Mathematics at Manchester
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A handbook for students in the Department of Mathematics

This booklet is addressed primarily to British students who are studying mathematics at A-level, with a view to entering a British university in the near future, to foreign students at a similar educational stage, and to their teachers and advisers. A copy is sent to every student who applies to study mathematics at Manchester, and to any other interested person upon request. Its function is to describe briefly the educational opportunities available in mathematics in this University and to give some idea of what it is like to be a mathematics student here. If you are interested enough to want to see at first hand our University and Department, we shall be pleased to arrange for you to come on one of our visiting days which are held in the first half of each academic year. All students applying to us through UCCA are automatically invited to visit on one of these days, when they have a chance to meet staff and students and to put their questions to them. Enquiries on matters not covered in this booklet are welcomed, and should be addressed, either by telephone or letter, to

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NOTE. This booklet describes the mathematics courses in the Faculty of Science of the University. Information about mathematics in the Faculty of Technology may be obtained from The Registrar, University of Manchester Institute of Science and Technology, P.O. Box No. 88, Manchester M60 1QD.

Contents

THE MATHEMATICS DEPARTMENT .................................................. 3
Scope and structure, the Departmental Board and its committees, the Mathematical Colloquium

COURSE STRUCTURE ............................................................ 7
Details of first year courses, second and third year programmes, examinations, joint honours schools

THE STUDENT IN MANCHESTER ............................................. 12

CAREERS FOR MATHEMATICS GRADUATES ............................... 16

Cover: The Mathematics Building viewed from Oxford Road
The Mathematics Department

The Mathematics Department is one of the largest in the University and is larger than Mathematics Departments in most other universities. There are some 55 members of staff and about 50 postgraduate and 350 undergraduate students. Every major branch of mathematics is represented. Although the academic staff are divided into groups labelled Pure Mathematics, Mathematical Logic, Applied Mathematics, Numerical Analysis, and Statistics, the Department operates as a single unit. This arrangement is reflected in the course structure for undergraduates who have the opportunity to obtain a broad mathematical education, or to specialise in pure or applied mathematics, or computational mathematics, or statistics. All the academic staff share the teaching responsibilities; they also carry on the research work of the Department. The teaching takes the form of lectures backed up by tutorials, where a lecturer teaches a small number of students at a time, or by examples classes, where students do examples under the supervision of a lecturer. Postgraduates often help with tutorials and examples classes.

All members of the Department, both staff and students, share in the work of running the Department. The more important Departmental matters are debated and decided at the regular meetings of the Departmental Board. The Board consists of all the academic staff together with eight student representatives elected by the whole student body. It is technically only an advisory body, since responsibility for the Department rests formally with the professors. Nevertheless, its opinion on academic matters carries some weight in higher University bodies and is usually decisive. Much of the detailed work of the Board is carried out by its committees. For example, the Courses and Teaching Committee oversees and makes recommendations about teaching arrangements, and the Staff-Student Liaison Committee reviews the administrative arrangements as they affect students. Student membership of these committees is quite substantial; roughly a third of the Courses and Teaching Committee and over half of the Staff-Student Liaison Committee are elected students. The work of the Staff-Student Liaison Committee often involves the secretarial staff and the porters of the Mathematics Building and thereby helps to maintain liaison between academic and non-academic staff and students.

Across: General view of Mathematics Building, with the main University Building and Science Blocks
The way the Department is run helps to continue its strong tradition of good staff-student relations, which are maintained despite its large size. Staff-student interaction and feedback about the students' view of the Department are encouraged by the Counsellors. Each student is assigned a Counsellor from the academic staff who is there to give advice on all matters connected with the student's university career. Many students have found that their Counsellors can help with other problems, although this sort of help is also available in other parts of the University—Halls of Residence, Students' Union Welfare Office, Student Health Service, etc. When a student leaves the University, the Counsellor will help by supplying references to prospective employers.

Above: Entrance to the Mathematics Building
Across: The ramp leading to the main entrance of the Mathematics Building
The Mathematical Colloquium

This is the undergraduate society of the Department. It is occupied in the main with organising social events for its members, but this is not its sole activity. It also arranges talks on topics related to its members' common interest in mathematics. Recent topics have been 'Mathematical Trees' and 'Models of Mental States'.

The entertainments provided are wide and varied, including such events as coach trips to Blackpool, parties, barn dances, and jazz evenings, to name but a few. The Colloquium is also responsible for the Departmental football team which plays in a University league, as well as other sporting activities.

A magazine, Iota, is published regularly and contains information about events as well as articles with a mathematical flavour. The Colloquium organises a second hand bookstall affording students a convenient and ready market in which to buy or sell books.

The Colloquium is run by a committee of elected officers. Some of the members of this committee sit on other committees in the Department, namely the Staff-Student Liaison Committee, the Courses and Teaching Committee and the Departmental Board.

The Course Structure

The course structure is very flexible and you can select any one of a large number of possible programmes to suit both your interests and your abilities. The first year is something of a foundation year in mathematics, and so the flexibility becomes more apparent in the second and third years. When the time comes to make your choice of programme, you will therefore have had ample time to assess your interests and abilities. Your Counsellor will also play an important role in helping you to make such choices.

It is important to remember that both the overall structure of the degree and the lecture courses are modified from time to time. Both the subject and the range of opportunities for our graduates are developing rapidly, so the course of learning must change correspondingly. This booklet is published for the 1976-7 entry but is expected to remain correct except in detail for several years.

This is an informal account. A more formal statement is to be found in the Faculty of Science Prospectus, which gives a precise statement of Ordinances and Regulations, and in the Faculty of Science Syllabus of Classes.

Students are expected to attend a specified number of lecture courses in each session, amounting altogether to about twelve hours of lectures per week. These courses do not all have to be in mathematics, however. Several departments in the Faculty of Science, including the Mathematics Department, allow their students to take up to one third of their courses in other subjects, which need not be science subjects. This can even make it possible, in some cases, for a student to start in mathematics and to change to another subject in his second and third years, and vice versa. More practically, by choosing all the outside courses in a single subject, the course can be converted, though not in title, almost into a joint honours course. The course is described below as it would be for a student who took no optional courses in subjects other than mathematics.

Mathematics may be studied in the Honours School of Mathematics or in any one of several joint honours schools. These are described separately below.

Honours School of Mathematics

First year

Students must attend three mathematics courses and one in a non-mathematical subsidiary subject. The subsidiary subject can be chosen from a wide range inclu-
The mathematics courses are Analysis, Algebra (with Probability Theory) and Mathematical Methods and Mechanics (with Numerical Analysis).

**Analysis**

In this course, the aim is to make more precise the notions of differentiation and integration which have already been introduced at school under the heading of 'calculus'. The concept of a limit is fundamental—a derivative is the limit of a difference quotient and an integral is the limit of a sum. Integration turns out to be the inverse of differentiation, and in Analysis we examine the reason for this. Using the same concept of the limit, we analyse the convergence of infinite series.

**Algebra**

The first year algebra course serves as an introduction to a variety of topics in linear algebra and co-ordinate geometry. Many of these topics are treated in greater detail in more advanced courses later. Most undergraduates find some of the ideas new, but there are few prerequisites. Some of the topics covered are: sets and functions, number systems, linear equations, matrices and Euclidean geometry in n-dimensions.

**Mathematical Methods and Mechanics**

In order to teach (and learn) mathematics, it is sometimes necessary to develop, in an informal manner, techniques taken from an area of the subject which the student has not yet studied in great depth. So it is with school 'calculus', and in this course we continue this approach to certain topics in 'advanced calculus' including the solution of differential equations and the treatment of multiple integrals.

The laws of mechanics of a particle are formulated using the notation of vectors. We then extend these laws to study the motion of systems of particles and of rigid bodies, learning to use the conservation laws for energy and momentum where appropriate. We then begin to study the equations of motion of such systems using the powerful general equations of Lagrange.

**Probability Theory and Numerical Analysis**

The purpose of these two short courses is to give students the flavour of two areas of mathematics with which they may have had little or no previous contact. The course in probability theory acts as an introduction to the various statistics courses offered in the second year. There are two numerical analysis courses, one on the basic ideas of the subject, and the other mainly on computing, to enable students who did not take the computer science subsidiary to acquire a basic understanding of computer programming.

Both of these courses are also connected with the analysis course. Numerical analysis complements the methods of pure analysis in approximating functions, in integration, and in solving ordinary differential equations. The connection of probability theory with analysis is less obvious, but becomes more apparent in the third year courses.
Second year

Courses, each of two lectures a week, are provided in Analysis, Algebra, Methods, Hydrodynamics, Mechanics and Electromagnetism, Statistics, Stochastic Processes, Mathematical Logic and Numerical Analysis; some of these are given at two levels for students of varying abilities. You must take six courses, with a choice that is free except for some restriction designed to secure a sound basic mathematical education and to avoid duplication.

Third year

The third year courses are organised in units of three lectures a week lasting for one term; some of them are given at two levels. There are about thirty-five courses in all, covering a wide variety of fields of mathematics. You must take eight of these courses, which may be chosen freely subject to certain prerequisites and to some restrictions imposed to prevent duplication. This freedom of choice can be used, for example, to specialise in pure mathematics or in physical applied mathematics, or to take a course orientated towards numerical analysis or mathematical statistics; alternatively you can take a broad spectrum of courses chosen from a number of fields.

Examinations

There are examinations at the ends of the first and second years, with resits in September, which must be passed to qualify for entry into the next year's course. The second year examinations are taken into account with the final examination in the third year in deciding the final degree classification.

Joint Honours Schools

There are, at present, five joint honours schools, each of which combines mathematics with another subject in approximately equal proportions. In each case the other subject is one which also has a separate honours school; the courses for the joint honours school are nearly all chosen from the list of courses prescribed for the separate honours schools, and the qualitative standards required are the same for the joint school as for the separate schools. Thus the joint honours schools should be entered only by students who genuinely wish to study both components. They should not be viewed as providing an escape from the more demanding parts of either component, and indeed it is probably more difficult to do well in joint honours than in single honours because of the need to share one's efforts between more or less disparate subjects. The joint honours schools can be entered directly, and it is also possible to transfer from honours mathematics to joint honours, or vice versa, at the end of the first year. For transfer from honours mathematics to joint honours it will usually be necessary to have made the appropriate choice of subsidiary subject.

In the joint Honours School of Mathematics and Social Science the mathematics courses in the first year are the same as in the Honours School of Mathematics. The courses in the joint Honours Schools of Mathematics and Philosophy, and Mathematics and Psychology, can also be chosen in this way. With this arrangement transfer between Honours Mathematics and joint honours at the end of the first year is straightforward, and leads to no restrictions in the second year.

In the joint Honours Schools of Computer Science and Mathematics, and Mathematics and Physics, and in Mathematics and Philosophy and Mathematics and Psychology if the student so chooses, only a part of first year mathematics is done in the first year. In this case transfer at the end of the first year may lead to some restriction of choice in the second year.

Because of the need to secure a properly integrated course, the choice of courses in the joint honours schools is in general more restricted than in the single honours school.
The Student in Manchester

As a student here, you will find that the University, the city and the surrounding area together provide a stimulating environment and a unique and varied range of cultural and recreational opportunities.

Manchester University is a city university, the main campus being only about one mile south of the city centre, on both sides of Oxford Road. This fact alone seems to give those who study here a feeling of being in touch with the life of the city, and perhaps helps to combat the ivory tower impression that a more secluded campus tends to produce. From its origins in Owens College (founded in 1851) the University has grown into a major centre of learning and scholarship, and at present has more than 10,000 students. It forms part of the new Manchester Education Precinct, which is an area of 280 acres stretching south from the city centre, and including, besides the University, the Institute of Science and Technology (UMIST), the Royal Northern College of Music, Manchester Polytechnic, the Whitworth Art Gallery, the University Theatre, the McDougall Sports Centre, as well as medical and dental teaching hospitals, and various student residences.

The University has grown a great deal in the last thirty years, so that many of the buildings are of modern design. A wide range of architectural styles, from the Victorian quadrangle of the original University to the very modern Mathematics Tower Building (opened in 1969), are combined with well-planned lawns and small gardens to produce a highly efficient but surprisingly pleasant environment for those who study and work here.

Of course the mathematics student tends to spend much of his time on campus either in the Mathematics Building, or in the Students' Union Building. The former consists of a four-storey base around a first-floor patio, with a tower rising a further fifteen storeys from one corner of the base. It contains a student mathematics library, a student common-room, lecture rooms, administrative offices, and staff offices, as well as locker and cloakroom facilities for undergraduates.

The Students' Union is the best place to meet and make friends from other departments of the University. Whether you prefer chatting in a coffee bar, mountaineering, decorating old people's houses or playing tiddlywinks, the Union is the place to meet your fellow fanatics. It is run by students for students, and every undergraduate is automatically a member. It organises all manner of catering, drinking, studying and sporting facilities, as well as many concerts and discos. It represents student views and interests to the University, and, through the National Union of Students, to the country and the Government. If you have a mind to, you can become involved, through the Union, in all the social and political issues of the day, and the Union Welfare Office can often help individual students who find themselves in particular legal, financial or bureaucratic difficulties.

For accommodation, you can choose from lodgings, a flat (usually shared with fellow students) or a University Hall of Residence. The last is the most popular choice for first-year students as it gives the greatest chance of making new friends. It is the policy of the University to guarantee a place in a Hall of Residence, or University flat, to any first-year student who wants one. Some of the University Halls and blocks of flats are within a few minutes walk of the Mathematics Building, and most of the remainder are situated in an area called Fallowfield about two miles south of the campus. For details on accommodation and how to apply for it, you should consult the booklet “Student Accommodation” available free from the University.
Manchester is not a physically beautiful city, but in recent years, as clearance schemes and rebuilding programmes have been carried out, its Coronation Street image has become less appropriate. Most student lodgings, flats and Halls of Residence lie in the southern part of the city, an area that has relatively little industrial development and plenty of parks and trees. It is scarcely twenty minutes walk from the University to Platt Fields Park, which contains a lake, gardens, a museum, a bowling green and playing fields, and is almost opposite Owens Park, the largest of the University’s residential developments, housing over 1,000 students.

The people of Manchester are known for their friendliness (even to non-Lancastrians) and the student community plays an active rôle in the life of the city. Many students spend a lot of their spare time in community projects organised by the Students’ Union Community Action Group, and almost everyone takes some part in the hectic activity known as Rag Week, which takes place annually in the Lent term. Besides being very enjoyable, this event produces a lot of money each year for local charities.

Another point of contact between local people and students in the city is a common interest in the fortunes of Manchester City and Manchester United football clubs, and an interest in either guarantees that you will almost never be stuck for a topic of conversation. Cricket at Old Trafford is another sporting attraction that is enthusiastically supported, and in recent years has been greatly enlivened by members of the city’s immigrant population. The presence of West Indian and Asian communities has led to the opening of many shops and restaurants selling non-European food. In general, Manchester is a good place for eating out, and there are still some decent restaurants that students can occasionally afford. In addition to the large number of Indian and Chinese restaurants, one can find Italian, Spanish, Armenian, French and even British restaurants.

Manchester has a long tradition of patronage of the arts and the city has several museums, theatres, art galleries and cinemas. Besides performances by Manchester’s two famous orchestras, the Hallé and the BBC Northern, there are several regular series of chamber music, as well as frequent concerts arranged by the Royal Northern College of Music and the University. Folk music and jazz, and some poetry, flourish in the local pubs and clubs, and most of the big name bands of pop music have performed in the city, and sometimes in the University in the past few years.

For the person who likes to live in a city but escape into the countryside occasionally, Manchester has an ideal geographical position. At each of the four points of the compass, and within easy distance, lies some of England’s finest countryside.

To the south lies the Derbyshire Peak District, and to the east this merges into the tough walking ground of the Pennine Way. Carrying on round to the north, the eye sweeps into the heart of industrial Lancashire, but if you work your imagination hard you can visualise the hills of the Lake District beyond. Finally, to the west, beyond the docks (yes, Manchester is a port!) and the Cheshire Plain, lie the mountains of North Wales. There is no better centre in England for the walker, hiker or mountaineer.
Careers for Mathematics Graduates

In a world of rapidly changing employment opportunities, and even during the country's recent economic troubles, mathematicians have remained among the most versatile and employable of graduates. For whilst our degree course is designed primarily as an educational experience, without specific vocational aims in mind, the facility with problem-recognition and problem-solving which our courses develop in our students is of value in a great variety of occupations.

The main areas of employment absorbing our graduates in recent years can be roughly classified as teaching (in schools and colleges), industry and computing (including operational research and engineering), finance (mainly actuarial work and accountancy), postgraduate study (mathematical and otherwise), and a fifth area not easily labelled, but including the Civil Service, law, administration, marketing and management. At present each of these areas claims about one-fifth of our graduates.

Of course you may have little idea at this stage about which career you wish to follow, but by the end of your degree course you will probably have a better picture of your talents and interests. At that stage you will be able to call upon our very experienced University Appointments Service to assist you in deciding on a future career, and in finding a specific post that suits you.