Imperial College London

Programme Specification for the MSc in Theory and Simulation of Materials

PLEASE NOTE. This specification provides a **concise** summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if he/she takes full advantage of the learning opportunities that are provided. This specification provides a source of information for students and prospective students seeking an understanding of the nature of the programme and may be used by the College for review purposes and sent to external examiners. More detailed information on the learning outcomes, content and teaching, learning and assessment methods of each module can be found in the course handbook or on-line at http://learn.imperial.ac.uk/. The accuracy of the information contained in this document is reviewed by the College and may be checked by the Quality Assurance Agency.

1. **Awarding Institution:** Imperial College London
2. **Teaching Institution:** Imperial College London
3. **External Accreditation by Professional / Statutory Body:** N/A
4. **Name of Final Award** (BEng / BSc / MEng etc): MSc
5. **Programme Title**: Theory and Simulation of Materials
6. **Name of Department / Division:** Physics
7. **Name of Faculty:** Natural Sciences
8. **UCAS Code** (or other coding system if relevant): N/A
9. **Relevant QAA Subject Benchmarking Group(s) and/or other external/internal reference points:** Physics
10. **Level(s) of programme within the Framework for Higher Education Qualifications (FHEQ):**

Bachelor's (BSc, BEng, MBBS)	Level 6
Integrated Master's (MSci, MEng)	Levels 6 and 7
Master's (MSc, MRes)	**Level 7**

11. **Mode of Study:** Full time
12. **Language of Study:** English
13. **Date of production / revision of this programme specification** (month/year): November 2009
14. **Educational aims/objectives of the programme:**

The formal aim of the MSc in Theory and Simulation of Materials (TSM) is to teach the students the core concepts and methods of theoretical and computational materials physics necessary for doctoral study in the field or for a technical career outside academia.

This aim is fulfilled via the following formal objectives. The MSc in TSM will:

- attract well-qualified Bachelor level students and provide an intellectually challenging degree programme;

- provide high quality advanced education in materials theory and simulation beyond Bachelor level within an environment with considerable teaching and research experience in the field;
- give students the experience of undertaking a major, individual project and reporting the results in a full scientific report and presentation;
- give students training in appropriate research methods;
- develop students' skills of communication, both written and oral, to specialised and non-specialised audiences;
- equip students for further academic study at Doctoral level in materials physics and subjects where this is an important enabling science, such as nuclear power, aerospace, automotive transport, renewable energy, defence, health-care and construction.

15. Programme Learning Outcomes

1. Knowledge and Understanding

Knowledge and Understanding of:

1. The fundamental laws and principles of the physics and simulation of materials; along with their application (some at the forefront of the discipline);

2. Research skills training which might include advanced problem solving, numerical techniques, writing software;

3. How to use advanced mathematical tools to describe the physical world;

4. How to research and provide lucid and critical summation of the scientific literature in a given topic of study;

5. How to plan, execute and report the results of an extended theoretical and/or computational project.

- The first four outcomes are achieved by a combination of lectures, computational classes, problem classes, seminars and project work. Students are encouraged to use their unsupervised time to undertake further study outside lectures.
- The project work requires students to research the appropriate scientific literature and use that to guide further theoretical or computational work. All such work needs to be presented by report. In particular, students undertake a project within the research groups of the Thomas Young Centre http://www.thomasyoungcentre.org or industry.
- The extended individual project work includes breaking down complex, real materials problems to design, construct and validate models of varying degrees of sophistication. This work is especially important for achieving A5. Mathematical and computational tools will be widely used on the course, and appropriate training will be given in their use.
- The programme has access to a wide range of Professional Skills courses via GSEPS, where presentation, communication and team-working skills are learned.

2. Skills and other Attributes

Intellectual Skills:

1. Apply knowledge of physical principles and mathematical techniques to practical problems;
2. Use mathematical techniques to develop and solve physical models of materials;
3. Demonstrate the ability to plan, undertake, and report on a programme of original work; including the planning and development of theoretical and/or computational models of complex structures, properties and processes in materials, the analysis and interpretation of experimental results, and validation of the models involved;
4. Research and examine critically the scientific literature.

- Problem solving computational exercises, problem sheets and research skills training and project

work are used to enable students to apply the theoretical knowledge gained from the taught course material to practical problems. This work includes the construction, manipulation and interpretation of mathematical and computer based models.
- Much of the project work will require significant prior research, planning and analysis to successfully undertake the original research in the allotted time.

Practical Skills:

1. Write, test and debug programs in a Linux-based professional computing environment;
2. Generate, visualise and analyse computational data, determine their validity, and make recommendations;
3. prepare technical reports;
4. give technical presentations;
5. use the scientific literature effectively;

- Computational skills are taught through specialist courses and exercises and project work. In particular, the 3-month project will require students to design and undertake computational experiments, analyse the data (including a discussion of their validity and errors) and prepare assessed technical reports and presentations.
- There will be briefing on general safety matters as part of the MSc induction programme.

Transferable Skills:

1. Problem-solving skills;
2. Investigative skills;
3. Communication skills;
4. Analytical skills;
5. IT skills;
6. Personal skills:

- A supervised written research project will require the students to prove their analytical and investigative skills by critiquing and applying a body of research to a real world problem.
- Research reports, presentations and publications of students' work test students' communication skills, supported by workshops on writing and presentation skills.
- All data analysis and modelling is undertaken using the appropriate IT tools, and computational work will require using and possibly writing specialist scientific packages. Training is given where necessary. All research reports and presentations are prepared with appropriate IT tools.
- During their studies within the DTC personal skills are developed using GSEPS courses on communication and presentations skills; team working and career skills are developed using workshops and group tasks throughout the programme. Students will be directed to attend the workshops most appropriate to their existing skill set.

16. The following reference points were used in creating this programme specification

- Subject benchmarking information for Physics, Astronomy and Astrophysics.
- Student Handbook for Course.

17. Programme structure and features, curriculum units (modules), ECTS assignment and award requirements

<u>Year One:</u>

Term one:

Students study the compulsory lecture courses: Mathematics for Theory of Materials and Numerical Methods (11 ECTS); Electronic Structure of Materials; Equilibrium in Materials; Transformation of Matter (each 7 ECTS). The Mathematics course has one hour of rapid feedback lesson a week and two hours of computer class a week. The lecture courses have one hour of rapid feedback classes a week.

Throughout the course the students meet with the Cohort Mentor once a week.

Students are encouraged to attend GSEPS professional skills workshops throughout their studies with the DTC.

Term Two:

The examination for the mathematics course is held at the start of term 2.

Students study two more compulsory lecture courses: Classical Field Theory of Materials and Methods of Simulating Materials (both 7 ECTS). In addition they study *two* options from Topics in Advanced Theory of Materials; Introduction to Complexity, and Surfaces and Interfaces (each 7 ECTS). The Surfaces and Interfaces and the Classical Field Theory of Materials courses both have weekly problems classes for the duration of the course, and the Introduction to Complexity course has two problem classes.

Term Three:

Examinations are held for the remainder of the courses except Methods of Simulating Materials, which is assessed by 3 mini-projects.

The students undertake a three-month research project and submit a report and give an assessed presentation (30 ECTS). The projects may be based at an external institution (but with an Imperial College supervisor assigned).

Students must pass both elements (Lecture courses and project) at 50% (after scaling) in order to gain a degree. A final degree class is awarded on the basis of the final mark (see section 22).

18. Support provided to students to assist learning (including collaborative students, where appropriate):

The first activity on the course is an introductory lecture where the structure, academic and administrative requirements of the course are explained and details given about the support services, including English language support, available within the College.

A detailed course handbook, covering the above information in considerable detail is available at the introductory lecture.

Students receive a Departmental welcome pack, which includes details on the College support services (i.e., counselling, health and safety and professional skills).

A briefing on general safety is compulsory for all students.

Each year's MSc in TSM class has a Cohort Mentor (who continues in that role during their PhD). The students meet their Mentor once a week, to discuss their progress on the course and to raise any issues and suggestions that may arise. The Mentor also acts as a point of contact for students who wish to raise concerns outside their studies.

All continually assessed coursework is returned with comments and a grade. Examination grades are given to the students (after a meeting of the examiners) and they are encouraged to discuss the results with the course director or cohort member.

Students who require assistance with their studies (including special examination arrangements) can approach the College Disabilities Advisory Service. The Department has a point of contact for administrative matters (such as the purchase of specialised equipment).

19. Criteria for admission:

Normally a first class honours BSc or MSci degree in Physics or other physical science or engineering subject with a strong mathematical and theoretical content from a UK university or overseas equivalent.

All applicants must satisfy the College's English proficiency requirements.

20. Processes used to select students:

Upon receipt into the Department, each application is considered by the DTC Admissions Tutor and the Course Director to determine whether the entry requirements have been satisfied. If the entry requirements are satisfied the applicant is invited for interview at which there are up to 4 members of the DTC Research Board, with representatives from the participating Departments: Aeronautics, Chemical Engineering, Chemistry, Materials, Mechanical Engineering and Physics. The Course Director and Admissions Tutor are present at all interviews. Applicants from remote locations are interviewed by telephone. Applicants are sent three questions of a mathematical nature in advance of the interview and invited to select one for detailed discussion at the interview. The interview panel decides whether an applicant should be turned down. If the applicant passes the interview their name goes forward for a final selection by members of the Research Board chaired by the Course Director, again with the Admissions Tutor present.

21. Methods for evaluating and improving the quality and standards of teaching and learning

a) Methods for review and evaluation of teaching, learning, assessment, the curriculum and outcome standards:

The external examiner system and Boards of Examiners are central to the process by which the College monitors the reliability and validity of its assessment procedures and academic standards. Boards of Examiners comment on the assessment procedures within the College and may suggest improvements for action by relevant departmental teaching Committees. All nominations for External Examiners require the approval of the Graduate School.

The Faculty Studies Committees and the Graduate Schools' Postgraduate Quality Committees review and consider the reports of external examiners and accrediting bodies and conduct periodic (normally quinquennial) and internal reviews of teaching provision. Regular reviews ensure that there is opportunity to highlight examples of good practice and ensure that recommendations for improvement can be made.

At programme level, the Head of Department/Division has overall responsibility for academic standards and the quality of the educational experience delivered within the department or division.

The Cohort Mentor meets the students weekly and reports to the Operations Board any concerns or issues which students have with any aspect of the MSc course. The Operations Board also meets weekly and is chaired by the Course Director. The Operations Board takes immediate action to address any concerns raised by students. It also identifies very quickly whether any student is having particular problems with any of the courses and the Cohort Mentor discusses possible remedies with the student. There is a student representative on the Operations Board who is invited to contribute in all discussions except confidential matters concerning particular students, when the student representative is asked to leave the room.

b) Committees with responsibility for monitoring and evaluating quality and standards:

The **Senate** oversees the quality assurance and regulation of degrees offered by the College. It is charged with promoting the academic work of the College, both in teaching and research, and with regulating and supervising the education and discipline of the students of the College. It has responsibility for approval of changes to the Academic Regulations, major changes to degree programmes and approval of new programmes.

The **Quality Assurance Advisory Committee** (QAAC) is the main forum for discussion of QA policy and the regulation of degree programmes at College level. QAAC develops and advises the Senate on the implementation of codes of practice and procedures relating to quality assurance and audit of quality and arrangements necessary to ensure compliance with national and international standards. QAAC also considers amendments to the Academic Regulations before making recommendations for change to the Senate. It also maintains an overview of the statistics on completion rates, withdrawals, examination irregularities (including cases of plagiarism), student appeals and disciplinaries.

The **Faculty Studies Committees** and **Graduate School Postgraduate Quality Committees** are the major vehicle for the quality assurance of undergraduate / postgraduate courses respectively. Their remit includes: setting the standards and framework, and overseeing the processes of quality assurance, for the areas within their remit; monitoring the provision and quality of e-learning; undertaking reviews of new and existing courses; noting minor changes in existing programme curricula approved by Departments; approving new modules, changes in module titles, major changes in examination structure and programme specifications for existing programmes; and reviewing proposals for new programmes, and the discontinuation of existing programmes, and making recommendations to Senate as appropriate.

The **Faculty Teaching Committees** maintain and develop teaching strategies and promote inter-departmental and inter-faculty teaching activities to enhance the efficiency of teaching within Faculties. They also identify and disseminate examples of good practice in teaching.

The **Departmental Postgraduate Taught Course Committee** has responsibility for the approval of minor changes to course curricula and examination structures and approves arrangements for course work. They also consider the details of entrance requirements and determine departmental postgraduate student numbers. There are student representatives from the Department's postgraduate taught courses. The Faculty Studies Committees and the Graduate School Postgraduate Quality Committees receive regular reports from the various Departmental Teaching Committees.

Within the DTC in Theory and Simulation of Materials, the **DTC Operations Board** has overall responsibility for the taught course content, examinations and other forms of assessment, and responding to feedback from students. The DTC Operations Board also keeps the MSc course under constant review, for example with regard to the development of new option courses, which are taught in the second term. The Research Board of the DTC, which is chaired by the DTC Director, who is also the MSc Course Director, is responsible for the soliciting and acceptance or rejection of the 3-month research projects, and for monitoring their execution and for their assessment. Criteria for eligible research projects are published on the web and circulated to all participating academic staff in the 6 departments at Imperial College. Students are also encouraged to propose their own projects provided they meet the same criteria of eligibility. The Course Director is a member of the Physics Department Postgraduate Masters Course Committee and works closely with academic staff in the 5 partner Departments.

c) Mechanisms for providing prompt feedback to students on their performance in course work and examinations and processes for monitoring that these named processes are effective:

Examination results are fed back to students (with a letter grade) after the examinations have been reviewed by the internal examiners. Most of the lecture courses have rapid feedback sessions (approximately every week) where students work through written problems with the lecturer, and receive immediate feedback. The course on Computational and Numerical Methods and on Methods of Simulating Materials are assessed by mini projects, for which students also receive immediate feedback.

Students and their supervisors complete monthly progress reports during the summer research project, which are reviewed by the Operations Board. These reports provide a mechanism each month for the supervisor to give written feedback to the student. Students give an oral presentation on their work at the annual MSc conference, where they also receive feedback.

d) Mechanisms for gaining student feedback on the quality of teaching and their learning experience and how students are provided with feedback as to actions taken as a result of their comments:

In the autumn and spring terms a MOLE questionnaire is completed by the students and the results reviewed by the DTC Operations Committee and comments will be passed to the course lecturers. Feedback from MOLE will also be considered by the Director of Post Graduate studies and the Course Director. If improvements are required, these are actioned and reviewed at subsequent meetings. Requests to make more significant changes are made to the Departmental Postgraduate Taught Course Committee and the GSEPS Postgraduate Quality Committees.

However, before the questionnaires are completed students meet the cohort mentor once a week throughout the terms and provide immediate feedback on all aspects of the teaching and their learning experience. This feedback is reported and discussed at the weekly Operations Board meetings where appropriate actions are implemented.

e) Mechanisms for monitoring the effectiveness of the personal tutoring system:

Students meet weekly with their Cohort Mentor. Absences are noted and followed up. Any personal concerns that students have are discussed privately with the Cohort Mentor. If the Cohort Mentor is unable to provide the advice the student needs the Cohort Mentor refers the student to appropriate body within the College. The effectiveness of the cohort mentor scheme is discussed with the student representative at the weekly Operations Board meetings. The effectiveness of the personal tutoring system will also be monitored by asking relevant questions on the autumn and spring term questionnaires.

f) Mechanisms for recognising and rewarding excellence in teaching and in pastoral care:

Staff are encouraged to reflect on their teaching, in order to introduce enhancements and develop innovative teaching methods. Each year College awards are presented to academic staff for outstanding contributions to teaching, pastoral care or research supervision. A special award for Teaching Innovation, available each year, is presented to a member of staff who has demonstrated an original and innovative approach to teaching. Nominations for these awards come from across the College and students are invited both to nominate staff and to sit on the deciding panels.

g) Staff development priorities for this programme include:

- Active research programme in physics, chemistry, materials and engineering
- Early in the probation period, lecturers attend an initial series of five workshops on teaching and learning
- Probationary lecturers are assigned a mentor who monitors and advises them on teaching
- New staff are required to take the College CASLAT learning and teaching certificate before completing probation
- Staff are appraised annually
- Staff are encouraged to attend College courses on teaching and learning and on professional development
- Graduate Teaching Assistants attend a workshop on demonstrating, and receive training on their particular teaching activity
- Staff are encouraged to join the Higher Education Academy (HEA)
- Staff are encouraged to attend meetings of the Institute of Physics Higher Education Group and the HEA

22. Regulation of Assessment

a) Assessment Rules and Degree Classification:

The Pass Mark for postgraduate taught courses is 50%. In order to be awarded a result of merit, a candidate must obtain an aggregate mark of 60% or greater; a result of distinction requires an aggregate mark of 70% or greater.

Where appropriate, a Board of Examiners may award a result of merit where a candidate has achieved an aggregate mark of 60% or greater across the programme as a whole AND has obtained a mark of 60% or greater in each element with the exception of one element AND has obtained a mark of 50% or greater in this latter element.

Where appropriate, a Board of Examiners may award a result of distinction where a candidate has achieved an aggregate mark of 70% or greater across the programme as a whole AND has obtained a mark of 70% or greater in each element with the exception of one element AND has obtained a mark of 60% or greater in this latter element.

b) Marking Schemes for undergraduate and postgraduate taught programmes:

The Pass Mark for all **postgraduate** taught course modules is 50%. Students must pass all elements in order to be awarded a degree.

c) Processes for dealing with mitigating circumstances:

A candidate for a Master's degree who is prevented owing to illness or the death of a near relative or other cause judged sufficient by the Graduate Schools from completing at the normal time the examination or Part of the examination for which he/she has entered may, at the discretion of the Examiners,

(a) Enter the examination in those elements in which he/she was not able to be examined on the next occasion when the examination is held in order to complete the examination,

or

(b) be set a special examination in those elements of the examination missed as soon as possible and/or be permitted to submit any work prescribed (e.g. report) at a date specified by the Board of Examiners concerned. The special examination shall be in the same format as specified in the course regulations for the element(s) missed.

Applications, which must be accompanied by a medical certificate or other statement of the grounds on which the application is made, shall be submitted to the Academic Registrar who will submit them to the Board of Examiners.

d) Processes for determining degree classification for borderline candidates:

Candidates should only be considered for promotion to pass, merit or distinction if their aggregate mark is within 2.5% of the relevant borderline. Nevertheless, candidates whom the Board deems to have exceptional circumstances may be considered for promotion even if their aggregate mark is more than 2.5% from the borderline. In such cases the necessary extra marks should be credited to bring the candidate's aggregate mark into the higher range.

e) Role of external examiners:

The primary duty of external examiners is to ensure that the degrees awarded by the College are consistent with that of the national university system. External examiners are also responsible for approval of draft question papers, assessment of examination scripts, projects and coursework (where appropriate) and in some cases will attend *viva voce* and clinical examinations. Although external examiners do not have power of veto their views carry considerable weight and will be treated accordingly. External examiners are required to attend each meeting of the Board of Examiners where recommendations on the results of individual examinations are considered. External examiners are required to write an annual report to the Rector of Imperial College which may include observations on teaching, course structure and course content as well as the examination

process as a whole. The College provides feedback to external examiners in response to recommendations made within their reports.

23. Indicators of Quality and Standards:

- Favourable comments by External Examiners
- High proportion of students achieving a high degree classification
- High proportion of MSc graduates continuing to PhD research in the DTC.
- Independent review of the quality of the educational provision of the Physics Department by the Quality Assurance Agency subject review process in 1998 achieving an excellent grading of 22 out of a maximum 24 points

24. Key sources of information about the programme can be found in:

- Postgraduate Prospectus, Imperial College of Science, Technology & Medicine (available on-line www.imperial.ac.uk)
- Postgraduate Training in Physics at Imperial College (available on-line http://www3.imperial.ac.uk/physics/admissions/pg/msc/)
- MSc Course Handbook