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	Masters
5.	Programme	Mathematical Modelling and Scientific Computing
6.	UCAS Code	n/a
7.	Relevant subject benchmark statement	Mathematics, Statistics and Operational Research; Computing
8.	Date of programme specification	September 2006

9. **Programme aims**

The programme aims:

- to provide graduates with a strong mathematical background with the skills necessary to apply their expertise to the solution of real problems;
- 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;
- to develop the students' skills so that they are able to:
  - (i) formulate a well posed problem from a possibly sketchy verbal description;
  - (ii) carry out relevant mathematical analysis;
  - (iii) develop an appropriate numerical scheme;
  - (iv) present and interpret these results;
- 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.

Students will gain a knowledge of:	*Related teaching/learning methods and assessment*

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 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 50-65 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. Intellectual skills
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.

Teaching/learning methods and strategies
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'.

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

III. General skills	***Teaching/Learning methods and strategies***
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, in projects, dissertations and submitted practical work.

11. Programme structures and features

An important feature of this programme is its dual-departmental nature: it is administered jointly by OCIAM (Oxford Centre for Industrial and Applied Mathematics) in the Mathematical Institute, and by the Numerical Analysis Group in the Computing Laboratory and the expertise available covers the full range of courses and allows students to specialise in either modelling or computation.

Students may choose to take the coursework intensive route (strand C) or the research intensive route (strand R) through the course. In either case, students on the course must complete 12 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. All students must complete the two core courses in the first 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** (0.5 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 for strand C (about 50 pages, not necessarily original) or 6 units for strand R (about 65 pages, some original ideas). 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. Students are required to give a short presentation of first steps of their dissertation work in June (strand C) or March (strand R).

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 are lending libraries in both the Computing Laboratory and 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.

Computer facilities are provided by the Computing Laboratory with a wide range of workstations available for use by students on-site or remotely from their colleges or rooms. The Computing laboratory has a technical support team to ensure the efficient running of this system, and machines are updated approximately every three years. 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 the Mathematical Institute or the Computing Laboratory, 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 Academic Administrator for the programme keeps the web pages up-to-date. 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 week is held 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 departments 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.

UK applicants are normally interviewed by an admissions committee, containing members from both OCIAM and the NA Group.

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. Lectures are appraised in the usual way and a course questionnaire is completed at the end of Trinity Term. The responses to the questionnaire are analysed and brought to the next Supervisory Committee meeting. 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.

An External Examiner is appointed in order:

i) 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.

ii) To ensure that the conduct of the examination and the determination of awards has been fairly conducted, and that individual student performances has been judged in accordance with the regulations and conventions of the Examining Board. This will entail signing the Final List as an endorsement that the processes of examinations have been fairly conducted.

External Examiners are expected to report to the Vice-Chancellor in each year in which they act. Their reports are expected to cover all 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 judgements;
•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 is addressed to the Vice-Chancellor, and will be considered by the relevant divisional board, the faculty/department and by the University's Educational Policy and Standards Committee.

Where an external examiner's report contains particular suggestions or criticisms, it is the responsibility of the faculty/department to ensure that full consideration is given to these, to institute further discussion or action, and to inform the external examiner within a reasonable time of what is done.

16. **Indicators of quality and standards**

The Numerical Analysis group is part of the Computing Laboratory (RAE grade 5) and OCIAM is part of the Applied Mathematics Section (RAE grade 5) and the groups are world leaders in the area of numerical analysis and industrial/applied mathematics respectively.

Reports from the External Examiner are received each year and action is taken on any criticisms of the course or its content.

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%). Former students of this course now in employment frequently return to find new recruits and to take part in the annual careers evening. A number of industrial companies sponsor the course each year.

Applications increased gradually from when the course started in 1978 until the MSc in Applied and Computational Mathematics was introduced in 2000. The total number of applications for the two courses together continued to rise until they were amalgamated in 2006. There are now over 100 applicants each year.

The course has been supported first by SERC and then by EPSRC since its inception.