COURSES IN MATHEMATICS AT MANCHESTER UNIVERSITY
Information about undergraduate lecture courses
for applicants for admission in 1989

Introduction
"Mathematics at Manchester: a guide for prospective undergraduates" contains general information about the Mathematics Department and the undergraduate degree courses on offer. This document contains more detailed information about the individual lecture courses. The detailed course descriptions vary from one year to the next; those given here are for 1988-1989.

Manchester University has four B.Sc. degree courses which involve Mathematics:
* Honours Mathematics (UCCA Code G100),
* Honours Computer Science and Mathematics (GG15),
* Honours Mathematics and Philosophy (GV17),
* Honours Mathematics and Physics (FG31).

It is also possible to take Mathematics as part of the B.A. with Honours in Combined Studies (Y300).

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HONOURS SCHOOL OF MATHEMATICS — The First Year Programme

In the first year the student studies six mathematics courses across the breadth of pure and applied mathematics.

MT110 Analysis (Terms 1 and 2): This course develops the theory of functions of a real variable in a systematic way and includes a rigorous treatment of the basic ideas of calculus which are usually met more informally at school. It begins with the formulation of an axiom system for the real numbers on which the logical structure of the course is based, and goes on to a treatment of the concept of limit including the convergence of infinite sequences and series, and the continuity of functions of a real variable. Famous paradoxes such as that of Achilles and the tortoise are resolved. Using these ideas the familiar results of differential and integral calculus are rigorously derived.

MT112 Algebra (All three terms): Students who have followed a modern mathematics syllabus at school will already be familiar with some of the material in this course, which introduces linear algebra from both the geometrical and algebraic points of view. The topics discussed include set theory, vector geometry in n dimensions, systems of linear equations, matrices and quadratic forms. There is also an introduction to the basic ideas of group theory and number fields.

MT114 Mathematical Methods (Terms 1 and 3): This course follows on from school calculus. The first part deals mainly with ordinary differential equations. The techniques covered here are used to describe particle motions in the Mechanics course, and indeed are required for the mathematical understanding of many physical systems. In the second part of the first term course, powerful techniques for solving optimisation problems in several dimensions are developed. The Summer Term course deals with multiple integrals which are used in later mathematics courses such as Hydrodynamics and Electromagnetism.

MT115 Probability and Statistics (Terms 2 and 3): This course introduces students to the basic concepts and some fundamental results and methods of probability and statistics. The early part deals with random variables and their distributions, and this is followed by ideas relating to sample spaces, events, independent observations etc. The course leads up to the classical limit theorems on repeated trials.

MT116 Mechanics (All three terms): This course is intended to give a general introduction to the techniques of classical applied mathematics and is accessible to students who have not studied mechanics at A-level. It begins with a short introduction to vector algebra. The Newtonian model of particle motion is then formulated in vector notation and applied to some simple problems concerning the motion of a single particle. The generalisation to many-particle systems is then considered and the concepts of linear momentum, kinetic energy and angular momentum introduced. Finally small oscillations of conservative mechanical systems with more than one degree of freedom are considered.

MT117 Computing and Computational Mathematics (All three terms): One aim of this course is to provide basic skills in programming in Pascal. It includes regular practical programming classes and a number of projects through the year. No previous programming experience is assumed. The course also introduces some basic ideas of numerical analysis including iterative methods for root-finding, applications of the discrete approximation of the derivative, and numerical methods for solving systems of linear equations, evaluating integrals and summing series. Assessment is partly by coursework.

Teaching

During the first year students have about thirteen fifty minute lectures each week. Each student is assigned to a tutorial group of up to ten students which meets once a week for each of analysis, algebra and mechanics. These groups provide an opportunity to discuss ideas and problems which arise from lectures and the work handed in by the students. For mathematical methods and probability and statistics there are weekly examples classes when problems can be discussed with one of the members of staff present.

Assessment

There is an examination in each of the courses at the end of the academic year. It is necessary to gain an overall pass in these examinations in order to proceed to the second year but the results do not count towards the final degree classification. Examinations are also held at the beginning of the Lent Term in order that students and staff can determine progress in the first term of the course but these are not used for formal assessment purposes.
HONOURS SCHOOL OF MATHEMATICS — The Second Year Programme

The second year programme consists of six courses, each running through the year with two lectures and one tutorial or examples class each week. All students take Analysis and Mathematical Methods and choose four other lecture courses. There are seven options within the Mathematics Department.

The Course Flexibility Scheme

Second year students may select up to two of their lecture courses outside the Mathematics Department. This enables a student to continue a subject taken at school, to embark on something new or to take courses which may be relevant to a possible future career. Careful selection of courses can result in exemption from certain professional examinations in accountancy, actuarial work and operational research.

During 1987-1988 courses in the following subjects were taken by Honours Mathematics students: computer science, physics, astronomy, geography, psychology, philosophy, theology, politics, government, sociology, economics, accountancy, education, music, history of art, linguistics, Arabic, French, German, Hebrew, Italian and Spanish.

The Two Tier Course Structure

In addition to flexibility in the choice of subject matter, there is also flexibility in relation to the level of presentation of the mathematics courses. Five second year courses are offered at both an upper and a lower level. The lower course covers similar topics to the corresponding upper course but more time is given to the consolidation of earlier material, practical concepts and worked examples, and some of the more abstract concepts and proofs are omitted. After consultation with their counsellor, students are free to select a mix of upper and lower courses appropriate to their own strengths and interests.

Core Mathematics Courses

MT210/211 Analysis: In these courses, one or other of which is taken by all Mathematics students, the ideas developed in first year Analysis are extended to functions of a complex variable. On the one hand this provides deeper insight into the more elementary real variable analysis of the first year, while on the other hand it introduces more sophisticated ideas, including topology, contour integration and uniform convergence. The courses conclude with a treatment of conformal mapping, a subject which has many applications in the physical sciences.

MT214 Mathematical Methods: This course taken by all Mathematics students continues in the spirit of the first year Analysis. Most of the course is devoted to the study of ordinary and partial differential equations: Laplace's equation, Bessel's equation and the wave equation are examples arising in other courses. Laplace transforms and Fourier series are developed as tools for solving differential equations. Towards the end of the course various methods for evaluating real integrals, using the complex variable theory developed in MT210/211, are developed. The Summer Term is devoted to the study of plane autonomous systems of ordinary differential equations.

MT212/213 Algebra: These courses deal with the theory of rings and groups. Rings are sets whose elements can be added, subtracted and multiplied together like the integers. Historically, the concept of ring arose from problems in number theory and in algebraic geometry. Groups are sets with only one operation. Natural examples are provided by the symmetries of a geometrical object. Group theory has a variety of applications, for example in crystallography and quantum mechanics. The syllabus has been revised for 1988-1989 to include applications to number theory, coding theory and cryptography. In the Summer Term, MT212 discusses the group of rigid motions of the plane with applications to the classification of wallpaper patterns, and MT213 explains the Jordan normal form with applications to systems of linear differential equations.

MT216/217 Hydrodynamics and Vector Field Theory: These first courses on fluid motion start with some simple problems that can be tackled using first year ideas. For example, momentum considerations enable us to find the force needed to keep a water hose nozzle at rest. The Euler partial differential equations that describe the motion of an ideal fluid are then derived with the aid of vector field theory; the operators grad, div and curl and the associated integral identities of Green and Stokes are introduced as required. Some simple irrotational flow solutions are obtained, such as flow past a sphere using ideas from the Methods course, and flow past two-dimensional aeroflows using conformal mappings. In the Summer Term, tensors are introduced in MT216 whilst MT217 completes the material on fluids.

MT218 Oscillations and Waves: This is an introduction to the linear theory of small oscillations. It begins by extending the theory of normal modes of mechanical systems (met in MT116) to any number of degrees of freedom; some general results concerning normal modes are also established. The course then turns to the small oscillations of continuous systems: the stretched string and membrane, sound waves in tubes, and water waves. The general theory is illustrated by particular examples which can be solved exactly, and variational principles are used in other cases.

MT220/221 Mathematical Statistics: These courses have three main aims: to develop some of the ideas and techniques of the basic probability theory introduced in MT115 with particular emphasis being placed on the handling of probability distributions, to introduce students to important random processes which have been widely used to model real life situations, and to apply the ideas of probability theory to problems of statistical inference — problems in which we are obliged to draw conclusions on the basis of limited data gathered in situations where there is inherently an element of uncertainty. MT221 gives a rather gentler treatment of the theory, puts greater emphasis on practical work and applications of the theory and includes continuous assessment giving 30% of the final mark.

MT222 Discrete Mathematics for Operational Research: This new course for 1988-1989 covers algorithmic graph theory in the Michaelmas Term, including networks, flows and tours of graphs. In the Lent Term the course turns to linear programming, the simplex method and applications to network problems. The Summer Term introduces linear differences and selected applications.
MT224 Mathematical Logic: The course begins with a study of the logical notions that are needed for an understanding of the formal structure of modern mathematics. It presents a precise definition of the concept of a logically valid inference for sentences in the formal language of first-order logic, and a complete proof-procedure for such inferences will be provided. The idea of a formal language has applications to philosophy, linguistics and computer science. The second part of the course is devoted to basic set theory approached axiomatically. Both of Cantor's transfinite generalisations of the notion of natural number and the axiom of choice and some of its applications will be presented.

MT226/227 Numerical Analysis: These courses provide a basic treatment of some of the common problems in numerical analysis, namely obtaining numerical values for the solutions of non-linear equations, systems of linear equations, definite integrals, ordinary differential equations etc. They are essentially analytic in nature but linear algebra is frequently used and the need to produce finite, practical methods (algorithms) gives a distinctive flavour. The work illuminates and gives additional insights to ideas of analysis and linear algebra by using them in practical contexts and provides a bridge between analysis and applied mathematics. Computer applications are discussed using the experience gained in MT117, and in MT227 programming examples are included as part of the course assessment.

HONOURS SCHOOL OF MATHEMATICS — The Third Year Programme
The third year programme consists of eight one-term courses each of thirty lectures and a weekly Examples Class. As in the second year some of the courses are given at both an upper and lower level; others are given only at one level (even numbers for higher and odd numbers for lower). Again students select upper and lower courses in accordance with their strengths and interests. Second year mathematics options not taken in the second year may be offered in place of one or more of these courses.

In place of one course students may offer a project. This provides experience in writing at length about a mathematical topic and involves the exploration of some area of mathematics outside the lecture courses. A list of suggested topics is circulated towards the end of the second year so that after consultation with the supervisor some preliminary work can be done during the summer vacation.

The course flexibility scheme allows students to offer courses outside the Mathematics Department for up to three of the options. These may follow on from outside courses taken in the second year or may be something new.

Course Options in the Mathematics Department
These vary from year to year. During 1988-1989 the following are available:

MT310 Functional Analysis
MT311 Complex Analysis
MT350 Elliptic Functions
MT351 Introduction to p-adic Numbers and p-adic Analysis
MT312 Topology I
MT352 Topology II
MT314 Group Theory
MT315 Algebraic Number Theory
MT317 Algebraic Curves
MT354 Coding Theory
MT356 Geometry
MT357 Field Theory
MT318 Gödel's Incompleteness Theorems
MT358 Computational Complexity
MT359 Machines
MT320/321 Mathematical Methods I
MT360/361 Mathematical Methods II
MT322/323 Viscosity
MT326 Thermodynamics
MT362 Waves
MT354 Elasticity
MT366 Electromagnetism and Special Relativity
MT330 Statistical Inference
MT370 Statistical Methods
MT371 Statistical Methods: Design and Analysis of Experiments
MT332 Probability Theory
MT372 Stochastic Processes
MT335 Stochastic Models in Operational Research
MT342 Numerical Linear Algebra
MT343 Numerical Analysis: Special Topics
MT382 Numerical Analysis: Advanced Topics
MT385 Linear Programming
MT386 Nonlinear Optimisation
JOINT HONOURS SCHOOLS

The lecture course options for Joint Honours students are mostly from amongst the courses offered to single Honours students in the two departments involved. However in the first year the Mathematics Department does provide some special courses for Joint Honours students. These are:

MT113 Numerical Analysis (Term 3): The course introduces some basic ideas of numerical analysis including iterative methods for root-finding, applications of the discrete approximation of the derivative, and numerical methods for solving systems of linear equations, evaluating integrals and summing series.

MT118 Algebra (Terms 2 and 3): This course covers similar material to MT112 but in less detail. In the Summer Term Joint Honours Computer Science and Mathematics students attend lectures on logic (the predicate calculus) and set theory, and Joint Honours Mathematics and Physics students attend lectures on real quadratic forms.

Computer Science and Mathematics

First Year. In Mathematics students take MT110, MT113, MT114 (term 1) and MT118. In Computer Science the courses are:

CS110 An Introduction to the Programming Process: This course presents a “whole process” view of software development. A series of twelve studies forms the backbone to the course. Each will be divided into four phases: requirements, specification, design and implementation. All the laboratory work is based on these case studies.

CS130 An Introduction to Graphics and Databases: This course is concerned with some of the application oriented software in a computer system. Firstly the storage and organisation of computer data is considered and the concept of a database introduced. Secondly graphical interfaces between the user and the computer are explored and the basic concepts of computer graphics introduced.

Second Year. Each student takes three Mathematics courses: MT210/211 together with two of MT212, MT220/221, MT222, MT224 and MT226/227. In Computer Science four courses are selected from:

CS204 Compilers and Software Tools
CS211 Computing Science I
CS212 Computing Science II
CS231 Information Systems Engineering I
CS232 Information Systems Engineering II
CS233 Computers in Design

Third Year. Each student prepares a project in Computer Science and takes four approved Mathematics courses plus five Computer Science courses.

Mathematics and Philosophy

First Year. In Mathematics students take MT110, MT112 and MT114 (term 1). In Philosophy the courses are:

PH102 Introduction to Philosophy: This course introduces students to some of the main issues in two major areas of philosophy. The first part deals with the central problems of the theory of knowledge, and the second with problems in moral, social and political philosophy.

PH103 Formal Logic: This course considers the various axiomatic and natural deduction formulations of propositional and predicate logics.

Second Year. In Mathematics students attend MT210/211, MT212/213 and MT224. Two Philosophy courses are selected from:

PH123 Ancient Philosophy
PH221 History of Modern Philosophy
PH223 Ethics
PH224 Twentieth Century Analytic Philosophy
PH225 Logic
PH226 Philosophy of Science
PH227 Philosophy of Mind
PH229 Contemporary European Thought
PT256 Modern Political Thought
TH221 Philosophy of Religion

Third Year. Students attend seven courses, at least three third year Mathematics courses and at least three third year Philosophy courses.
Mathematics and Physics

First Year. In Mathematics students take MT110, MT114 and MT118. In Physics the courses are:

- **PC110 Introductory Quantum Mechanics (Terms 2 and 3):** An introductory course on the concepts of quantum mechanics and their physical implications. In particular it is stressed how the wave properties of particles lead to indeterminacy, uncertainty and energy quantisation.
- **PC111 Dynamics (Terms 2 and 3):** An introduction to kinematics and Newton's laws in vector notation together with the dynamics of rigid bodies.
- **PC114 Electricity and Magnetism (Terms 2 and 3):** An introduction to electricity and magnetism using vector notation.
- **PC115 Properties of Matter (All three terms):** The dominant theme is the relation of the structural, thermal and transport properties of solids, liquids and gases to the kinetic energy of atoms and the potential energy of the interaction of atoms. This involves an introduction to thermal physics, in particular kinetic theory, the first law of thermodynamics and the Boltzmann distribution.
- **PC117 Vectors and Special Relativity (Term 1):** An introduction to vector algebra and Special Relativity theory.
- **PC118 Physics Laboratory (Term 1):** The main purposes of the laboratory classes are to introduce the student to the methods and apparatus of experimental physics, to develop a critical approach to the evaluation of experimental data, and to develop the ability to communicate effectively in writing.
- **PC119 Data Analysis for Laboratory Work (Term 1):** An introduction to statistical methods of data analysis for experimental physics.
- **PC120 Vibrations and Waves (Terms 2 and 3):** A basic treatment of vibrations and waves including an introduction to Fourier series and transforms.

Second Year. In Mathematics students normally attend MT210/211, MT214 and MT216/217. The Physics courses are:

- **PC210 Quantum Mechanics**
- **PC214 Electromagnetism**
- **PC218 Physics Laboratory**
- **PC225A Thermal Physics**
  together with one of
- **PC212 Optics**
- **PC251 Advanced Classical Mechanics**
- **PC252 Waves**
- **CS151 Fortran Programming**

Third Year. Students normally attend four third year Mathematics courses and three course units in Physics.

Honours in Combined Studies

In this programme Mathematics may be combined with a subject or subjects selected from within one of the following areas of study:

- History and related subjects
- Philosophy and related subjects
- Social Sciences
- Languages
- Literary Studies
- Linguistics and related subjects
- Classical Civilisation, Archaeology and related subjects
- Religious Studies and Comparative Religion

Further details are given in the University Undergraduate Prospectus (pp 26-31) and more information is available on request. The Mathematics component makes up about three fifths of the overall programme.
FURTHER INFORMATION

Preliminary reading

A-level teachers will be able to advise students on general books on Mathematics which provide a suitable background to University Mathematics. The following books may help to bridge the leap from A-level to University:


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Further information on any aspect of the courses may be obtained from either of the Admissions Tutors:
Dr. Peter J. Eccles (Telephone 061-275 5888)
Dr. Nigel Ray (Telephone 061-275 5848)

or from the Admissions Secretary:
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