Programme Specification: BA and MMath in Mathematics and Statistics

1. Awarding institution/body	**University of Oxford**
2. Teaching institution	**University of Oxford**
3. Programme accredited by	**Royal Statistical Society**
4. Final award	**BA (Hons) [3-year course]** **MMath (Hons) [4-year course]**
5. Programme	**Mathematics and Statistics**
6. UCAS code	**GG13 BAMSt/MMTH**
7. Relevant subject benchmark statement	**Mathematics, Statistics and Operational Research (QAA)**
8. Date of programme specification	**24 August 2006**

9. Educational aims of the programme

- To provide a course of high academic quality in Mathematics and Statistics in a challenging and supportive learning environment that encourages students to reach their full potential, personally and academically.
- To provide students with a broad, balanced knowledge of Mathematics and Statistics and an appreciation of their applications.
- To provide a course that is suitable both for students aiming to pursue research and for students going into other careers, in particular careers requiring numeracy, together with modelling and problem-solving abilities.
- For students taking the 4-year MMath, to provide foundations for graduate study for a research degree at a leading university either in the UK or overseas.

10. Programme outcomes ***A. Students will develop a knowledge and understanding of:***	***Related teaching/learning methods and strategies***
1. The core areas of Mathematics and Statistics, the basic ideas of mathematical and statistical modelling, and some of their principal areas of application.	Lectures on algebra, analysis, probability, statistics, differential equations, mathematical methods and models in the first four terms of the programme, supported by college-based tutorials, together with further options later in the course.
2. The correct use of mathematical language and formalism in mathematical thinking and logical processes.	Examples in lectures in the first two years, practice in weekly problem sheets, with critical feedback by college tutors, tutorial discussion, printed notes of guidance (available on the web).
3. Some of the processes and pitfalls of	Examples on problem sheets and Maple in the first

mathematical approximation	year.
4. Techniques of manipulation and computer-aided numerical calculation.	Practice in work for college tutorials and Maple practical work in the first year.
5. The basic ideas of a variety of areas of specialisation.	Lecture courses in probability and statistics, and a choice of pure and applied courses, supported by college tutorials or small classes in the second part of the second year.
6. Statistical inference and the application of statistical methods.	Lectures in the third year, supported by problem classes and practical classes. For MMath students, undertaking an extended statistics project and writing a dissertation in the fourth year.
7. Several specialised areas of Mathematics and Statistics or their applications, the principal results in these areas, how they relate to real-world problems and to problems within Mathematics and Statistics.	Lectures in the third year and fourth years, with supporting problem classes, conducted by subject specialists.

Assessment

Formative assessment on a weekly basis by marking of tutorial and class work, and on a termly basis by college examinations at the beginning of term or assessed vacation assignments. Summative assessment by four three-hour written papers at the end of year one, assessment of two computer projects in year one, by two three-hour 'breadth papers' in year two designed to test, through bookwork and unseen problems, breadth of understanding across the whole syllabus for the year, and two three-hour 'depth papers', designed to test understanding in depth through further questions on bookwork, and more substantial unseen problems. In years three and four, summative assessment is by a combination of one and three quarter- or three-hour subject papers on bookwork and unseen problems, practical work, extended essays, projects and mini-projects.

B. Skills and other attributes

Students will have the opportunity to develop the following skills during the course:

I. Intellectual skills

1. The ability to demonstrate knowledge of key concepts and topics in Mathematics and Statistics, both explicitly and by applying them to the solution of problems.

2. The ability to understand problems, formulating them in terms of appropriate theoretical frameworks, to facilitate their analysis and solution.

3. An understanding of how mathematical and statistical concepts and theories may be applied to the solution of problems including, where appropriate, an understanding that this may give only a partial solution.

4. The ability to select and apply appropriate techniques and processes.

5. The ability to construct and develop logical mathematical arguments, with clear identification of

assumptions and conclusions.

6. The ability to use computational and more general IT facilities as an aid to mathematical processes and for acquiring any further information that is needed and available.

7. The ability to present mathematical arguments and conclusions from them with clarity and accuracy.

8. The ability to conduct a statistical analysis of data and write a report on the outcome of that analysis.

Teaching/learning methods and strategies

These skills are acquired through lectures, classes, tutorials, practical classes, studying recommended textbooks and through work done for projects, extended essays and dissertations.

Assessment

These intellectual skills are tested summatively in the examination process at the end of each year, in projects, extended essays, dissertations and submitted practical work, and formatively in weekly tutorials or classes, and in college examinations.

II. Mathematics and Statistics related practical skills	***Teaching/learning methods and strategies***
1. Calculate fluently and accurately in abstract notation.	Practised throughout the course in problem work for tutorials and classes.
2. Use a Mathematics computer package.	Lectures, Maple practical classes and informal practice sessions supported by demonstrators in the first year; use of Maple/other packages where appropriate in later years.
3. Use a Statistics computer package.	Statistics practical classes supported by demonstrators in the third year and, for MMath students, in the fourth year where appropriate.

Assessment

There is summative assessment of 1 in the examination process at the end of each year, of 2 in the assessment of first year Maple projects, and of 3 in the assessment of third year statistics practical assignments and, for MMath students, fourth year dissertations where appropriate. Formative assessment takes place through weekly tutorials, classes, practical classes and college examinations, and for MMath students through project supervision by a member of academic staff.

III. General skills	***Teaching/learning methods and strategies***
1. The ability to analyse and solve problems and to reason logically and creatively.	Weekly problem sheets with tutorial or class support, often requiring significant development of ideas beyond material found in lectures or books.
2. Effective verbal and written communication and	Weekly tutorial and class assignments, with discussion and defence of written work in tutorials

presentation.	and presentation of solutions in classes.
3. The ability to study and learn independently.	A learning process that requires students to assimilate material from several sources, including lectures, tutorials, classes, books, and online sources, largely self-guided.
4. Independent time management.	Requirement to produce substantial amounts of written work to strict tutorial and class deadlines. Necessity to balance academic and non-academic activities without continuous oversight.
5. The ability to think critically about problems and their solutions, and to defend an intellectual position.	Discussion and criticism in tutorials and classes.
6. Collaboration.	Tutorial groups are encouraged by the tutorial system to work together, to share ideas and to develop the practice of crediting others for their contributions.
7. Use information technology.	Compulsory practical work; extensive use of the network for distributing teaching materials and for communication.

Assessment

The tutorial system provides continual formative assessment of all aspects of students' intellectual development. There is summative assessment of 2 in the yearly examinations and of 7 in the assessment of first-year computer projects and third-year practicals.

11. Programme Structures and Features

- A three year course leading to a BA (Hons) in Mathematics and Statistics, or with a further fourth year at M level, a four year course leading to an MMath (Hons) in Mathematics and Statistics.
- The QAA benchmark statement for Mathematics, Statistics and Operational Research recognizes the very wide variability among the programmes that come within its scope. This joint Mathematics and Statistics programme is identical to the Oxford Mathematics programme for the first year and first term of the second year. This emphasis towards Mathematics at the start of the programme is balanced by the requirement that BA students in their 3rd year, and MMath students in their 3rd and 4th years, take at least 50% Statistics in those years.
- The first year covers foundational material in pure and applied mathematics, including probability and statistics. All students study the same material (no options) leading to the Honour Moderations examination at the end of the first year. Students must either pass this exam, or pass a Preliminary Examination in September, in order to proceed into the second year of the programme.
- The BA is examined in two parts (A & B) taken in the second and third years. The MMath is examined in three parts (A, B & C), taken in the second, third and fourth years.
- In the 2nd year (Part A) students take core mathematics courses, core statistics courses, and choose

some optional courses.

- In the 3rd and 4th years the available units and half-units are designated as level H (aimed at 3rd year undergraduates) or as level M (aimed primarily at 4th year undergraduates or MSc students). At least 50% of each student's third year units, and at least 50% of each MMath student's fourth year units, must be in statistics.

- In the 3rd year (Part B) all students take 4 units, and each student may take up to one unit at M level. All students take the H level unit *Applied Statistics*, which includes statistics practicals, and also take at least one full unit from the H level units and half-units available on (i) *Statistical Inference*, (ii) *Stochastic Modelling.*

- In the 4th year (Part C) MMath students take 2 units at M level and also undertake an extended statistics project, which is the equivalent of one further unit at M level.

- In the 3rd and 4th years each unit or half unit, other than an extended essay half-unit or the 4th year statistics project, will be assessed by an examination paper, or by an examination paper plus evidence of practical work, or by a mini-project.

Learning: Year 1

Subjects

Linear Algebra
Some Theory of Sets and Groups
Geometry I
Analysis I: Sequences and series
Analysis II: Continuity and differentiability
Analysis III: Integration
Geometry II
Calculus of One Variable
Dynamics
Probability
Statistics
Calculus of Two or More Variables
Fourier Series and Two Variable Calculus
Partial Differential Equations in Two Dimensions and Applications
Calculus in Three Dimensions and Applications
Exploring Mathematics with Maple

Assessment

Four written papers of 3 hours each, together with assessed Maple practical work.

Year 2

Subjects

Core mathematics courses (50%):
- Algebra
- Analysis

- Differential Equations

Core statistics courses (25%):
- Probability
- Statistics

Options (25%):
- Graph Theory
- Combinatorial Optimisation
- Linear Programming
- Groups in Action
- Introduction to Fields
- Number Theory
- Integration
- Topology
- Multivariable Calculus
- Calculus of Variations
- Classical Mechanics
- Electromagnetism
- Fluid Dynamics and Waves
- Numerical Analysis

Assessment (Finals Part A, both BA and MMath)

Four written papers of 3 hours each: two papers on the core mathematics courses, plus two papers on the core statistics courses and the options.

Year 3

Subjects

Core statistics course (25%):
- Applied Statistics

Options (75%):

Statistics options including:
- Statistical Inference
- Stochastic Modelling
- Actuarial Science

Mathematics options from areas including:
- Logic and Set Theory
- Algebra
- Geometry
- Analysis
- Applied Analysis
- Theoretical Mechanics
- Mathematical Physics
- Number Theory
- Mathematical Ecology and Biology
- Martingales and Financial Mathematics

- Communication Theory

Assessment (Finals Part B, both BA and MMath)

The equivalent of four written papers of 3 hours each.

Year 4

Subjects

Options (67%):

Statistics options:
- Graphical Models and Inference
- Statistical Data Mining
- Bioinformatics and Computational Biology
- Stochastic Models in Mathematical Genetics
- Levy Processes and Finance
- Probabilistic Combinatorics

Mathematics options from areas including:
- Algebra
- Analysis
- Applied Analysis
- Theoretical Mechanics
- Mathematical Physics
- Mathematics and the Environment
- Number Theory
- Graph Theory

Statistics Project (33%)

Assessment (Finals Part C, MMath)

The equivalent of two written papers of 3 hours each, plus a project report.

12. Support for students and their learning

College Support. All students have a college tutor who oversees their academic progress. The college tutor arranges college teaching (tutorials and classes), advises on general academic matters such as choice of options, oversees library provision of relevant texts in the college, arranges college examinations and provides career advice and references.

Students may also turn for help and advice to other officers of their college, including the Senior Tutor or Tutor for Undergraduates, the College Dean or Junior Dean, the College Chaplain, College Counsellor, College Doctor or Nurse, or the Head of the College. All students have access to college and university hardship funds and travel funds.

Role of college teaching. Undergraduates have tutorials and classes in their colleges during the first and all or most of the second year of the degree course, typically two paired tutorials or one tutorial and one class

per week. In the third and fourth years, undergraduates are supported by specialist inter-college classes, which typically contain 6–10 students, and are given by a class tutor assisted by a marker. For both tutorials and classes, students submit their written answers to the assigned problems before the tutorial or class for marking. The advantage of the class system is that undergraduates can receive specialist tuition on the more advanced topics that are studied in the later parts of the programme. A record of attendance and achievement is kept for inter-college classes and reported to tutors at the end of each term, or earlier if poor attendance or achievement gives cause for concern.

Library provision. The University's libraries provide all students with excellent resources. College libraries and the University's lending library for science undergraduates provide students with all primary course texts (in many cases multiple copies), and provide a wealth of supplementary reading. Other resources include excellent local bookshops, a successful student-run second hand book stall, printed lecture notes and supporting material distributed via the web, many text books written by members of staff, and past examination papers and examiners' reports that are accessible online.

IT. The provision of IT services and access to them is made within the context of the University's IT policy. The university has installed the IT network infrastructure, manages central servers and provides training courses. Users have benefited from substantial college enhancements. All students are given user names to enable them to access the Mathematical Institute network, and email accounts with the University network. All computing facilities necessary for the practical work of the courses are provided. Taking advantage of site licences, students may run most relevant packages on their own PCs, or access them via the network on college machines.

13. Criteria for Admission

- Applications are made to colleges of the University, not to the faculty/department, in the case of undergraduates.
- Grades required are usually AAA or AAB at A-level, or equivalent marks on the Scottish Highers and CSYS, or the IB.
- Offers are made on the basis of students' academic record, the recommendations of their teachers, and their performance in a written test and in interviews held in colleges in December.
- Applicants are required at the time of interview to take a written test in mathematics. This test contains questions on core knowledge common to all A-level syllabuses in mathematics and is designed to be accessible to students who are studying for a single mathematics A-level.
- The purpose of the interviews is to determine those students, from an excellent cadre of applicants, who might best benefit from the intensive, tutorially based learning methods employed in the University.

14. Methods for evaluating and improving the quality and standards of learning

Responsibility for the course is vested in the Mathematical and Physical Sciences Division. The divisional board has formal responsibilty for the maintainance of educational quality and standards in the broad subject areas, and exercises its responsibility through its Academic Committee, and in particular the scrutiny it gives to the new course proposals and proposed course revisions, to reports from examiners, and to more general questions of academic policy.

Student feedback on lectures and intercollegiate classes is encouraged by the distribution and collection of anonymous multiple-choice questionnaires and comment forms towards the end of each course. Responses to these questionnaires and comments are collated each term. These are then reported to the teaching staff

concerned, scrutinised by the Chairman of the Department's Academic Committee and the Head of Department, and considered by the Academic Committee for action to be taken where appropriate.

Student concerns are discussed at termly meetings of the Joint Consultative Committee for Undergraduates. There is further student representation at Faculty meetings.

Student comments on tutorial provision in colleges are commonly sought by the Senior Tutor of each college, and are reviewed and acted upon in ways that vary from college to college.

The Academic Committee of the Department of Statistics is responsible for day-to-day running of the programme, oversees minor changes to the syllabus, and publishes annually a course handbook giving detailed syllabuses, synopses and reading lists for each lecture course.

15. Regulation of assessment

Examiners and the Examining Framework

The Academic Committee of the Department of Statistics is responsible for establishing the conventions for the setting, checking, marking of the examinations; and for the classification conventions.

The examinations are conducted within this framework by small Boards of Examiners appointed by the University. An important feature is that each Board's members are formally independent of the course lecturers and tutors. The Boards of Examiners are responsible for the setting all papers, and the marking of scripts. The Boards appoint Assessors (generally course lecturers) to assist in the setting and marking of papers. Candidate numbers are used to ensure anonymity.

At the conclusion of the examination, Boards of Examiners make detailed written reports giving overall statistical information, information on new examining methods and procedures, and changes under consideration; and also giving detailed commentary on each paper, usually on a question-by-question basis.

Each examination board has at least one External Examiner, who is appointed by the Vice Chancellor, to act as an impartial advisor and in particular

- to verify that standards are appropriate to the award, in part by comparison with the standards of comparable institutions, and to ensure that the assessment procedures and the regulations governing them are fair and otherwise appropriate.

- to ensure that the conduct of the examination and the determination of awards has been fairly conducted, and that individual student performance has been judged in accordance with the regulations and conventions of the Examining Board. [This will entail signing the Class List as an endorsement that the processes of examination and classification have been fairly conducted.]

Each External Examiner is expected to report annually to the Vice-Chancellor, covering the following points:

- the standards demonstrated by the students
- the extent to which standards are appropriate for the award
- the design, structure and marking of assessments
- the procedures for assessment and examinations
- whether or not external examiners have had sufficient access to, and the power to call upon, any material necessary to make the required judgments
- students' performance in relation to their peers in comparable courses
- the coherence of the policies and procedures relating to external examiners and their consonance with

the explicit roles required of them
- the basis and rationale for any comparisons made
- the strengths and weaknesses of the students as a cohort
- the quality of teaching and learning which may be indicated by student performance

The report of the Board of Examiners, and of each External Examiner, is addressed to the Vice-Chancellor and considered by the Academic Committee of the Mathematical and Physical Sciences Division, and by Educational Policy and Standards Committee of the University.

The reports are also considered in detail by the Academic Committee of the Department of Statistics, whose responsibility it is to ensure that full consideration is given to any particular criticism or suggestion made by an External Examiner, and to institute further discussion or action, and to inform the External Examiner within a reasonable time of what is done.

Assessment Rules and Classification

- Classification for the BA is based on 4 second year papers, and 4 third year papers (or their equivalent).

- Classification for the MMath is based on 4 second year papers, 4 third year papers (or their equivalent), and 2 fourth year papers (or their equivalent) plus a project report. [It has been agreed that from 2007 all students should receive a classification at BA level based on the second and third years, and that the fourth year is classified separately. Thus two classifications would be attached to the MMath.]

- The performance of each candidate on each paper/module is reported in the form of a Standardised Mark for that paper/module:

    - 70+: First class performance on paper
    - 60–69: Upper Second class performance on paper
    - 50–59: Lower Second class performance on paper
    - 40–49: Third class performance on paper
    - 30–39: Pass performance on paper
    - 0–29: Fail performance on paper

- The descriptors for these levels of performance are, in summary:

First Class: the candidate shows excellent problem-solving skills and excellent knowledge of the material, and is able to use that knowledge in unfamiliar contexts;

Upper Second Class: the candidate shows good problem-solving skills and good knowledge of much of the material;

Lower Second Class: the candidate shows adequate basic problem-solving skills and knowledge of much of the material;

Third Class: the candidate shows reasonable understanding of at least part of the basic material and some problem solving skills. Threshold level.

Pass: the candidate shows some limited grasp of basic material demonstrated by the equivalent of an average of one meaningful attempt at a question on each unit of study. A stronger performance on some papers may compensate for a weaker performance on others.

Fail: little evidence of competence in the topics examined; the work is likely to show major misunderstanding and confusion, coupled with inaccurate calculations; the answers to the questions

attempted are likely to be fragmentary only.

- The final class is determined by the weighted average of the paper standardised marks.
- For the three-year degree the weights of second and third year papers are 40 : 60.
- For the four-year degree the weights of second, third and fourth year papers are 22 : 33 : 45. [This will be irrelevant where there is a separate class attached to the fourth year of the MMath (from 2007).]

16. Indicators of quality and standards

The first students on the Mathematics and Statistics programme began the first year of the programme in October 2002. For the well-established Mathematics programme, which has substantial overlap with Mathematics and Statistics:

The QAA Subject Review grades in 2000 were:

- QAA Subject Review in 2000 achieving excellent grading
- The reports of External Examiners regularly address issues of quality and standards.
- The annual returns on first destinations of graduates demonstrate the success graduates from the mathematics courses enjoy in the job-market, and in obtaining admission to graduate courses.