

PROGRAMME SPECIFICATION FOR MSc IN MATHEMATICAL MODELLING AND SCIENTIFIC COMPUTING

- 1. Awarding institution/body:** University of Oxford
- 2. Teaching institution:** University of Oxford
- 3. Programme accredited by:** n/a
- 4. Final award:** Master of Science
- 5. Programme:** Mathematical Modelling and Scientific Computing
- 6. UCAS Code:** n/a
- 7. Relevant subject benchmark statement:** Mathematics, Statistics and Operational Research (QAA)
<http://www.qaa.ac.uk/academicinfrastructure/benchmark/statements/Maths07.asp>
- 8. Date of programme specification:** First drafted in 2003. Subsequently revised annually; most recently September 2011.

9. Programme aims:

The programme aims:

- i) to provide graduates with a strong mathematical background with the skills necessary to apply their expertise to the solution of real problems;
- ii) to provide students with a systematic understanding of core areas in both applied mathematics and numerical analysis as well as source advanced topics in one or both of these areas;
- iii) to develop the students' skills so that they are able to:
 - formulate a well posed problem from a possibly sketchy verbal description;
 - carry out relevant mathematical analysis;
 - develop an appropriate numerical scheme;
 - present and interpret these results;
- iv) to lay the foundation for further research for a career as a research mathematician in a whole range of application areas.

10. Programme outcomes

A.

<i>Students will gain a knowledge of:</i>	<i>Related teaching/learning methods and assessment</i>
1. Core methods of mathematics.	1. Lectures and classes in terms 1 & 2, written examinations in January and April.
2. Core methods of numerical analysis.	2. Lectures and classes in terms 1 & 2, written examination in January and April.
3. Practical Numerical Analysis	3. Introductory course on MATLAB followed by weekly practical sessions. This is followed by group work on case studies that are written up as reports.
4. Modelling Classes	4. Students work in small groups on case studies and give oral presentations and write reports.
5. More advanced topics in Modelling, Methods and Numerical Analysis.	5. About 20 lecture courses are available and each student will follow 3 courses and write up a mini project for assessment.
6. An in depth study of a specific problem that will typically involve modelling, analysis and numerical work.	6. Students work with a supervisor (and sometimes an industrial sponsor) and write a thesis of about 50 pages. The thesis is assessed by the board of examiners who also examine the students viva voce.

B. Students will have the opportunity to develop the following skills during the course.

<i>I. Intellectual skills</i>
1. The ability to demonstrate knowledge of key mathematical concepts and topics, both explicitly and by applying them to the solution of problems.
2. The ability to comprehend problems, abstract the essentials of problems and formulate them mathematically and in symbolic form so as to facilitate their analysis and solution.
3. Grasp how mathematical processes may be applied to problems, including where appropriate, an understanding that this might give only a partial solution.
4. The ability to select and apply appropriate mathematical 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, in forms suitable for the audiences being addressed.
8. The ability to formulate a real problem in mathematical terms, solve the resulting equations analytically or numerically, and give interpretations of the solutions.

<i>Teaching/learning methods and strategies</i>
These are acquired through lectures, classes, practical classes, studying recommended textbooks and through work done for projects, extended essays and dissertations. In addition regular sessions are held on 'research skills'.

<i>II. Mathematics related practical skills</i>	
1. Calculating fluently and accurately in abstract notation.	1. Practised throughout the course in problem work for classes.
2. Use of mathematics computer packages especially MATLAB.	2. Practised throughout course especially in practical numerical analysis classes.

<i>III. General skills</i>	<i>Teaching/Learning methods and strategies</i>
1. To analyse and solve problems, and to reason logically and creatively.	1. Weekly mathematical problem sheets with class support often requiring significant development of ideas beyond material found in lectures and books.
2. Effective communication and presentation orally.	2. Presentation of solutions in classes and viva voce exam.

3. Written skills.	3. There is a substantial amount of written work on the course: weekly problem sheets, special topics and the dissertation.
4. The ability to learn independently.	4. The dissertation and special topics require students to put together material from a number of sources including lectures, textbooks, and electronic sources, in their own time.
5. Independent time management.	5. Requirement to produce substantial amounts of written work against class deadlines; necessity to balance academic and non-academic activities without continuous oversight.
6. To think critically about solutions and to defend an intellectual position.	6. Discussion and criticism in classes and with supervisor.
7. Collaboration.	7. Modelling classes involve group work so that students share ideas and develop the practice of crediting others for their contributions.
8. Use of information and technology.	8. Compulsory practical work; extensive use of the network for distributing teaching materials for communications.

Assessment

These skills are tested summatively in the examination, and in projects, dissertations and submitted practical work.

11. Programme structures and features

An important feature of this programme is that it is administered jointly by OCIAM (Oxford Centre for Industrial and Applied Mathematics) and by the Numerical Analysis Group. The expertise available covers the full range of courses and allows students to specialise in either modelling or computation.

Students on the course should complete 13 units, counted as follows:

- **Core courses** (1 unit each): There are four core courses: one on Mathematical Methods and one on Numerical Analysis in each of the first two terms. Each course is assessed by a written examination in the week preceding the following term.
- **Special topics** (1 unit each): There are about 20 special topics to choose from spread over all three terms. These are assessed by writing a mini-project.
- **Case studies in Modelling and in Scientific Computing** (1 unit each): Students work together in groups on a range of different projects. They are required to give an oral presentation and are assessed by writing a report.
- **Dissertation:** (4 units) The dissertation is often on some aspect of a real problem arising from an industrial, biological, medical, environmental or algorithmic background and involves modelling, analysis and computation. The dissertation should be up to 50 pages in length. Students are required to give a short presentation of the first steps of their dissertation work in June.

In addition students all learn MATLAB and attend regular sessions on other skills and subjects, which include mathematical writing, time management, career development,

document preparation with LaTeX, additional computer skills, sources of available software, and presentation skills.

12. Support for students and their learning

There is a lending library in the Mathematical Institute. Students have access to the Radcliffe Science Library for journals and periodicals. There is also a library in each student's college.

Students have access to computer facilities in the Mathematical Institute and the department has an IT support team. A wide range of workstations is available for use by students on-site or remotely from their colleges or rooms. Working space with computers (but not an individual desk) is provided for students on this course in the Mathematical Institute. The network of I.T. resources and support within the University is extensive, especially the Oxford University Computing Services which provides facilities for graduates and an extensive range of training programmes. Colleges also provide good I.T. resources and support officers prepared to train and assist students. Students can download all information about the course from the course website.

Each student is appointed a supervisor in either OCIAM or the Numerical Analysis Group, with whom they meet regularly. The student may turn to the Course Director or the Course Organiser who hold regular office hours and can offer advice on course content and options. All information about the course is web based and the course website is regularly updated. Within college each student will have an advisor and there will be a Tutor for Graduates, and a Senior Tutor. Each college has an extensive support structure of advisors, welfare officers and peer support groups, and the University counselling service offers a range of assistance.

A week long induction programme take place before term starts to introduce students to MATLAB and to deal with administrative matters.

Lecture courses are supported by problem sheets and classes. Some of the classes, especially in mathematical modelling, require extensive working in groups and oral presentations. In addition to the academic side of the course, regular additional events are organised to develop students' research skills more broadly. Courses are delivered in scientific writing and presentation, software packages, and LaTeX.

Extensive facilities for language development are available through the University's Language Centre.

13. Criteria for admission

Applications are made to the department and after consideration by the MSc admissions committee they are passed on to Colleges. The qualifications required are an undergraduate degree in mathematics, applied mathematics, or a closely related subject (usually a First or a II.1) and evidence of motivation for work in this area. At least two references from people who are familiar with the applicant's work or study achievements are required and great reliance is put on the opinions expressed by the academics. For overseas applicants, the usual criteria of English proficiency are applied. All shortlisted applicants are interviewed. Those in the UK are invited to visit Oxford for the interview and other shortlisted applicants are interviewed by telephone. Two members of the admissions committee, which contains members from both

OCIAM and the NA Group, are present for each interview. A full statement of Admissions Criteria is appended.

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

The programme is administered by a Supervisory Committee which contains representatives from both OCIAM and the NA Group, as well as a member from outside the university, typically from industry. This committee meets three times a year in addition to conducting business as necessary by email. Day-to-day operations are coordinated by a pair of Course Organisers, one from OCIAM and one from the NA Group.

Student feedback is sought on all aspects of the course and students are invited to give feedback on each of the lecture courses they attend through questionnaires. The Course Organiser and Course Director hold a meeting at the end of Trinity Term which all students are invited to attend to discuss the course and ways it could be improved. Students are also given the opportunity to express their views in the end of course questionnaire. The responses to all questionnaires are analysed and brought to the next Supervisory Committee meeting.

Students are also encouraged to provide feedback on the course to the University through the online Oxford Student Course Experience Questionnaire at <http://ceq.oucs.ox.ac.uk>.

Students are eligible to serve on departmental consultative committees with graduate students, which have the right to raise any matter with the Supervisory Committee. Suggestions for improvements in the course are also solicited from employers. The external examiner provides useful comments and his/her annual report is scrutinized by the Supervisory Committee which reports to both departmental committees and to the division.

Responsibility for the course is vested in the Mathematical Physical and Life Sciences Division. The Divisional Board has formal responsibility for the maintenance 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 new course proposals and proposed course revisions, to reports of examiners, and to more general questions of academic policy.

The Division carries out reviews of the course. Changes in regulations require Divisional and EPSC approval. The Divisional Board is also responsible for academic appointments and for the arrangements (including mentoring, appraisal, and reviews of performance) for the support of newly appointed lecturers and for monitoring their teaching competence.

15. Regulation of assessment

The course is assessed as described in Section 10 & 11 above. There are four Examiners internal to Oxford and also an external examiner. Dissertations are read by at least two examiners or assessors and all are examined by a viva voce examination. Dissertations are marked on grounds of mathematical/scientific content and presentation in print and the viva is an important assessment tool. The examiners receive the students' marks on the coursework modules and put all the information

together to decide on the final result. The marking of coursework is done by lecturers with clear instructions to provide uniformity.

In order to pass the course, students need to show that:

- i) they have an understanding of the core areas of applied mathematics and scientific computing.
- ii) they have acquired the skills laid out in Section 9.
- iii) they have presented a coherent well-researched dissertation and are able to defend it orally.

The criteria used to award a distinction are a 'very good' performance in both parts of the course or a 'good' performance on coursework coupled with an 'excellent' dissertation. Students who are unable to obtain more than a 'weak' grade in both parts of the course will fail. It is possible for a student with 'weak' coursework to pass if they produce a 'good' dissertation and special topics, and are able to convince the examiners in the viva that they have acquired the required basic knowledge and skills.

The Examination Board contains an External Examiner, nominated by the Supervisory Committee and appointed by the Vice Chancellor, who acts as an external arbiter of standards. In particular, national guidance requires external examiners to report on three major areas:

1. whether the standards set are appropriate for the institution's awards;
2. the standards and comparability of student performance in the programmes concerned;
3. the extent to which procedures for assessment, examination and the determination of awards are sound and have been fairly conducted.

Within this framework, boards of examiners will work with their external examiner(s) in a variety of ways, but the University expects external examiners to:

1. have opportunity to comment on all examination papers in draft form;
2. have access to all scripts and other material submitted by candidates;
3. see a sample of scripts including scripts at the borderlines of classes;
4. see a sufficient sample of dissertations, extended essays and course work to be able to comment on the marks awarded;
5. be in a position to comment on the fairness of any procedures for the reconciliation of marks, moderation, scaling and adjustments arising out of medical or other evidence.

In relation to 5, the University does not regard this as requiring the external examiner to give a definitive final mark where there is initial disagreement between first markers (although examining boards may choose to ask the external examiner(s) to act in this way) but to be in a position to report on the soundness of the procedures used to reach a final agreed mark.

Assessment rules and classification

All students should take and be assessed on 13 units, normally:

- 4 core courses (1 unit each);
- 3 special topics (1 unit each);
- 1 case studies in mathematical modelling (1 unit);
- 1 case study in scientific computing (1 unit);

- 1 dissertation and viva (4 units).

For each unit students are given a USM (0-49 fail, 50-69 pass, 70-100 distinction). The USMs, weighted as above, are averaged to give an Average USM.

Students will only be considered for a Distinction if they fulfil all the following criteria:

- Average USM ≥ 70 ;
- All partial USM ≥ 50 ;
- Dissertation and Viva USM ≥ 70 .

Students will fail if the average USM < 50 . Candidates who fail 4 or more units of assessment may also fail even if their average USM ≥ 50 .

Otherwise, students will be awarded a Pass.

Qualitative class descriptors for these levels of performance are summarised below.

Distinction: High quality work throughout the course. The candidate shows excellent problem-solving skills and excellent knowledge of the material over a wide range of topics, and is able to use that knowledge innovatively and/or in unfamiliar contexts.

Pass: The pass covers a wide range of results from candidates who show basic problem solving skills and adequate knowledge of most of the material to candidates who show good or very good problem-solving skills, and good or very good knowledge of much of the material over a wide range of topics.

Fail: The candidate shows inadequate grasp of the basic material. Candidates may have shown some understanding but the majority of work is likely to show major misunderstanding and confusion, and/or inaccurate calculations.

16. Indicators of quality and standards

- QAA Subject Review in 2000 achieved excellent grading.
- Departmental Review (by the MPLS Division) 2004 and follow-up.
- The reports of the External and Internal Examiners regularly address issues of quality and standards.
- Students graduating from the course are able to find employment easily although about half the students will go onto doctoral work. The rest go into the financial sector (25%), industry (15%), teaching (5%) or other areas (5%).

Departmental contact for queries

The Course Organiser is Dr Kathryn Gillow, email: kathryn.gillow@maths.ox.ac.uk.