This includes the Chapman Kolmogorov equation, communication of states, periodicity, recurrence and transience properties, asymptotic behaviour, limiting and stationary distributions, and an introduction to Poisson processes. Applications in different areas, in particular in insurance, are considered.

LINEAR STATISTICAL MODELS (MATH363)

Credits: 15 / Semester: semester 1

This module extends earlier work on linear regression and analysis of variance, and then goes beyond these to generalised linear models. The module emphasises applications of statistical methods. Statistical software is used throughout as familiarity with its use is a valuable skill for those interested in a career in a statistical field.

GAME THEORY (MATH331)

Credits: 15 / Semester: semester 2

In this module you will explore, from a game-theoretic point of view, models which have been used to understand phenomena in which conflict and cooperation occur and see the relevance of the theory not only to parlour games but also to situations involving human relationships, economic bargaining (between trade union and employer, etc), threats, formation of coalitions, war, etc.

NUMERICAL METHODS FOR ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS (MATH336)

Credits: 15 / Semester: semester 2

Many real-world systems in mathematics, physics and engineering can be described by differential equations. In rare cases these can be solved exactly by purely analytical methods, but much more often we can only solve the equations numerically, by reducing the problem to an iterative scheme that requires hundreds of steps. We will learn efficient methods for solving ODEs and PDEs on a computer.

COMBINATORICS (MATH344)

Credits: 15 / Semester: semester 2

Combinatorics is a part of mathematics in which mathematicians deal with discrete and countable structures by means of various combinations, such as permutations, ordered and unordered selections, etc. The seemingly simple methods of combinatorics can raise highly non-trivial mathematical questions and lead to deep mathematical results, which are, in turn, closely related to some fundamental phenomena in number theory

THE MAGIC OF COMPLEX NUMBERS: COMPLEX DYNAMICS, CHAOS AND THE MANDELBROT SET (MATH345)

Credits: 15 / Semester: semester 2

A "dynamical system" is a system that changes over time according to a fixed rule. In complex dynamics, we consider the case where the state of the system is described by a single (complex) variable, and the rule of evolution is given by a holomorphic function. It turns out that this seemingly simple setting leads to very rich, subtle and intricate problems, some of which are still the subject of ongoing mathematical research, both at the University of Liverpool and internationally. This module will provide an introduction to this fascinating subject, and introduce students to some of these problems. In the course of this study, we will encounter many results about complex functions that may seem "magic" when compared with what might be expected from real analysis. A highlight of this kind is the theorem that every polynomial is "chaotic" on its Julia set. We will also see how this "magic" can help us understand phenomena that at first seem to have no connection with complex numbers at all.

TOPOLOGY (MATH346)

Credits: 15 / Semester: semester 2

Topology is the mathematical study of space. It is distinguished from geometry by the fact that there is no consideration of notions of distance, angle or other similar quantities. For this reason topology is sometimes popularly referred to as 'rubber sheet' geometry. It was introduced by Poincaré, under the name of analysis situs, in 1895 and became one of the most successful areas of 20th century mathematics. It continues to be an active research area to this day, and its insights and methods underlie many areas of modern mathematics. More recently, new applications of topological ideas outside mathematics have been developed, in particular to provide qualitative analysis of large data sets. This module introduces the basic notions of topological space and continuous map, illustrating them with many examples from different areas of mathematics. It also introduces homotopy theory, the study of paths in a space, which has become one of the most fundamental areas of modern mathematics.

THEORY OF STATISTICAL INFERENCE (MATH361)

Credits: 15 / Semester: semester 2

This module introduces fundamental topics in mathematical statistics, including the theory of point estimation and hypothesis testing. Several key concepts of statistics are discussed, such as sufficiency, completeness, etc., introduced from the 1920s by major contributors to modern statistics such as Fisher, Neyman, Lehmann and so on. This module is absolutely necessary preparation for postgraduate studies in statistics and closely related subjects.

MEDICAL STATISTICS (MATH364)

Credits: 15 / Semester: semester 2

In recent years a culture of evidence-based practice has become the norm in the medical profession. Central to this is the medical statistician, who is required to not only analyse data, but to design research studies and interpret the results. The aim of MATH364 is to provide the student with the knowledge to become part of a "team" to enhance and improve medical practice. This is done by demonstrating the design of studies, methods of analysis and interpretation of results through a number of real-world examples, covering epidemiology, survival analysis, clinical trials and meta-analysis.

MEASURE THEORY AND PROBABILITY (MATH365)

Credits: 15 / Semester: semester 2

This module is important for students who are interested in the abstract theory of integrating and in the deep theoretical background of the probability theory. It will be extremely useful for those who plan to do MSc and perhaps PhD in Probability, including financial applications. If you plan to take level 4 module(s) on Financial Mathematics next year, MATH365 can be very helpful.

MATHEMATICAL RISK THEORY (MATH366)

Credits: 15 / Semester: semester 2

To provide an understanding of the mathematical risk theory used in practise in non-life actuarial depts of insurance firms, to provide an introduction to mathematical methods for managing the risk in insurance and finance (calculation of risk measures/quantities), to develop skills of calculating the ruin probability and the total claim amount distribution in some non - life actuarial risk models with applications to insurance industry, to prepare the students adequately and to develop their skills in order to be exempted for the exams of CT6 subject of the Institute of Actuaries (MATH366 covers 50% of CT6 in much more depth).

NETWORKS IN THEORY AND PRACTICE (MATH367)

Credits: 15 / Semester: semester 2

MATH367 aims to develop an appreciation of optimisation methods for real-world problems using fundamental tools from network theory; to study a range of 'standard problems' and techniques for solving them. Thus, network flow, shortest path problem, transport problem, assignment problem, and routing problem are some of the problems that are considered in the syllabus. MATH367 is a decision making module, which fits well to those who are interested in receiving knowledge in graph theory, in operational research, in economics, in logistics and in finance.

STOCHASTIC THEORY AND METHODS IN DATA SCIENCE (MATH368)

Credits: 15 / Semester: semester 2

This module raises the awareness of students on how mathematical methods from stochastics can help to deal with problems arising in a variety of areas, ranging from quantifying uncertainty, to problems in physics, to optimisation and decision making, among others. The module summarises probability theory, explain the basics of simulation and sampling and then focuses on learning theory and methods. Specific topics and examples will be presented along with the theory and computer experiments.

MORE IS DIFFERENT: STATISTICAL MECHANICS, THERMODYNAMICS, AND ALL THAT (MATH327)

Credits: 15 / Semester: semester 2

Statistical Physics is a core subject in Physics and a cornerstone for modern technologies. To name just one example, quantum statistics is informing leading edge developments around ultra-cold gases and liquids giving rise to new materials. The module will introduce foundations of Statistical Physics and will develop an understanding of the stochastic roots of thermodynamics and the properties of matter. After successfully completing this module students will understand statistical ensembles and related concepts such as entropy and temperature, will understand the properties of classical and quantum gases, will be know the laws of thermodynamics and will be aware of advanced phenomena such as phase transition. The module will also develop numerical computer programming skills for the description of macroscopic effects such as diffusion by an underlying stochastic process.

PROFESSIONAL PROJECTS AND EMPLOYABILITY IN MATHEMATICS (MATH390)

Credits: 15 / Semester: semester 1

This module gives the opportunity to further develop skills of mathematical problem solving and the application of mathematical results to real-world scenarios through group activities. The module aims to develop skills that are needed when undertaking employment or research, such as working in-depth on a problem over an extended period, writing reports, communicating mathematical results to different audiences and working in collaboration with others. This module will provide employability skills experiences and develop students' ability to articulate their skills, which will be useful to draw on when applying for jobs.

MATHS SUMMER INDUSTRIAL RESEARCH PROJECT (MATH391)

Credits: 15 / Semester: semester 1,summer

The research internship module is designed to give students the experience of working in a research environment or setting that is quite different from any project work that they undertake in the Department of Mathematics. It should provide an insight into how students may apply skills and experiences later in their career; whether working abroad, in industry or in a scientific setting.

APPLIED STOCHASTIC MODELS (MATH360)

Credits: 15 / Semester: semester 1

Stochastic processes are ways of quantifying the dynamic relationships of sequences of random events. Stochastic models play an important role in elucidating many areas of the natural and engineering sciences. They can be used to analyse the variability inherent in biological and medical processes, to deal with uncertainties affecting managerial decisions and with the complexities of psychological and social interactions, and to provide new perspectives, methodology, models and intuition to aid in other mathematical and statistical studies. This module is intended as a beginning course in introducing continuous-time stochastic processes for students familiar with elementary probability. The objectives are: (1) to introduce students to the standard concepts and methods of stochastic modelling; (2) to illustrate the rich diversity of applications of stochastic processes in the science; and (3) to provide exercises in the applications of simple stochastic analysis to appropriate problems.

LINEAR DIFFERENTIAL OPERATORS IN MATHEMATICAL PHYSICS (MATH421)

Credits: 15 / Semester: semester 1

This module is concerned with linear partial differential equations (PDEs) that arise in mathematical physics, and advanced methods for solving them. There is a particular focus on methods that use singular solutions, which satisfy the PDE at all but a finite number of points. We will study three canonical PDEs: Laplace's equation, the heat equation and the wave equation. In each case we will see how the solution to complicated problems can be built up from solutions to simpler problems, typically in the form of an infinite series or an integral.

QUANTUM FIELD THEORY (MATH425)

Credits: 15 / Semester: semester 1

Quantum Field Theory provides the mathematical language of modern theoretical particle and condensed matter physics. Historically Quantum Field Theory was developed to be the consistent theory of quantum mechanics and special relativity. The mathematical techniques developed in this course form the theoretical basis for varied fields such as high energy particle physics or superconductivity.

STOCHASTIC ANALYSIS AND ITS APPLICATIONS (MATH483)

Credits: 15 / Semester: semester 2

This module provides the foundations of stochastic analysis. Many of the basic results are considered in detail, in particular the ones that play a crucial role in applications such as mathematical finance. Students taking this module will study conditional expectations, martingales, Brownian motion, Brownian bridge, the reflection principle and scaling, stopping times, Ito's integral and stochastic calculus, stochastic differential equations (linear and nonlinear), martingale representation, Girsanov theorem, and Feynman-Kac formula. Applications include stochastic control, optimal investment, and mathematical finance. All the theoretical results are illustrated with numerical examples from various fields of applications.

MATH499 - PROJECT FOR M.MATH. (MATH499)

Credits: 15 / Semester: whole session

This is a one-semester module for Year 4 G101 Mathematics MMath students. Research is performed in an advanced topic in a particular area of Mathematics under the supervision of a member of staff, which is followed by preparation of a report and an oral presentation. It is hoped that this will provide further insights into advanced subjects and additional experience in handling specialist literature.

ADVANCED TOPICS IN MATHEMATICAL BIOLOGY (MATH426)

Credits: 15 / Semester: semester 1

Mathematics can be applied to a wide range of biological problems, many of which involve studying how systems change in space and time. In this module, an example selection of mathematical applications will be presented chosen from staff research interests involving developmental biology, epidemic dynamics & biological fluid dynamics.

WAVES, MATHEMATICAL MODELLING (MATH427)

Credits: 15 / Semester: semester 2

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Credits: 15 / Semester: semester 2

Networks are familiar to us from many real-world systems such as the internet, power grids, transportation and biological networks. The underpinning mathematical concept is called a graph an it is no surprise that the same issues arise in each area, whether this is to identify the most important or influential individuals in the network, or to prevent dynamics on the network (e.g. epidemics) or to make the network robust to the dynamics it supports (e.g. power grids and transportation). In this module, we learn about different classes of networks and how to quantify and describe them including their structures and their nodes. Much of our detailed understanding of networks and their features will come from analysis of idealised random networks which nevertheless are often good representations of those seen in the real world. We will consider real-world biological applications of network theory, in particular focusing on epidemics.

MANIFOLDS, HOMOLOGY AND MORSE THEORY (MATH410)

Credits: 15 / Semester: semester 1

An introduction to the topology of manifolds, emphasising the role of homology as an invariant and the role of Morse theory as a visualising and calculational tool.

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Credits: 15 / Semester: semester 1

Groups appear everywhere in mathematics where symmetry is involved. Representation Theory analyses groups by using tools from linear algebra. This course studies the representation theory of finite groups, a beautiful theory that starting with a few basic facts from group theory and linear algebra quickly leads to beautiful and powerful theorems unlocking major insight into the structure of finite groups and their representations. Representation theory also has spectacular applications to Chemistry, making it possible to calculate the colours of the world!

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HIGHER ARITHMETIC (MATH441)

Credits: 15 / Semester: semester 1

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GALOIS THEORY (MATH449)

Credits: 15 / Semester: semester 2

This module introduces the theory of polynomial equations of one variable: Galois Theory. This theory provides criteria when a polynomial equation can be solved in radicals, when a geometric construction can be performed by a ruler and a compass.

Any optional modules listed above are illustrative only and may vary from year to year. Modules may be subject to minimum student numbers being achieved and staff availability. This means that the availability of specific optional modules cannot be guaranteed.

YEAR FOUR

Students in year four complete a project in an area of mathematics of their choice, supervised by one of our expert staff. This gives you the opportunity to experience research in mathematics, and to develop your skills in independent working, technical writing, communicating complex ideas and presenting your work. Additional credits are earned through choosing optional modules not taken in year three. There are no compulsory modules in year four, but the options available to individual students will vary depending on choices made in years two and three.

OPTIONAL MODULES

LINEAR DIFFERENTIAL OPERATORS IN MATHEMATICAL PHYSICS (MATH421)

Credits: 15 / Semester: semester 1

This module is concerned with linear partial differential equations (PDEs) that arise in mathematical physics, and advanced methods for solving them. There is a particular focus on methods that use singular solutions, which satisfy the PDE at all but a finite number of points. We will study three canonical PDEs: Laplace's equation, the heat equation and the wave equation. In each case we will see how the solution to complicated problems can be built up from solutions to simpler problems, typically in the form of an infinite series or an integral.

QUANTUM FIELD THEORY (MATH425)

Credits: 15 / Semester: semester 1

Quantum Field Theory provides the mathematical language of modern theoretical particle and condensed matter physics. Historically Quantum Field Theory was developed to be the consistent theory of quantum mechanics and special relativity. The mathematical techniques developed in this course form the theoretical basis for varied fields such as high energy particle physics or superconductivity.

STOCHASTIC ANALYSIS AND ITS APPLICATIONS (MATH483)

Credits: 15 / Semester: semester 2

This module provides the foundations of stochastic analysis. Many of the basic results are considered in detail, in particular the ones that play a crucial role in applications such as mathematical finance. Students taking this module will study conditional expectations, martingales, Brownian motion, Brownian bridge, the reflection principle and scaling, stopping times, Ito's integral and stochastic calculus, stochastic differential equations (linear and nonlinear), martingale representation, Girsanov theorem, and Feynman-Kac formula. Applications include stochastic control, optimal investment, and mathematical finance. All the theoretical results are illustrated with numerical examples from various fields of applications.

MATH499 - PROJECT FOR M.MATH. (MATH499)

Credits: 15 / Semester: whole session

This is a one-semester module for Year 4 G101 Mathematics MMath students. Research is performed in an advanced topic in a particular area of Mathematics under the supervision of a member of staff, which is followed by preparation of a report and an oral presentation. It is hoped that this will provide further insights into advanced subjects and additional experience in handling specialist literature.

MATH490 - PROJECT FOR M.MATH. (MATH490)

Credits: 30 / Semester: whole session

This is a two-semester module for Year 4 G101 Mathematics MMath students. Research is performed in an advanced interesting topic which should lead to acquiring knowledge useful for potential continuation of mathematical studies through a PhD. Students who took a Year 3 project module have the opportunity to continue research in the same topic.

ADVANCED TOPICS IN MATHEMATICAL BIOLOGY (MATH426)

Credits: 15 / Semester: semester 1

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FURTHER METHODS OF APPLIED MATHEMATICS (MATH323)

Credits: 15 / Semester: semester 1

Ordinary and partial differential equations (ODEs and PDEs) are crucial to many areas of science, engineering and finance. This module addresses methods for, or related to, their solution. It starts with a section on inhomogeneous linear second-order ODEs which are often required for the solution of higher-level problems. We then generalize basic calculus by considering the optimization of functionals, e.g., integrals involving an unknown function and its derivatives, which leads to a wide variety of ODEs and PDEs. After those systems of two linear first-order PDEs and second-order PDES are classified and reduced to ODEs where possible. In certain cases, e.g., `elliptic' PDEs like the Laplace equation, such a reduction is impossible. The last third of the module is devoted to two approaches, conformal mappings and Fourier transforms, which can be used to obtain solutions of the Laplace equation and other irreducible PDEs.

CARTESIAN TENSORS AND MATHEMATICAL MODELS OF SOLIDS AND VISCOUS FLUIDS (MATH324)

Credits: 15 / Semester: semester 1

This module provides an introduction to basic concepts and principles of continuum mechanics. Cartesian tensors are introduced at the beginning of the module, bringing simplicity and versatility to the analysis. The module places emphasis on the importance of conservation laws in integral form, and on the fundamental role integral conservation laws play in the derivation of partial differential equations used to model different physical phenomena in problems of solid and fluid mechanics.

QUANTUM MECHANICS (MATH325)

Credits: 15 / Semester: semester 1

The development of Quantum Mechanics, requiring as it did revolutionary changes in our understanding of the nature of reality, was arguably the greatest conceptual achievement of all time. The aim of the module is to lead the student to an understanding of the way that relatively simple mathemactics (in modern terms) led Bohr, Einstein, Heisenberg and others to a radical change and improvement in our understanding of the microscopic world.

RELATIVITY (MATH326)

Credits: 15 / Semester: semester 1

Einstein's theories of special and general relativity have introduced a new concept of space and time, which underlies modern particle physics, astrophysics and cosmology. It makes use of, and has stimulated the development of modern differential geometry. This module develops the required mathematics (tensors, differential geometry) together with applications of the theory to particle physics, black holes and cosmology. It is an essential part of a programme in theoretical physics.

NUMBER THEORY (MATH342)

Credits: 15 / Semester: semester 1

Number theory begins with, and is mainly concerned with, the study of the integers. Because of the fundamental role which integers play in mathematics, many of the greatest mathematicians, from antiquity to the modern day, have made contributions to number theory. In this module you will study results due to Euclid, Euler, Gauss, Riemann, and other greats: you will also see many results from the last 10 or 20 years.Several of the topics you will study will be familiar from MATH142 (Numbers, groups, and codes). We will go into them in greater depth, and the module will be self-contained from the point of view of number theory. However, some background in group theory (no more than is in MATH142) will be assumed.

GROUP THEORY (MATH343)

Credits: 15 / Semester: semester 1

The module provides an introduction to the modern theory of finite non-commutative groups. Group Theory is one of the central areas of Pure Mathematics. Being part of Algebra, it has innumerable applications in Geometry, Number Theory, Combinatorics and Analysis, but also plays a very important role in Theoretical Physics, Mechanics and Chemistry. The module starts with basic definitions and some well-known examples (the symmetric group of permutations and the groups of congruence classes modulo an integer) and builds up to some very interesting and non-trivial constructions, such as the semi-direct product, which makes it possible to construct more complicated groups from simpler ones. In the final part of the course, the Sylow theory and its applications to the classification of groups are considered.

DIFFERENTIAL GEOMETRY (MATH349)

Credits: 15 / Semester: semester 1

Differential geometry studies distances and curvatures on manifolds through differentiation and integration. This module introduces the methods of differential geometry on the concrete examples of curves and surfaces in 3-dimensional Euclidean space. The module MATH248 (Geometry of curves) develops methods of differential geometry on examples of plane curves. This material will be discussed in the first weeks of the course, but previous familiarity with these methods is helpful. Students following a pathway in theoretical physics might find this module interesting as it discusses a different aspect of differential geometry, and might take it together with MATH326 (Relativity). MATH410 (Manifolds, homology and Morse theory) and MATH446 (Lie groups and Lie algebras).

APPLIED STOCHASTIC MODELS (MATH360)

Credits: 15 / Semester: semester 1

Stochastic processes are ways of quantifying the dynamic relationships of sequences of random events. Stochastic models play an important role in elucidating many areas of the natural and engineering sciences. They can be used to analyse the variability inherent in biological and medical processes, to deal with uncertainties affecting managerial decisions and with the complexities of psychological and social interactions, and to provide new perspectives, methodology, models and intuition to aid in other mathematical and statistical studies. This module is intended as a beginning course in introducing continuous-time stochastic processes for students familiar with elementary probability. The objectives are: (1) to introduce students to the standard concepts and methods of stochastic modelling; (2) to illustrate the rich diversity of applications of stochastic processes in the science; and (3) to provide exercises in the applications of simple stochastic analysis to appropriate problems.

APPLIED PROBABILITY (MATH362)

Credits: 15 / Semester: semester 1

This module studies discrete-time Markov chains, as well as introducing the most basic continuous-time processes. The basic theory for these stochastic processes is considered in detail. This includes the Chapman Kolmogorov equation, communication of states, periodicity, recurrence and transience properties, asymptotic behaviour, limiting and stationary distributions, and an introduction to Poisson processes. Applications in different areas, in particular in insurance, are considered.

LINEAR STATISTICAL MODELS (MATH363)

Credits: 15 / Semester: semester 1

This module extends earlier work on linear regression and analysis of variance, and then goes beyond these to generalised linear models. The module emphasises applications of statistical methods. Statistical software is used throughout as familiarity with its use is a valuable skill for those interested in a career in a statistical field.

GAME THEORY (MATH331)

Credits: 15 / Semester: semester 2

In this module you will explore, from a game-theoretic point of view, models which have been used to understand phenomena in which conflict and cooperation occur and see the relevance of the theory not only to parlour games but also to situations involving human relationships, economic bargaining (between trade union and employer, etc), threats, formation of coalitions, war, etc.

NUMERICAL METHODS FOR ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS (MATH336)

Credits: 15 / Semester: semester 2

Many real-world systems in mathematics, physics and engineering can be described by differential equations. In rare cases these can be solved exactly by purely analytical methods, but much more often we can only solve the equations numerically, by reducing the problem to an iterative scheme that requires hundreds of steps. We will learn efficient methods for solving ODEs and PDEs on a computer.

COMBINATORICS (MATH344)

Credits: 15 / Semester: semester 2

Combinatorics is a part of mathematics in which mathematicians deal with discrete and countable structures by means of various combinations, such as permutations, ordered and unordered selections, etc. The seemingly simple methods of combinatorics can raise highly non-trivial mathematical questions and lead to deep mathematical results, which are, in turn, closely related to some fundamental phenomena in number theory

THE MAGIC OF COMPLEX NUMBERS: COMPLEX DYNAMICS, CHAOS AND THE MANDELBROT SET (MATH345)

Credits: 15 / Semester: semester 2

A "dynamical system" is a system that changes over time according to a fixed rule. In complex dynamics, we consider the case where the state of the system is described by a single (complex) variable, and the rule of evolution is given by a holomorphic function. It turns out that this seemingly simple setting leads to very rich, subtle and intricate problems, some of which are still the subject of ongoing mathematical research, both at the University of Liverpool and internationally. This module will provide an introduction to this fascinating subject, and introduce students to some of these problems. In the course of this study, we will encounter many results about complex functions that may seem "magic" when compared with what might be expected from real analysis. A highlight of this kind is the theorem that every polynomial is "chaotic" on its Julia set. We will also see how this "magic" can help us understand phenomena that at first seem to have no connection with complex numbers at all.

TOPOLOGY (MATH346)

Credits: 15 / Semester: semester 2

Topology is the mathematical study of space. It is distinguished from geometry by the fact that there is no consideration of notions of distance, angle or other similar quantities. For this reason topology is sometimes popularly referred to as 'rubber sheet' geometry. It was introduced by Poincaré, under the name of analysis situs, in 1895 and became one of the most successful areas of 20th century mathematics. It continues to be an active research area to this day, and its insights and methods underlie many areas of modern mathematics. More recently, new applications of topological ideas outside mathematics have been developed, in particular to provide qualitative analysis of large data sets. This module introduces the basic notions of topological space and continuous map, illustrating them with many examples from different areas of mathematics. It also introduces homotopy theory, the study of paths in a space, which has become one of the most fundamental areas of modern mathematics.

THEORY OF STATISTICAL INFERENCE (MATH361)

Credits: 15 / Semester: semester 2

This module introduces fundamental topics in mathematical statistics, including the theory of point estimation and hypothesis testing. Several key concepts of statistics are discussed, such as sufficiency, completeness, etc., introduced from the 1920s by major contributors to modern statistics such as Fisher, Neyman, Lehmann and so on. This module is absolutely necessary preparation for postgraduate studies in statistics and closely related subjects.

MEDICAL STATISTICS (MATH364)

Credits: 15 / Semester: semester 2

In recent years a culture of evidence-based practice has become the norm in the medical profession. Central to this is the medical statistician, who is required to not only analyse data, but to design research studies and interpret the results. The aim of MATH364 is to provide the student with the knowledge to become part of a "team" to enhance and improve medical practice. This is done by demonstrating the design of studies, methods of analysis and interpretation of results through a number of real-world examples, covering epidemiology, survival analysis, clinical trials and meta-analysis.

MEASURE THEORY AND PROBABILITY (MATH365)

Credits: 15 / Semester: semester 2

This module is important for students who are interested in the abstract theory of integrating and in the deep theoretical background of the probability theory. It will be extremely useful for those who plan to do MSc and perhaps PhD in Probability, including financial applications. If you plan to take level 4 module(s) on Financial Mathematics next year, MATH365 can be very helpful.

MATHEMATICAL RISK THEORY (MATH366)

Credits: 15 / Semester: semester 2

To provide an understanding of the mathematical risk theory used in practise in non-life actuarial depts of insurance firms, to provide an introduction to mathematical methods for managing the risk in insurance and finance (calculation of risk measures/quantities), to develop skills of calculating the ruin probability and the total claim amount distribution in some non - life actuarial risk models with applications to insurance industry, to prepare the students adequately and to develop their skills in order to be exempted for the exams of CT6 subject of the Institute of Actuaries (MATH366 covers 50% of CT6 in much more depth).

NETWORKS IN THEORY AND PRACTICE (MATH367)

Credits: 15 / Semester: semester 2

MATH367 aims to develop an appreciation of optimisation methods for real-world problems using fundamental tools from network theory; to study a range of 'standard problems' and techniques for solving them. Thus, network flow, shortest path problem, transport problem, assignment problem, and routing problem are some of the problems that are considered in the syllabus. MATH367 is a decision making module, which fits well to those who are interested in receiving knowledge in graph theory, in operational research, in economics, in logistics and in finance.

STOCHASTIC THEORY AND METHODS IN DATA SCIENCE (MATH368)

Credits: 15 / Semester: semester 2

This module raises the awareness of students on how mathematical methods from stochastics can help to deal with problems arising in a variety of areas, ranging from quantifying uncertainty, to problems in physics, to optimisation and decision making, among others. The module summarises probability theory, explain the basics of simulation and sampling and then focuses on learning theory and methods. Specific topics and examples will be presented along with the theory and computer experiments.

MORE IS DIFFERENT: STATISTICAL MECHANICS, THERMODYNAMICS, AND ALL THAT (MATH327)

Credits: 15 / Semester: semester 2

Statistical Physics is a core subject in Physics and a cornerstone for modern technologies. To name just one example, quantum statistics is informing leading edge developments around ultra-cold gases and liquids giving rise to new materials. The module will introduce foundations of Statistical Physics and will develop an understanding of the stochastic roots of thermodynamics and the properties of matter. After successfully completing this module students will understand statistical ensembles and related concepts such as entropy and temperature, will understand the properties of classical and quantum gases, will be know the laws of thermodynamics and will be aware of advanced phenomena such as phase transition. The module will also develop numerical computer programming skills for the description of macroscopic effects such as diffusion by an underlying stochastic process.

PROFESSIONAL PROJECTS AND EMPLOYABILITY IN MATHEMATICS (MATH390)

Credits: 15 / Semester: semester 1

This module gives the opportunity to further develop skills of mathematical problem solving and the application of mathematical results to real-world scenarios through group activities. The module aims to develop skills that are needed when undertaking employment or research, such as working in-depth on a problem over an extended period, writing reports, communicating mathematical results to different audiences and working in collaboration with others. This module will provide employability skills experiences and develop students' ability to articulate their skills, which will be useful to draw on when applying for jobs.

MATHS SUMMER INDUSTRIAL RESEARCH PROJECT (MATH391)

Credits: 15 / Semester: semester 1,summer

The research internship module is designed to give students the experience of working in a research environment or setting that is quite different from any project work that they undertake in the Department of Mathematics. It should provide an insight into how students may apply skills and experiences later in their career; whether working abroad, in industry or in a scientific setting.

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GALOIS THEORY (MATH449)

Credits: 15 / Semester: semester 2

This module introduces the theory of polynomial equations of one variable: Galois Theory. This theory provides criteria when a polynomial equation can be solved in radicals, when a geometric construction can be performed by a ruler and a compass.

Any optional modules listed above are illustrative only and may vary from year to year. Modules may be subject to minimum student numbers being achieved and staff availability. This means that the availability of specific optional modules cannot be guaranteed.

HOW YOU'LL LEARN

We use a range of teaching methods, including traditional lectures and tutorials, video content, interactive learning sessions and one-to-one project supervision. Opportunities for individual discussions are provided for every taught module, for example via online forums or staff office hours.

HOW YOU'RE ASSESSED

Each module has an assessment scheme tailored to fit its syllabus. This might include a traditional written exam, class test, assignments, projects, group work, or online exercises

with automatic marking and immediate feedback.

LIVERPOOL HALLMARKS

We have a distinctive approach to education, the Liverpool Curriculum Framework, which focuses on research-connected teaching, active learning, and authentic assessment to ensure our students graduate as digitally fluent and confident global citizens.

Careers and employability

A mathematically-based degree opens up a wide range of career opportunities, including some of the most lucrative professions as employers value mathematicians' high level of numeracy and problem solving skills.

Typical types of work our graduates have gone onto include:

- actuarial trainee analyst in the audit practice
- graduate management trainee risk analyst
- trainee chartered accountant on a graduate business programme.

Recent employers of our graduates include:

- Aston University
- Deloitte
- EuroMoney Training
- Norwich Union
- Venture Marketing Group
- Wolsley Group.

87.5% OF MATHEMATICAL SCIENCES GRADUATES GO ON TO WORK OR FURTHER STUDY WITHIN 15 MONTHS OF GRADUATION.

Discover Uni, 2018-19.

Fees and funding

Your tuition fees, funding your studies, and other costs to consider.

TUITION FEES

UK fees (applies to Channel Islands, Isle of Man and Republic of Ireland)	
Full-time place, per year	£9,535
Year abroad fee	£1,385

International fees	
Full-time place, per year	£26,600
Year abroad fee	£13,300

The UK full-time tuition fee, international course fee and fee for the year abroad for international students shown are correct for 2025/26 entry. We are currently awaiting confirmation of whether the year abroad fee for UK students will change, so the fee shown is for 2024/25. Please note that the year abroad fee also applies to the year in China.

Tuition fees cover the cost of your teaching and assessment, operating facilities such as libraries, IT equipment, and access to academic and personal support. Learn more about fees and funding.

ADDITIONAL COSTS

Your tuition fee covers almost everything but you may have additional study costs to consider, such as books.

Find out more about the additional study costs that may apply to this course.

SCHOLARSHIPS AND BURSARIES

We offer a range of scholarships and bursaries that could help pay your tuition and living expenses.

We've set the country or region your qualifications are from as United Kingdom. [Change it here](#)

- ## UNDERGRADUATE GLOBAL ADVANCEMENT SCHOLARSHIP

  - [International students](#)
  [If you're a high-achieving international student starting an undergraduate degree with us from September 2024, you could be eligible to receive a fee discount of up to £5,000. You'll need to achieve grades equivalent to AAA in A levels. Most of our undergraduate degrees are eligible, with the exception of clinical programmes in Medicine and Dental Surgery.](#)

- ## THE LIVERPOOL BURSARY

  - [Home students](#)
  [If you're a UK student joining an undergraduate degree and have a household income below £35,000, you could be eligible for a Liverpool Bursary worth up to £2,000 for each year of undergraduate study.](#)

- ## ASYLUM SEEKERS SCHOLARSHIP

  - [Home students](#)
  [Apply for an Asylum Seekers Scholarship and you could have your tuition fees paid in full and receive help with study costs. You'll need to have applied for asylum in the UK, or be the dependant of an asylum seeker, and be joining an eligible undergraduate degree.](#)

- ## CARE LEAVERS' OPPORTUNITY BURSARY

  - [Home students](#)
  [If you've spent 13 or more weeks in Local Authority care since age 14, you could be eligible for a bursary of £3,000 per year of study. You'll need to be a UK student joining an eligible undergraduate degree and be aged 28 or above on 1 September in the year you start.](#)

- ## COWRIE FOUNDATION SCHOLARSHIP

  - [Home students](#)
  [Are you a UK student with a Black African or Caribbean heritage and a household income of £25,000 or less? You could be eligible to apply for a Cowrie Foundation Scholarship worth up to £8,000 for each year of undergraduate study.](#)

- ## ESTRANGED STUDENTS BURSARY

  - [Home students](#)
  [If you're a UK student identified as estranged by Student Finance England (or the equivalent UK funding body), you could be eligible for a bursary of £1,000 for each year of undergraduate study.](#)

- ## GENESYS LIFE SCIENCES SCHOLARSHIP

  - Home students

  Joining a School of Biosciences degree and have a household income of less than £25,000? If you're a UK student, you could apply to receive £4,500 per year for three years of your undergraduate course.

- ## GRADUATE ASSOCIATION HONG KONG & TUNG UNDERGRADUATE SCHOLARSHIPS

  - International students
  - Hong Kong

  If you're an undergraduate student from Hong Kong who can demonstrate academic excellence, you may be eligible to apply for a scholarship worth £10,000 in partnership with the Tung Foundation.

- ## KAPLAN DIGITAL PATHWAYS EXCELLENCE SCHOLARSHIP

  - International students

  Completed a Kaplan Digital Pathways Foundation Certificate? We're offering a £5,000 fee discount off the first year of undergraduate study for a maximum of two high achieving students joining one of our non-clinical degrees from an online Kaplan Foundation Certificate.

- ## NOLAN SCHOLARSHIPS

  - Home students

  Do you live in the Liverpool City Region with a household income of £25,000 or less? Did neither of your parents attend University? You could be eligible to apply for a Nolan Scholarship worth £5,000 per year for three years of undergraduate study.

- ## RIGBY ENTERPRISE AWARD

  - Home students

  Are you a UK student with a household income of £25,000 or less? If you've participated in an eligible outreach programme, you could be eligible to apply for a Rigby Enterprise Award worth £5,000 per year for three years of your undergraduate degree.

- ## ROLABOTIC SCHOLARSHIP

  - Home students

  Are you a UK student with a household income of £25,000 or less? Did neither of your parents attend University? You could be eligible to apply for a ROLABOTIC Scholarship worth £4,500 for each year of your undergraduate degree.

- ## SPORT LIVERPOOL PERFORMANCE PROGRAMME

  - Home and international students

  Apply to receive tailored training support to enhance your sporting performance. Our athlete support package includes a range of benefits, from bespoke strength and conditioning training to physiotherapy sessions and one-to-one nutritional advice.

- ## TECHNETIX BROADHURST ENGINEERING SCHOLARSHIP

  - Home students

  Joining a degree in the School of Electrical Engineering, Electronics and Computer Science? If you're a UK student with household income below £25,000, you could be eligible to apply for £5,000 a year for three years of study. Two awards will be available per academic year.

- ## UNIVERSITY OF LIVERPOOL INTERNATIONAL COLLEGE EXCELLENCE SCHOLARSHIP

  - International students

  Completed a Foundation Certificate at University of Liverpool International College (UoLIC)? We're offering a £5,000 fee discount off the first year of undergraduate study to some of the highest achieving students joining one of our non-clinical degrees from UoLIC.

- ## UNIVERSITY OF LIVERPOOL INTERNATIONAL COLLEGE FIRST CLASS SCHOLARSHIP

  - International students

  We're offering a £1,000 fee discount for years 2 and 3 of undergraduate study to eligible students progressing from University of Liverpool International College. You'll need to be studying a non-clinical subject and get an average of 70% or above in year 1 of your degree.

- ## UNIVERSITY OF LIVERPOOL INTERNATIONAL COLLEGE IMPACT PROGRESSION SCHOLARSHIPS

  - International students

  If you're a University of Liverpool International College student awarded a Kaplan Impact Scholarship, we'll also consider you for an Impact Progression Scholarship. If selected, you'll receive a £3,000 fee discount off the first year of your undergraduate degree.

- ## YOUNG ADULT CARER'S (YAC) BURSARY

  - Home students

  If you're a young adult and a registered carer in the UK, you might be eligible for a £1,000 bursary for each year of study. You'll need to be aged 18-25 on 1 September in the year you start your undergraduate degree.

Entry requirements

The qualifications and exam results you'll need to apply for this course.

Your qualification	Requirements [About our typical entry requirements](#)
A levels	ABB including Mathematics A level grade A. Applicants with the Extended Project Qualification (EPQ) are eligible for a reduction in grade requirements. For this course, the offer is **ABC** with **A** in the EPQ. You may automatically qualify for reduced entry requirements through our [contextual offers scheme](#).
GCSE	4/C in English and 4/C in Mathematics
Subject requirements	Applicants must have studied Mathematics at Level 3 within 2 years of the start date of their course. For applicants from England: For science A levels that include the separately graded practical endorsement, a "Pass" is required.
BTEC Level 3 National Extended Diploma	D*DD in relevant diploma, when combined with A Level Mathematics grade A.
International Baccalaureate	33 including 6 in Higher Mathematics.
Irish Leaving Certificate	H1, H2, H2, H2, H3, H3 including Mathematics at H1.
Scottish Higher/Advanced Higher	Advanced Highers accepted at grades ABB including grade A in Mathematics.

Your qualification	Requirements [About our typical entry requirements](#)
Welsh Baccalaureate Advanced	Acceptable at grade B or above alongside AB at A level including grade A in Mathematics.
Access	Access - 45 Level 3 credits in graded units in a relevant Diploma, including 39 at Distinction and a further 6 with at least Merit. 15 Distinctions are required in Mathematics.
International qualifications	Many countries have a different education system to that of the UK, meaning your qualifications may not meet our entry requirements. Completing your Foundation Certificate, such as that offered by the [University of Liverpool International College](#), means you're guaranteed a place on your chosen course.

ALTERNATIVE ENTRY REQUIREMENTS

- If your qualification isn't listed here, or you're taking a combination of qualifications, [contact us](#) for advice
- Aged 20+ and without formal qualifications? The one-year [Go Higher](#) diploma qualifies you to apply for University of Liverpool arts, humanities and social sciences programmes
- [Applications from mature students](#) are welcome.

THE ORIGINAL
REDBRICK