PROGRAMME SPECIFICATION FOR MSC IN BIOMEDICAL ENGINEERING

1. Awarding institution/body	University of Oxford
2. Teaching institution	University of Oxford
3. Programme accredited by	To be sought from the IPEM in due course
4. Final award	MSc in Biomedical Engineering
5. Programme	MSc in Biomedical Engineering
6. UCAS code	Not applicable
7. Relevant subject benchmark statement	Not applicable
8. Date of programme specification	January 2012

9. Educational aims of the programme

The programme aims to:

- Train students in advanced engineering techniques and skills that can be applied to solve problems in medicine and medical science.
- Provide students with appreciation of how biomedical engineering today relates to both current practices in clinical medicine and the healthcare industry.
- Train students in multi-disciplinary research skills and provide the opportunity to practice them in a team project and an individual project.
- Provide a structured programme of study that is relevant to the needs of employers, and lays the foundation for a successful career in biomedical engineering.

10. Programme outcomes

A. Students will develop a knowledge and understanding of:

A1. Mathematics: mathematical modelling and computational methods appropriate to biomedical engineering.

A2. Biomedical Science: anatomy, systems biology, pathology relevant to the BME syllabus.

A3. Biomedical Engineering: medical instrumentation, biomedical image analysis, biomechanics, biomedical fluid dynamics, modelling physiological and pathological processes, tissue engineering, cardiovascular engineering.

A4. Business studies; healthcare industry, ethical issues

A5. Research skills: general and also specific to working in a multi-disciplinary team

A6. Via a research project, an understanding of a real clinical problem in some depth

Related teaching/learning methods and strategies

These are achieved via:

Lectures/classes: offer information, literature review and illustrative application and present and explore core ideas in the subject (A1-A4). A student prepares solutions to questions on an examples sheet for every 4 lectures, which will be discussed in a small class. This provides a student with the opportunity to follow-up the lectures with first self-study and then small-group discussion to deepen their individual knowledge of the topic.

Research skills classes: research skills are taught in classes, principally involving group activities, with some preparation and post class assignments (A5). These are in support of general skill development and to support the group and research projects in particular.

Practical sessions: computational methods are taught as a series of computer-based practicals with short introductory lectures on theory (A1). This enables a student to understand issues in application of computational methods to simulated and real problems and also develop computing skills relevant to the rest of the course including the research project. Practicals, computer-based and experimental lab based, provide an opportunity for a student to consolidate the theory they have learned in lectures with practical experience (A1-A3).

Group project: provides an opportunity to study a real biomedical engineering problem in depth, practice analytic and problem-solving skills, and work in a team (A1-A5).

Individual project: involves a literature review, problem specification and experiments/analysis written up in a report. This enables a student to demonstrate that they can apply the knowledge they have acquired on different aspects of the course to a clinical problem in some depth as well as put into practice general research skills (A1-A6).

In addition:

Expert (guest) lectures and seminars: provide a student with the opportunity to hear internal speakers and external speakers from industry and clinical medicine. This enables a student to gain appreciation of some applications, needs and roles of BME and biomedical engineers as well as career opportunities.

Assessment:

Assessment of knowledge and understanding is by:

Unseen written examinations (A1,A2,A3)

Written essay assignments (A4)

Assessment of practical work (A1,A2,A3)

Group project report write-up (no more than 30 pages, including all diagrams, photographs, references and assignments) and team presentation (A1-A6)

Individual project report (no more than 60 pages, including all diagrams, photographs, references and appendices)

B. Skills and other attributes

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

I. Intellectual skills

By the end of the course a student will have developed skills in:

B1. Synthesis: integrate theory and practice, and devise appropriate theoretical models of organs or other parts of the body and biomedical engineering systems.

B2. Computational analysis: select and apply appropriate computational techniques to solve a given problem

B3. Experimental analysis: acquire, analyse and interpret synthetic, experimental and clinical data and understand the strengths and limitation of using each type of experimental data analysis.

B4. Critical analysis: read, critique and discuss scientific articles, especially those that cross discipline boundaries between engineering and medicine. Present a written argument based on reading from a variety of sources.

B5. Problem solving: apply engineering principles to solve biomedical problems.

B6. Evaluation: interpret experimental data scientifically and demonstrate skills necessary to plan, conduct and report on a research project

Teaching/learning methods and strategies

Lectures/classes: offer information, literature review and illustrative application and present and explore core ideas in the subject. A student will apply intellectual skills to prepare solutions to examples sheet questions (B1,B2,B5) which will be discussed in a small class.

Practical sessions: computational methods are taught as a series of computer-based practicals with short introductory lectures on theory. This enables a student to understand issues in application of computational methods to simulated and real problems and also develop computing skills relevant to the rest of the course including the research project. Practicals, computer-based and experimental lab based, provide an opportunity for a student to consolidate the theory they have learned about in lectures and apply it to problems (B1,B2,B3).

Group project: provides an opportunity to study a real biomedical engineering problem in depth, practice analytic and problem-solving skills, and work in a team (B1,B2,B4,B5,B6).

Individual project: involves a literature review, problem specification and experiments/analysis written up in a report. This enables a student to practice the application of techniques they have learned about to a clinical problem in some depth as well as put into practice general research skills (B1-B6).

Assessment:

Assessment of intellectual skills is by:

Written examinations (B1,B2,B4)

Written essay assignments (B4)

Assessment of practical work (B2,B3,B5,B6)

Group project report and team presentation (B1,B2,B4-B6)

Individual project report (B1-B6)

II. ***Discipline-specific Practical skill*****s**

By the end of the course a student will be expected to have practical skills to enable them to:

C1. model biological organs and systems and biomedical engineering systems.

C2. select and apply appropriate computational methods to solve biomedical engineering problems.

C3. use information technology for the collection and analysis of experimental data.

C4. undertake a research project independently and with minimal supervision/guidance.

C5. understand issues in and have gained experience in working in multi-disciplinary teams.

Teaching/learning methods and strategies

Practical sessions: computational methods will be taught as a series of computer-based practicals with short introductory lectures on theory. This enables a student to understand issues in application of computational methods to simulated and real problems (C1,C2) and also develop computing skills relevant to the rest of the course including the research project. Practicals, computer-based and experimental lab based, will provide an opportunity for a student to consolidate the theory they have learned about in lectures with practical experience (C1,C2,C3).

Group project: provides an opportunity to study a real biomedical engineering problem in depth (C1), practice analytic and problem-solving skills (C2,C3), and work in a team (C4).

Individual project (C1-C5): involves a literature review, problem specification (C1) and experiments/analysis (C2,C3) written up in a report (C4). This enables a student to practice the application of techniques they have learned about to a clinical problem in some depth as well as put into practice general research skills. This may involve working in a multi-disciplinary team (C5).

Assessment

Assessment of discipline-specific practical skills is by:

Assessment of practical work (C1-C3)

Group project report and team presentation (C1-C4)

Individual project report (C1-C4)

III. Transferable skills

By the end of the course a student will have developed a range of transferable skills including skills in:

D1. Managing their own learning and conducting independent thinking and study

D2. Problem specification and modelling

D3. Applying mathematical and computational methods to solve (engineering) problems

D4. Use of general information technology

D5. Managing a research project, including planning and time management

D6. Conducting an engineering-based research-based work, from hypothesis to report writing

D7. Working in a multi-disciplinary team

D8. Critical analysis

Teaching/learning methods and strategies

These are achieved via:

Lectures/classes: offer information, literature review and illustrative application and present and explore core ideas in the subject. A student will prepare solutions to problems set in an examples sheet (D2,D3), which will be discussed in a small class. This provides a student with the opportunity to follow-up the lectures with first self-study and then small-group discussion to deepen their individual knowledge of the topic (D1).

Practical sessions: Computational methods will be taught as a series of computer-based practicals with short introductory lectures on theory. This enables a student to understand issues in application of computational methods to simulated and real problems and also develop computing skills relevant to the rest of the course including the research project (D2,D3,D4). Practicals, computer-based and experimental lab based, will provide an opportunity for a student to consolidate the theory they have learned about in lectures with practical experience (D2,D3,D4).

Group project: provides an opportunity to study a real biomedical engineering problem in depth, practice analytic and problem-solving skills (D2,D3,D4,D8), and work in a team (D7).

Individual project: involves a literature review (D8), problem specification (D2,D3) and experiments/analysis (D3,D4) written up in a report (D1,D6). This enables a student to apply knowledge developed on the course practice to a clinical problem in some depth as well as put into practice general research skills. The project work may involve working as part of a multi-disciplinary team (D7).

Assessment:

Assessment of transferable skills is evidenced in:

Written examinations (D1,D2,D3)

Written essay assignments (D1,D2,D3)

Assessment of practical work (D1,D2,D3,D4)

Group project report and team presentation (D5,D6,D7)

Individual project report (D1-D6)

11. Programme Structures and Features

The course components are:

BME1 Biomechanics (16 lectures, 4 classes, written examination)
BME2 Biomedical Modelling and Monitoring (16 lectures, 4 classes, written examination)
BME3 Medical Imaging and Informatics (16 lectures, 4 classes, written examination)
BME4 Cellular Engineering and Therapy (16 lectures, 4 classes, written examination)
BME5 Healthcare Industry (8 lectures, 2 classes, essay assignments)
BME6 Computational and Mathematical Methods (60 hrs laboratories, Pass/Fail)
BME7 Biomedical Engineering Laboratories (22hrs, 6 laboratories, practical write-ups).
BME8 Research Skills Project (weekly group meetings; report and presentation)
BME9 Individual Project (literature review; project work continued during the summer vacation; report and viva)

12. Support for Students and their learning

1. All students will participate in the Induction programme for new graduate students run by the Department of Engineering Science at the beginning of Michaelmas Term.

2. The Course Director and tutors will organise an introductory session on the course in week 0.

3. A Course Handbook including course structure, assessment methods, details of examination submission dates and procedures, criteria for the award of the MSc, department and contact information will be given to students at the beginning of study and will also be available on-line.

4. Students will complete a self-assessment of their progress each term. This will be discussed with the Course Director or departmental advisor.

5. One or more of the Director of Graduate Studies, Graduate Studies Administrator, Academic Administrator and the Course Director of the MSc will be available for consultation at all times, and there will be good access to other course tutors.

6. Supervisors of individual projects will meet students weekly during the project period and provide feedback on one draft of the project report.

7. Supervisors of group projects will meet the group weekly and provide feedback on one draft of the project report.

8. Prior to starting the course, students with identified gaps in pre-requisite knowledge for the course, will be sent preparatory material to complete prior to starting the course.

9. Student feedback on the course will be collected and reviewed by the BME Panel on a regular basis and the course revised to improve the course based on this feedback as appropriate.

10. Students will have access to all the normal University support mechanisms for graduate students, including; the OU Careers service, access to hardship funds; an OU card; access to OUCS services, University libraries and counselling services.

11. Students will have access to both department and University library facilities. The department library will have one or more reference copies of key books used on the course/recommended by course tutors.

12. Students will be given an email account and will have access to Departmental computers for practicals, internet-based academic work and email (for course communication).

13. The level of library and IT provision varies from college to college. The essential requirements will be catered for by departmental provision.

13. Criteria for Admission

13.1 Criteria for Admission
Within equal opportunities principles and legislation, applications will be assessed in the light of a candidate's ability to meet the following criteria:

13.2 Academic ability
Applicants are normally expected to be predicted or to have achieved a first-class undergraduate degree (or equivalent international qualifications[1]) in Engineering or a subject related to Biomedical Engineering (interpreted broadly).

For applicants with a degree from the USA, the minimum GPA we seek is 3.5 out of 4.0. The minimum Graduate Record Examination (GRE) score we seek is 750 (quantitative).

Appropriate indicators will include:

Academic references/letters of recommendation, which support intellectual ability, academic achievement, motivation, ability to work in a group.

Research proposal or personal statement written in English. This will be assessed for: your reasons for applying; evidence of motivation for and understanding of the course; the ability to present a reasoned case in English. Your statement should focus on research rather than personal achievements, interests and aspirations. It should aim for brevity and no other written material (such as conference papers or technical reports) should be submitted.

Performance at interview(s) Interviews may be held as part of the admissions process. These will be held by telephone for all candidates.

13.3 Other qualifications and experience
Research or working experience in an area relevant to the proposed field of study may be an advantage.

13.4 Availability of supervision, teaching, facilities and places
The following factors will govern whether candidates can be offered places:

- The ability of the Department of Engineering Science to provide the appropriate supervision, research opportunities, teaching and facilities for your chosen area of work.
- There are minimum and maximum limits to the numbers of students who may be admitted onto Oxford's research and taught programmes.

13.5 English Language Requirement
Applicants whose first language is not English are usually required to provide evidence of proficiency in English at the higher level required by the University.

[1] If you hold non-British qualifications, you are advised to check with the National Recognition Information Centre for the United Kingdom (UK NARIC) www.naric.org.uk how your qualifications match these requirements.

13.6 Deadlines and required full set of application material

Please refer to the Graduate Admissions website at

http://www.ox.ac.uk/admissions/postgraduate_courses/apply/application_guide.html#awhen_to_apply

for information on the deadlines which must be met, and the full set of supporting materials required, in order for applications to be guaranteed to be considered.

1**3.7 Whether you have yet secured funding** is not taken into consideration in the decision to make an initial offer a place, but please note that the initial offer of a place will not be confirmed until the college which gives you an initial offer of a place is satisfied that you have sufficient funding to cover your fees and living costs for the standard period of fee liability for your course.

13.8 Disability, health conditions and specific learning difficulties.

Students are selected for admission without regard to gender, marital or civil partnership status, disability, race, nationality, ethnic origin, religion or belief, sexual orientation, age or social background. Decisions on admission are based solely on the individual academic merits of each candidate and the application of the selection criteria appropriate to the programme of study. Further information on how these matters are supported during the admissions process is available here: http://www.ox.ac.uk/admissions/postgraduate_courses/about_the_university/graduate_welfare/e_d.html

13.9. Assessors
All applications will be assessed by at least one member of the academic staff with relevant experience and expertise.

13.10. Course webpage
http://www.ox.ac.uk/admissions/postgraduate_courses/course_guide/courses_az.html]

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

Mechanisms for gaining student feedback on teaching quality and their learning experience

- Questionnaries collected for each component of the course and considered by the course director/tutors in a BME Panel meeting and acted on as appropriate.
- Termly individual meetings between students and the Course Director.
- Self-assessment progress reports completed by students at the end of each term.

Mechanisms for the review and evaluation of teaching, learning, assessment, the curriculum and outcome standards

- BME Panel meeting in May/June at which course tutors consider current course structure, delivery arrangements, student performance in assessment, and student feedback and make recommendations for change and improvement. Also used to help spread best practice for teaching and learning techniques.
- Examiners reports (both internal and external) on the examinations in a particular year, commenting on pass rates, standards of learning and examination performance.
- Teaching evaluation questionnaires.
- Course Director reports to the Department's Postgraduate Studies Committee with details on admissions, staffing, course changes and feedback, student performance, destination of graduated MSc students, and any difficulties encountered on the course.
- Student destination, whether employment or further study.
- An Advisory Board (from industry and clinical practice) providing occasional and valuable comments on the progress and development of the course from their respective perspectives.

Committees with responsibility for monitoring and evaluating quality and standards

- Departmental Biomedical Engineering Panel
- Departmental Postgraduate Studies Committee
- Faculty of Engineering Science
- MPLS Division Academic Committee
- University of Oxford Education Committee

15. Regulation of assessment

The Examination Board will consist of 3 nominated members of Faculty who teach on the MSc (one to be elected Chairman of Examiners) and one external examiner.

The Examination Board will meet in late June/early July to assess coursework (to coincide with MEng classification), and mid-September to confirm the outcome for each of the MSc candidates.

The conventions to be used by the examiners will be approved by the Faculty of Engineering Science on an annual basis and will be communicated to candidates via email, with a reference copy available on the Department's internal web site.

External examiners

External Examiners are appointed in order:

1. 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.

2. 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.

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 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 is addressed to the Vice-Chancellor, and will be considered by the relevant Divisional Boards, faculties/departments and by the University's Education 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.

To be awarded the MSc, students must, to the satisfaction of the examiners, have passed all components of the course.

Sufficient conditions for Distinction (MSc)
The examiners may award a Distinction for exceptional performance in the MSc. A distinction will be awarded if the candidate has passed all components of the course, and has an average of 70.0 or above.

The examiners may also award a distinction if these conditions are not satisfied if, in their judgement, it would be appropriate to do so.

Details of Assessment and Marking Schemes

Table 15.1 below summarizes the course components and assessment methods.
Table 15.2 below summarizes the marking scheme for written examinations and essays.
Table 15.3 below summarizes the marking scheme for team and individual reports.

Table 15.1 Course components and assessment methods

Component	Assessment Method	Weighting
BME1 Biomechanics	Written examination	10
BME2 Biomedical Modelling and Monitoring	Written examination	10
BME3 Medical Imaging and Informatics	Written examination	10
BME4 Cellular Engineering and Therapy	Written examination	10
BME5 Healthcare Industry	Coursework	5
BME6 Computational Methods	Pass/Fail	0
BME7 Biomedical engineering Laboratories	Coursework	5
BME8 Team Project	Presentations, written work	15
BME9 Individual Project	Written report	35

Table 15.2 Marking Scale for Written examination papers and assignments		
>70	Distinction	The candidate shows excellent problem-solving skills and excellent knowledge of the material over a wide range of topics.
60-69	Pass	The candidate shows good problem-solving skills and good knowledge of most of the material.
50-59	Pass	The candidate shows adequate problem-solving skills and adequate understanding of at least part of the basic material over a reasonable range of topics.
40-49	Fail	The candidate shows a limited grasp of basic material over a restricted range of topics, with large gaps in understanding.
<39	Fail	The candidate shows inadequate grasp of the basic material. The work is likely to show major misunderstanding and confusion, and/or inaccurate calculations; the answers to most of the questions attempted are likely to be fragmentary only.

Table 15.3 Marking Scale for Team and Individual Projects		
>70	Distinction	Original identification of questions to be investigated; critical appraisal of key ideas/theory relevant to question/solution; research design carefully defined and critically applied; insightful analysis of data with critical/original interpretation.
60-69	Pass	Clear statement of research questions; justification of research design/approach taken with some relation to theory. Critical analysis of data and presentation of results, with conclusions drawn on study.
50-59	Pass	Research questions stated though not necessarily clearly; appropriate selection of methods; limited attempt to justify research design/approach with theory; satisfactory analysis of data. Some conclusions drawn on study but omits several points.
40-49	Fail	Research questions stated in general terms only; methods selected sufficient to address at least part of question(s) and applied appropriately; limited/no theoretical justification for design; limited but correct data analysis. Some conclusions drawn on study but omits key points.
<39	Fail	Research questions unclear; weak rationale; methods misapplied or chosen inappropriately; little/no theoretical justification for design; limited and unjustified data analysis. Weak conclusions.

16. Indicators of quality and standards

Indicators of programme quality include:

- Student retention and completion rates: a high level shows a high degree of student satisfaction and student support
- Evidence of progression through the course: improving coursework and examination marks show that a student is working to a higher standard in the later stages of the course.
- First destination data for MSc graduates: a high proportion finding employment or proceeding to further postgraduate research training in biomedical engineering or related areas such as medicine indicate that students have met the objectives of the course and have the appropriate skills set to further their career in the biomedical area.
- External examiners report: provides an impartial judgement of the quality of the course.
- Examination results: provides a profile of the overall quality of the course and students.
- Accreditation: we may seek accreditation for the course in due course. This will provide an impartial judgement of the quality of the course.
- Student questionnaires: provide a “user assessment” of the course content and delivery.
- Internal University reviews of teaching delivery and quality.