UNIVERSITY OF CAMBRIDGE
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Master's Programme in

Scientific Computing

Course Handbook
2013 - 2014

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- The Executive Director of the Centre for Scientific Computing
- Representatives from the Departments of the School of Physical Sciences, Technology and Biological Sciences.

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Introduction

Computation is an essential element of every branch of science and technology over the next decade, driven by the vast amount of experimental data requiring analysis, and the need for increasingly realistic simulations of ever more complex systems.

Computational science is now being perceived as a core skill that is crucial to the construction of theories and models at a new conceptual level and therefore to the progress of many scientific agendas.

There is a high demand for computer-literate science graduates across all areas of industry (significantly so in life sciences, technology and engineering) but the availability of suitably-trained candidates is low.

A dynamic new initiative, the University's **Centre for Scientific Computing** is an ambitious response to the growing demand to develop more quantitative approaches to scientific research. The University of Cambridge offers enormous scope for extending the benefits of computation across the whole of science and technology. The co-location of many world-leading researchers in almost every area of science, combined with outstanding computational facilities, encourages and widens the interdisciplinary collaboration for which the University is renowned.

The MPhil programme on Scientific Computing is offered by the University of Cambridge as a full-time course which aims to provide education of the highest quality at Master's level.

Covering topics of high-performance scientific computing and advanced numerical methods and techniques, it produces graduates with rigorous research and analytical skills, who are formidably well-equipped to proceed to doctoral research or directly into employment in industry, the professions, and the public service.

It also provides training for the academic researchers and teachers of the future, encouraging the pursuit of research in computational methods for science and technology disciplines, thus being an important gateway for entering PhD programmes containing a substantial component of computational modelling.

The MPhil is administered by the Department of Physics, but it serves the training needs of the Schools of Physical Sciences, Technology and Biological Sciences. The ability to have a single Master's course for such a broad range of disciplines and applications is achieved by offering core (i.e. common for all students) numerical and High Performance Computing (HPC) lecture courses, and complementing them with elective courses relevant to the specific discipline applications.

In this way, it is possible to generate a bespoke training portfolio for each student without losing the benefits of a cohort training approach. This bespoke course is fully flexible in allowing each student to liaise with their academic or industrial supervisor to choose a study area of mutual interest.

An indication of the success of this course is that all of its past graduates to-date have been offered fully-funded PhD placements in this University and elsewhere.

Course objectives

By the end of the course, students will have:

- a comprehensive understanding of numerical methods, and a thorough knowledge of the literature, applicable to their own research;
- demonstrated originality in the application of knowledge, together with a practical understanding of how research and enquiry are used to create and interpret knowledge in their field;
- shown abilities in the critical evaluation of current research and research techniques and methodologies;
- demonstrated self-direction and originality in tackling and solving problems, and acted autonomously in the planning and implementation of research.

Admission to the course

Applications for the course will be submitted through the University-wide online system for processing postgraduate applications, which then passes them to the Department of Physics. Successful candidates will have a first class (or high upper second class) honours degree from a UK university (or equivalent from international institutions) in a science or technology discipline, and are expected to be able to demonstrate an adequate level of computer literacy (should be able to write code performing a science/maths application using a programming language such as C/C++, FORTRAN or Java).

Full details of the application procedure, including an application form, can be found on the Board's website http://www.admin.cam.ac.uk/students/gradadmissions/prospec/index.shtml.

Candidates are encouraged to pay particular attention, on the application form, to the section where their choice of **research area** must be stated. Their choice must be identified at this stage, so that their application can be forwarded to an appropriate supervisor for consideration. Alternatively, if a specific supervisor has been identified, they can be named in the appropriate box in the application form.

Funding your studies

The main University website has a webpage listing all of the possible sources of funding http://www.admin.cam.ac.uk/students/gradadmissions/prospec/studying/funding/index.html

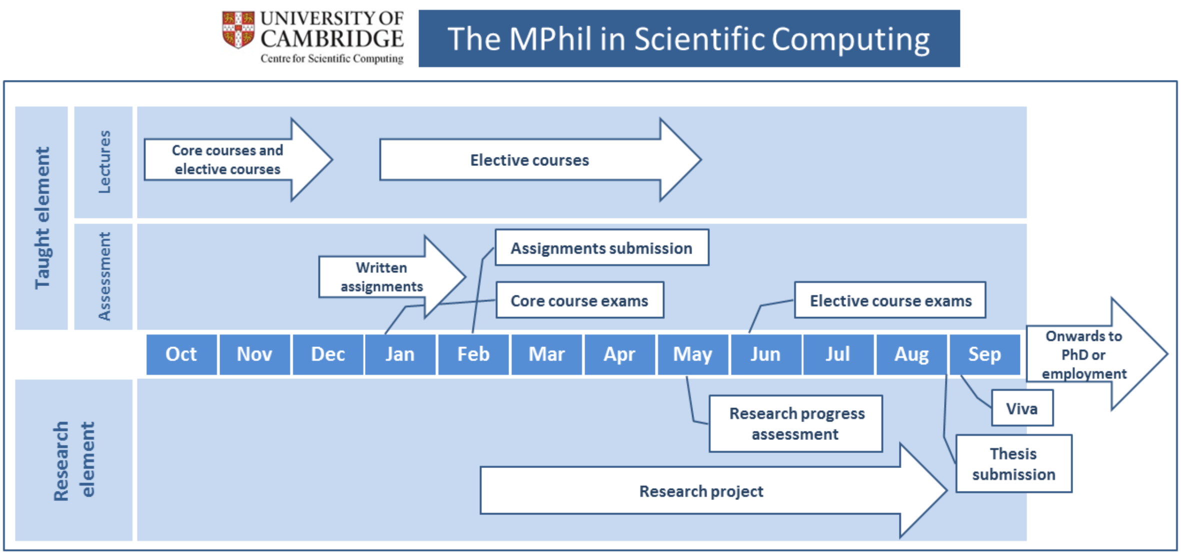
However, individual research supervisors may have their own sources of internal or industrial funding.

Course Architecture

The MPhil in Scientific Computing is a 12-month full-time Master's Degree, which has a research and a taught element. The research element is a project on a science or technology topic which is studied by means of scientific computation. The taught element comprises of core lecture courses on topics of scientific computing and elective lecture courses relevant to the science or technology topic of the project. Most of the projects are expected to make use of the University's High Performance Computing Service.

The structure of the course	
Length:	12 months
Course structure:	Core taught courses: Michaelmas Term. Elective taught courses: Michaelmas and Lent Terms. Research Project/Dissertation: Lent and Easter Terms. Entrepreneurship/Simulation in Industry seminars: Easter and Lent Terms.
Teaching methods:	Lectures, practicals, tutorials and supervision (for the dissertation).
Forms of assessment and weighting:	Core courses by written assignments (start of Lent Term), 25% credit. Elective and core courses by exam (Lent or Easter Term), 25% credit. 15,000-word (max) dissertation (submission date in August), 50% credit, examined by *viva voce* examination (September).

The students will attend lecture courses during Michaelmas Term (some courses may be during Lent Term) and then they will undertake a substantial Research Project over the following 6 months (from March to the end of August) in a participating Department. The research element aims to provide essential skills for continuation to a PhD programme or employment, as well as to assess and enhance the research capacity of the students. It is based on a science or technology topic which is studied by means of scientific computation. Research project topics will be provided by academic supervisors or by the industrial partners who are working with the participating Departments and may be sponsoring the research project. A timeline of the year is shown below:



There is equal examination credit weighting between the taught and the research elements of the course, which is gained by submitting a dissertation on the project and by written assignments & examinations on the core and elective courses. Weighting of the assessed course components is as follows: Dissertation (research) 50%; written assignments 25%; written examinations 25%.

Taught Element

The taught element comprises core lecture courses on topics of all aspects of scientific computing, and elective lecture courses relevant to the topic of the research project.

The student submits his/her choice of core and elective courses to the course administrator in writing (using the relevant form), by 12:00 noon on the Wednesday of the first week of Michaelmas Term, for approval by the academic committee. Amendment of the list at a later date is allowed, as long as it meets the course requirements, but any changes have to be sanctioned by the supervisor and the academic committee.

The structure of the taught element is summarised in the following table.

Taught Element Lecture Courses		
Core courses	High Performance Computing	Computational hardware, software design, scientific programming in C++, MPI, OpenMP, scientific programming for GPGPUs.
	Numerical Analysis	Fundamentals, linear and nonlinear systems, interpolation, numerical differentiation and integration, numerical solution of ordinary and partial differential equations.
	Computational methods and techniques	Finite difference, element and volume schemes, Monte Carlo and molecular dynamics, density functional theory methods, model fitting and data analysis.
	Continuum methods based on PDEs	Advanced methods for the solution of elliptic, parabolic and hyperbolic PDEs, mesh generation and mesh adaptation for computational material and fluid dynamics.
	Atomistic modelling	Molecular modelling, Monte Carlo and molecular dynamics, electronic structure.
Elective courses	Courses related to the science or technology application	Selected from the lecture lists of Master's level courses from the Schools of Physical and Biological Sciences & Technology.

A list of the core lectures is given in Appendix A: List of core courses.

Core lectures

The core lectures are on topics of high performance scientific computing numerical analysis and advanced numerical methods and techniques. They are organized by the Centre for Scientific Computing and are taught and examined during the first five months (October-February). Their purpose is to provide the students with essential background knowledge for completing their dissertation and for their general education in scientific computing.

In particular, their objective is to introduce students to the simulation science pipeline of problem identification, modelling, simulation and evaluation - all from the perspective of employing high-performance computing. Numerical discretisation of mathematical models will be a priority, with a specific emphasis on understanding the trade-offs (in terms of modelling time, pre-processing time, computational time, and post-processing time) that must be made when solving realistic science and engineering problems. Understanding and working with computational methods and parallel computing will be a high priority. To help the students understand the material, the lecturers will furnish the courses with practical coursework assignments.

The lectures on topics of numerical analysis and HPC are complemented with hands-on practicals using Linux-based laptops provided by the course (students may bring their own), as well as on the University's High Performance Computing Service.

Elective lecture courses

Appropriate elective lecture courses are selected from Master's-level courses offered by the Departments of the School of Physical Sciences, Technology or Biological Sciences. The choice of courses will be such as to provide the students with essential background knowledge for completing their theses and for their general education in the materials science application of the project. They are decided in consultation with the project supervisor. While every effort is made within the Departments to arrange the timetable in a coherent fashion, it is inevitable that some combinations of courses will be ruled out by their schedule, particularly if the choices span more than one department. A list of links to the participating Master's-level courses is given in *Appendix B: Elective Courses.*

Assessment

The taught element is examined by means of two written assignments amounting to 6 credit units and unseen written examination papers also amounting to 6 credit units, i.e. the students must accumulate a total of 12 units for examination credit (24 hrs course = 4 units, 16 hrs course = 2.5 units, 12 hrs course = 2 units, 6 hrs course = 1 unit).

The unseen written examination papers

Students will be expected to take the majority (if not all) of the examination credit units from unseen written examination papers offered by the MPhil in Scientific Computing. These currently are:

Paper 1: Fundamentals, Interpolation and Nonlinear Systems (12hrs, 2units).
Paper 2: Linear systems (12hrs, 2units).
Paper 3: Ordinary Differential Equations, Numerical Integration (12hrs, 2units).
Paper 4: Partial Differential Equations and Numerical Differentiation (12hrs, 2units).
Paper 5: Electronic Structure (24hrs, 4units).
Paper 6: Monte Carlo Methods and Molecular Dynamics (12hrs, 2units).

Students may take written examination papers from other Master's level courses in the University, but this has to be approved by the Course Director and sanctioned by the Course Academic Committee. The form and timing of those papers will be dictated by the structure of the corresponding Master's programme.

The written assignments

The written assignments will be directly relevant to the student's dissertation and will have to be submitted by the end of February. The objective of the assignments is to provide the student with suitable background training on the underlying numerical methods and techniques which are necessary to complete the research project. The lecturers of the core courses or the research project supervisors, will offer a choice of assignments (with detailed instructions of what is expected) on the lectured topic. The students may propose an assignment theme of their own choice (which may be better suited to their research project), which has to be of similar standard to the assignments proposed by the lecturer (who may suggest modifications to this end).

Students have to write the assignments in the LaTeX typesetting language using a research journal templates (will be provided by the course organisers), so as to resemble an article submitted for publication. This is part of their training for communicating their research in the scientific literature and in conference proceedings.

Each candidate is required to submit one soft-bound copy of the written assignment, together with one completed cover sheet**,** and one electronic copy.

The **submission deadline** for the **two written assignments** is **12:00 noon on Monday 3rd March 2014** and any candidate who fails to meet this deadline without advance permission from the Course Directors will normally get no credit for this part of the assessment. Permission to defer submission will be granted only in exceptional cases, and candidates are asked to note in particular that computer-related problems will not normally be considered as grounds for deferral. Any application to defer submission must be made in writing to the Course Directors in advance of the deadline and must be accompanied by a supporting letter from the candidate's College Tutor.

The written assignments are marked by suitable assessors, who could be the lecturers of the course or the research supervisors, but the marks are subject to moderation by the Examiners of the course. The assessors' reports will be released to candidates. The written assignments will be made available to the research project dissertation examiners.

In response to growing concerns over plagiarism in all University courses, each piece of submitted work must be accompanied by a standard cover sheet, including a signed declaration to the effect that the work is the student's own unaided effort and meets the University's guidelines and regulations on plagiarism which are outlined in *Appendix C: Regulations on plagiarism*.

The Research Project

The topic of the project (and hence the choice of supervisor) should fall within the research interests of the groups within the Departments of the Schools of Physical Sciences, Technology and Biological Sciences. The project is supervised by a member of the research groups of the Departments of the School. To this end, the course Director will advise prospective students and liaise with the corresponding Departments at the application stage.

To gain examination credit for the research element (50% credit towards the degree), students have to submit by the end of August a 15,000-word (maximum) dissertation on a substantial project of original research. The *viva voce* examination of the dissertation will take place during September, conducted by two examiners (an external examiner from another institution and an internal examiner, who cannot be the student's supervisor or anyone closely associated with the supervision process) and carried out according to the relevant University regulations. The assessment of the projects is based on the candidate's understanding of the background literature, the commitment of the candidate to the project, the degree of originality shown in the research and the degree of rigour applied in justifying any conclusions.

In the interim period between submitting their dissertations and the *viva voce* examination, the students have to prepare a poster as if they were to present their research to a conference. The students have to give a 10 minute presentation of their poster at the start of their viva.

Students are expected to contact their supervisors on the Monday of the first week of Michaelmas Term, or soon as possible thereafter. During the first contact, the student will receive detailed information about the background of the project, the anticipated preparation procedure and schedule of the project and future meetings with the supervisor. At the same time the supervisor will recommend suitable core and elective courses.

Research Project Guidelines

The research project title

Once a research project is selected, the respective title will be registered with the Course Academic Committee as a ‘provisional working title’ for the student’s project. The provisional title can be changed to a ‘final title’ during the course of the project. At any time of the duration of the project, it is the students’ responsibility to inform the Course Director and the Course Administrator of changes in the title and subject of their project, in the form of a written statement, signed by their supervisor. Any unchanged provisional title will automatically receive the status ‘final title’.

Conduct of the research project

It is very important that the whole project is planned carefully and sufficient time allowed for each step of the research process, including writing up. During the course of their work, students may be expected to see their supervisors regularly (the frequency of the meetings depends partly on the nature of the dissertation selected) to receive feedback and advice on the design and implementation of their research projects and to receive critical comments on draft chapters of their dissertation.

It is the responsibility of students to make and maintain contact with their supervisors, to attend supervisions when requested to do so, and to keep demands on their supervisors reasonable. Supervisors cannot be expected to do the students’ work for them, or to respond instantly to requests for comments and advice. In particular students should agree dates for the completion of near final drafts so that time can be set aside in advance for reading and commenting on these.

It is the responsibility of supervisors to monitor their student’s work and ensure that it is progressing satisfactorily, to respond promptly to student’s requests for meetings, and to turn work around in a timely manner. A good relationship between students and supervisor is crucial to the success of the MPhil course and supervisors are asked to contact the Director of the course as a matter of urgency if they experience any problems in this respect.

Format of the research project dissertation

The dissertation should be of **not more than 15000 words** in length. It should be printed legibly on A4 paper, using one side of the paper only, in 12-point type, one and a half or double spaced and with margins of at least 2 cm. The dissertation title page should bear, at the top of the page, the author’s name, the approved title of the dissertation and the degree for which it is submitted. The supervisor’s name should appear at the bottom right hand corner of the page. All submitted copies must be at least soft bound. Candidates should take particular care to ensure that the correct version of the text appears in each copy of a dissertation submitted, that the title corresponds to that approved by the Degree Committee, and that an identical copy is retained for reference. A dissertation must be a connected account of an MPhil student’s work, written by himself/herself.

The dissertation should contain a literature survey which may be partly based on the written assignments, but it is expected that the majority of the dissertation will deal with the research actually performed during the research period. The form in which the dissertation is presented and the care with which it has been prepared and illustrated are in themselves evidence of the candidate’s capabilities and will receive consideration as such. Apart from quotations (where appropriate) and recognised technical formulae, dissertations must be written in English and candidates are expected to show a reasonable command of the English language, to use a spellcheck facility, and to check their work carefully before submission. In submitting a dissertation, each candidate must state, generally in a preface and specifically in notes or in a bibliography, the sources from which his or her information is derived, the extent to which the candidate has availed himself or herself of the work of others, and the portions of the dissertation which the student claims as his or her own original work. **The following declaration of originality should appear on the page following the title page:**

“This dissertation is substantially my own work and conforms to the University of Cambridge’s guidelines on plagiarism. Where reference has been made to other research this is acknowledged in the text and bibliography.”

In response to growing concerns over plagiarism in all University courses, each piece of submitted work must be accompanied by a standard cover sheet, including a signed declaration to the effect that the work is the student’s own unaided effort and meets the University’s guidelines and regulations on plagiarism which are outlined in *Appendix C: Regulations on plagiarism*.

Submission of the research project dissertation

The **submission deadline for dissertations is 12:00 noon on Thursday 28th August 2014** and any candidate who fails to meet this deadline without advance permission from the Course Directors will normally be awarded no marks for the research project and will fail the entire MPhil degree. Permission to defer submission will be granted only in exceptional cases, and candidates are asked to note in particular that computer-related problems will not normally be considered as grounds for deferral. Any application to defer submission must be made in writing to the Course Director in advance of the deadline and must be accompanied by supporting letters from the candidate’s College Tutor and Supervisor. Except in the case of genuinely unforeseeable emergencies, applications to defer submission will only be considered if they are received at least one week before the deadline.

Each candidate is required to submit three soft-bound copies of the dissertation, together with a completed **Certificate of Dissertation Submission**, and one electronic version.

Marking and feedback of the research project dissertation

All dissertations are marked independently by two project examiners, and assessed by *viva voce* examination between the student and both examiners. The examination will take place in September (exact date to be arranged). In the case of a significant difference of opinion between the two examiners, or in the case of a borderline mark (*i.e.* pass/fail) the examiners will usually ask for a third independent report. The mark given for a dissertation is then determined by the examiners on the basis of all the marks received and, where appropriate, of their own readings of the dissertation. The dissertation reports will be released to candidates in due time.

The primary purpose of the *viva voce* examination is to assess the student’s depth of understanding of the subject area and interpretation of the results obtained. If a student is unable to explain the concepts or thinking underlying the text of the dissertation, the mark awarded for the research project is likely to be substantially reduced.

Criteria for the Marking of Dissertations and Viva Voce Examinations

In their dissertation and viva, the student should demonstrate the following:

1. An awareness of the basic background science underlying their project work and an awareness and critical understanding of the literature which is relevant to their project work, particularly where that literature may impact on their analysis of data or their conclusions.
2. An understanding of the computational techniques they have employed, including the limitations of those techniques and how these limitations might impact on their understanding or analysis of their data.

3. An ability to accurately describe and interpret computational results.
4. An awareness of errors and ambiguities arising in computational techniques, and, where appropriate, an ability to quantify those errors.
5. An ability to draw convincing conclusions based on the evidence presented.
6. An ability to present their findings appropriately. This should include:
a. Providing a clear outline of the research problem and/or the goals of the research undertaken.
b. Writing a well-structured, concise dissertation of appropriate length.
c. Choosing appropriate illustrations and presenting them clearly with suitable annotations and legends.
d. Selecting references carefully, and presenting them in a consistent and appropriate form.

Additionally, the examiner is asked to assess to what extent the project work makes a fair contribution to the subject, and if it contains elements of originality. To pass the research project component of the MPhil course, the student should broadly meet criteria 1 - 6 described above. To achieve a "Distinction" the student should fully meet all criteria. Additionally, to achieve a "Distinction", the research presented should represent a genuine and useful original contribution to the field of study, and the dissertation as a whole should approach the quality expected of reports in reputable scientific journals.

Notes for the *Viva Voce* Examinations

Viva voce **examinations normally take place in the first two weeks of September, on dates arranged by the Course Administrator on the basis of the availability of external and internal examiners. The examination lasts for about 1.5 hour, during which the student and two examiners discuss the project work in a closed session (no one else is admitted).**

The purpose of a viva voce examination is to:

- check that the dissertation is the candidate's own work.
- confirm that the candidate understands what he or she has written.
- investigate the candidate's awareness of where his or her original work sits in relation to the wider research field.
- provide the candidate with an opportunity to justify their arguments and conclusions.
- establish whether the dissertation is of sufficiently high standard to merit the award of the MPhil degree.

All *viva voce* examinations are different. The examiners will have read your dissertation in detail, and can choose to ask you about any aspect of your written work, or the background science theory which relates directly to your dissertation. (We would not expect questions to be asked about background science or theory which is unrelated to the dissertation). However, various types of questions are quite common:

- At the beginning of the viva, you may be asked to summarise your dissertation, or describe the main achievements of your project work.
- You will probably be asked some questions about the background science theory in your introduction. These questions may require depth or breadth of thinking about these topics, rather than a simple factual response.
- You will probably be asked some questions about the methods or techniques you have used. The examiners may want to check that you have understood the technique properly, as a way of confirming that you actually did the work described in the dissertation yourself. They may also want to check that you have understood any limitations of the techniques you have used, and any sources of error.
- You may also be asked questions about any quantitative analysis you have done. The examiners may want to check that you have understood the quantification procedure, rather than, for example, just pressing buttons on some software, with no understanding of what the software does to your data.

- The examiners may ask you to justify elements of your discussion and conclusion, or to look at your data from an alternative viewpoint, and consider whether this alternative viewpoint impacts on the validity of your conclusions.

The examiners won't expect you to have an instant answer to every question they ask. It is fine to take some time to think about the question, or to ask for clarification. If you really have no idea how to answer a question, then you can tell the examiners this. They will usually be willing to give you some hints to help you think about their question. Occasionally, the examiners may even misunderstand an element of your dissertation, and if you think this has happened, so that the questions you are being asked appear to be addressing topics which are not relevant to your dissertation, you may wish to politely ask the examiners to explain the relevance of their questions.

The examiners are trying to give you an opportunity to demonstrate your knowledge, not to catch you out. If you have worked hard on your project and written it up carefully, the viva should be an enjoyable experience, since it gives you the opportunity to talk in detail about the work you have done, and perhaps discuss some new ideas arising from that work.

Progress monitoring

The progress of the students is continuously monitored during the practical sessions (Michaelmas Term) and by means of the reports of the course supervisors (part of the Cambridge supervision system). Their performance on the two written assignments offers another opportunity for assessment, approximately half way through the course calendar (February).

Mid-term progress review

Although project supervisors continuously monitor the students during the 6 months of the research project, students are expected to hand in a first draft of their dissertation approximately half-way through the project period (**third week of May**).

The draft should have a skeleton of the dissertation (in terms of chapters), an almost complete literature review and some preliminary results. The drafts are made available to an assessment committee (composed by the Course Director and project supervisors) ahead of **two days (in 4th week of May) of 15-minute presentations (including questions)** by the students to the committee. Members of the committee assess progress of the projects by means of a two-page *pro forma*. Feedback is given to the students during appraisal sessions by the Course Director or the research project supervisor. This process ensures that the students are on track to submit their dissertations and also helps to ensure that the projects are of consistently high research quality.

Guidelines for the interim progress assessment

The purpose of the interim research project assessment is to provide each student with the opportunity to deliver an interim written and oral report on the work in progress towards their Master’s Dissertation. In many cases the work will not yet be complete and so the exercise should generate a useful review of what has been achieved so far, and any general discussion which is stimulated may help to provide a useful steer for the final writing up of the thesis. For this reason it will be understood if conclusions are loosely drawn at this stage.

The main aims of the dissertation presentation are:

- To communicate effectively on a chosen research topic
- To demonstrate the ability to defend a presentation in public
- To provide evidence of satisfactory progress with the Master’s Dissertation

Submission deadline of the interim progress review

The **submission deadline** for the progress report is **12:00 noon on Monday 12th May 2014**). Two versions of each report should be submitted: one printed and one electronic.

Structure of the mid-term progress presentation

On the presentation day, students will be required to provide an oral presentation of their research work to date**, not exceeding 10 minutes**. This time will be strictly adhered to, and students exceeding 10 minutes will be asked to stop. Afterwards, **5 minutes** will be used for questions and a general discussion of the work with the audience. The final programme for the day will be generated shortly before the day and made available online at the course website.

Data projection facilities will be available, together with an overhead projector. Special requirements will have to be communicated to the Course Administrator at least one week before the presentation day.

If using PowerPoint presentations, students can either use their own lap-top, provided they make sure that the presentation can be started on time, or load their file onto a laptop provided by the course at least two days in advance of the presentation.

Assessment of the presentation

The dissertation presentation represents a mandatory contribution to the overall dissertation requirements. Characteristics of a good presentation are:

- Clarity of delivery (organisation of material, engagement with audience, effective use of visual aids)
- Technical depth (relevance of material, critical awareness and grasp of the problem, nature of conclusions)
- Response to questions (factual probity, depth of reply, understanding of issues).

Important Dates[1]

Although most lecture courses take place during the University term dates (see table below), written assignment and project-related work is carried out outside these dates. Students are required to be resident in Cambridge (unless working on a designated project placement) for the duration of the course, and are expected to participate in all mandatory course activities outside the periods of Cambridge Terms. Although most of the important course dates are given below, you are advised to consult the online course timetable, available at http://www.csc.cam.ac.uk/academic/mphil , for an up-to-date schedule.

All lectures, events, deadlines etc are listed on the course Google calendar:

http://www.google.com/calendar/embed?src=cam.ac.uk_nj957gb9dc88gudb08kcdiag1c%40group.calendar.google.com&ctz=Europe/London

Event Timetable	
Contact research supervisors:	7 October (Monday before full Michaelmas Term)
Induction Programme:	3 October 2013 (day during first week of Michaelmas)
Numerical Analysis Mock exams	9-12 December 2013 (week after end of lectures)
Numerical Analysis exams	13-22 January 2014 (third week of January)
Electronic Structure exam	27 January 2014 (third week of January)
MC & MD exam	29 January 2014 (third week of January)
Progress review:	20 and 21 May 2014 (fourth week of May)
Viva voce examination:	First or second week of September
Examiners meeting:	Third week of September

Submission deadlines	
	12:00 noon on:
List of taught courses:	8 October 2013 (Tuesday of first week of Michaelmas)
Written assignments:	3 March 2014 (Monday of first week of March)
Project progress report:	12 May 2014 (second Monday of May)
Dissertation:	28 August 2014 (Thursday of the last week of August)

University Terms		
	from	to
Michaelmas	Tuesday 8 October 2013	Friday 6 December 2013
Lent	Tuesday 14 January 2014	Friday 14 March 2014
Easter	Tuesday 22 April 2014	Friday 13 June 2014

[1] Note that the information contained in this Handbook is correct at the time of going to the press but may change during the year. You are advised to check the course website and Google calendar for up-to-date information and for the latest version of this Handbook.

Examination Regulations

The Board of Examiners consists of the Academic Committee and the Course External Examiner. The Examiners will appoint assessors to help with the assessment of the written assignments and dissertations.

Published Examination Notice

Examination in Scientific Computing for the MPhil Degree, 2013-14

The scheme of examination for the one-year course of study in Scientific Computing for the degree of Master of Philosophy shall be as follows:

1. The Degree Committee for the Faculty of Physics and Chemistry shall publish, not later than the division of Michaelmas Term preceding the examinations, a list of modules in 'Scientific Computing'. The list will include core courses in scientific computing and elective courses from Master's-level courses offered by the Departments of the Schools of the Physical Sciences, Technology and Biological Sciences. In publishing the list of modules, the Degree Committee shall announce the form of examination for each module.

2. The examination shall consist of:
(*a*) a thesis of not more than 15,000 words in length (including tables, figure legends, and appendices, but excluding bibliography) on a major project, involving in-depth original scientific research and a literature survey of the topic. The topic of the project shall be approved by the Degree Committee;
(*b*) two written assignments. The topic of the assignments shall be approved by the Degree Committee;
(*c*) written examination papers. The form of the examination of these papers shall be dictated by the regulations of the donor Department.

3. The examination shall include an oral examination of the thesis or other work submitted by the candidate under Regulation 2(*b*), and on the general field of knowledge within which they fall.

The form of examination of each module is shown below:

Module name	Mode of Assessment
Core courses in Scientific Computing	C (written assignments), E
Elective courses in science or technology	E
Project	C (dissertation + viva)

C = coursework assignment (as specified)
E = unseen written examination

Weighting of the Assessed Course Components

<table>
<tr><th>Course Element</th><th>Weight</th><th>Pass Mark
(% overall mark)</th></tr>
<tr><td>Dissertation:</td><td>50</td><td>60</td></tr>
<tr><td>Written assignments on the core courses:</td><td>25</td><td rowspan="2">60</td></tr>
<tr><td>Written examinations on the elective courses:</td><td>25</td></tr>
<tr><td>Total:</td><td>100</td><td>60</td></tr>
</table>

Marking of the Course Components

Lecture courses and Research Project	
Distinction	≥ 75%
pass	60% - 74%
Marginal fail	55%-59%
fail	≤ 54 %

Marking Guidelines

The following are marking guidelines, which are designed primarily for the marking of the dissertation but may be adapted for coursework and examinations. Where marks are awarded using a different scale they will be adjusted by the Examiners at their final meeting to achieve comparability with the scale below.

The MPhil in Scientific Computing has an overall pass mark of 60% overall marks, achieved in the Lecture-course component and the Project component, and no one component can be missed or failed completely.

Additional requirement: The minimum achievement in the each element is **55%** (*i.e.* **marginal fail**), and in the case of marginal fail of the taught elements, the candidate would subsequently need to obtain a **distinction** mark for the project component (and vice versa), in order to pass the degree course.

Marking guidelines for the dissertation and the viva voce examination

Fail: Work that is not of the standard that might be expected of an MPhil dissertation, either because of lack of original content or because it shows a poor grasp of the relevant literature or research method adopted, because the analysis is seriously flawed, because the argument is incoherent or because the standard of writing or presentation is unacceptably poor.
Marginal fail: Work that, while below the standard that might be expected of an MPhil dissertation shows some evidence of independent thought and research, and a good basic command of the subject.
Pass: Work that shows evidence of independent thought and research, is of genuine interest as a contribution to its area of research, maintains a high standard of argument and scholarship throughout and provides evidence of the suitability of the candidate for Ph.D. research.
Distinction: Work of undoubted interest and originality, which combines the qualities noted above to an impressive degree and provides clear evidence of the suitability of the candidate for Ph.D. research. Work at the upper end of the range will be able to stand comparison against leading scholars in the field.

Overall Marking

Module Grades	Project Grades	Final Grade
Distinction	Distinction	Distinction
Distinction	Pass	Pass
Distinction	Marginal fail	Pass
Pass	Distinction	Pass
Pass	Pass	Pass
Pass	Marginal fail	Fail
Marginal fail	Distinction	Pass
Marginal fail	Pass	Fail
Marginal fail	Marginal fail	Fail
Any outcome	Fail	Fail
Fail	Any outcome	Fail

Examination results

The examiners for the MPhil in Scientific Computing meet in the third week of September. The course overall external examiner is re-appointed every few years and is an expert in the field of scientific computing. They will review the coursework and the exam scripts, in order to moderate the marks awarded to ensure consistency between the different marking styles across this multi-disciplinary course.

All students must be available in the Department on the day of the examiners visit. It may be necessary to call the student for a short *viva voce* exam to confirm the mark that will be awarded to the student.

At the end of the meeting with the external examiner, a provisional list of marks is reached. These recommendations will then be considered by the Degree Committee of the Faculty of Physics and Chemistry and by the Board of Graduate Studies. Once confirmed by the Degree Committee, the marks will be entered onto the online CamSIS system and will be used to produce the official Transcripts at the end of the course.

The whole procedure can take some time so it is likely that the final outcome of the examination process will not be formally confirmed before the end of September and the detailed marks will not appear in CamSIS before the end of October.

Candidates should note that arrangements for the receipt of degrees are the responsibility of the Colleges, and that only candidates whose Colleges are able to present them may graduate at any particular congregation. The College will require proof that you are to be awarded the Degree of MPhil. This proof will be in the form of a letter from BGS to your College confirming the MPhil.

Student Feedback Procedures

The MPhil Academic Committee values and very strongly encourages feedback from students on the performance of its academic and administrative staff and other aspects of the MPhil programme. Unless they get feedback in a standardised form and from a statistically significant sample of the class the staff cannot determine how the quality of their provision is changing from year to year and from module to module and are severely hampered both in addressing problem areas and in meeting their objective of continuing quality improvement. The Course Administrator will contact the students with a University-approved polling system.

In addition to the formal mechanisms, informal feedback is welcome at any time and through any route (through student representatives, directly to the Coordinator of the course or to other staff members). Any serious or potentially serious problems should be communicated as quickly as possible so that action can be taken to correct them.

Course Liaison Committee

A course liaison committee will be established before the end of the academic year, allowing sufficient time for the student group to get to know each other and elect two student representatives. The committee will consist of the following:

- The Course Director and Deputy Director
- The Academic Administrator of the Department of Physics
- Two student representatives (substitutes may attend in place of a course representative by prior agreement of the student group)
- The Course Administrators

- A representative from the previous cohort.

Appendix A: List of core courses

Conventions: M=Michaelmas Term, L=Lent Term, E=Easter Term. The number shown in the brackets refer to the number of hours of the course.

The timetable for the lectures can be found in the course Google calendar:
http://www.google.com/calendar/embed?src=cam.ac.uk_nj957gb9dc88gudb08kcdiag1c%40group.calendar.google.com&ctz=Europe/London

Fundamentals, Non-linear Systems and Interpolation [M12]

Dr Anita Briginshaw

The aims of this course are to provide introductions to floating-point arithmetic and numerical techniques. The principles of good numerical methods will be illustrated by examples, but it will be shown that the design of a numerical algorithm is not necessarily straightforward, even for simple problems - that the solution has to fit the problem. At the end of the course students should be able to apply numerical techniques with an understanding of their underlying principles. The contents are:

Fundamentals

- Floating point arithmetic
- Overflow and underflow
- Floating point arithmetic
- Absolute, relative error and machine epsilon
- Forward and backward error analysis
- Loss of significance
- Robustness
- Convergence, error testing and order of convergence
- Condition
- Computational complexity

Non-linear Systems

- Bisection, rule of false position, secant method
- Newton-Raphson method
- Broyden's method
- Householder methods
- Muller's method and inverse quadratic interpolation
- Fixed-point iteration theory
- Mixed methods

Interpolation

- Polynomial interpolation
- Lagrange formula
- Divided Differences and Newton's formula
- Polynomial Best Approximations
- Orthogonal (Chebychev) polynomials and their recurrence relations
- Least-squares Polynomial Fitting

- Peano Kernel Theorem

Numerical Integration and ODEs [M12]

Dr Anita Briginshaw

The course introduces numerical methods for ordinary differential equations. At the end of the course students should be adept at choosing methods appropriate for a specific application, and they should understand the problem of stiffness and its associated difficulties. The contents include:

Numerical Integration

- Mid-point rule, Trapezium rule and Simpsons rule
- Newton-Cotes formulae
- Gauss rule/ Gaussian quadrature
- Peano kernel theorem
- Composite rules and order of convergence
- Lobatto / Radau rule
- Higher dimensions and the dimensional effect

ODEs

- One-step methods : Euler, backward Euler, Trapezoidal rule, etc
- Order and Convergence
- Stiffness and A-stability
- Adams methods
- Backward differentiation formulae
- Rational methods
- Runge-Kutta methods
- Milne device with predictor and corrector
- Zadunaisky device for error estimation

Numerical Differentiation and PDEs [M12]

Dr Anita Briginshaw

The course introduces numerical methods for numerical differentiation and their application to partial differential equations. At the end of the course students should be adept at choosing methods appropriate for a specific application and constructing their own methods, they should understand the various notions of stability. The contents are:

Numerical Differentiation

- Floating point arithmetic
- Finite Differences
- Forward, backward and centred divided differences

PDEs

- Classification of PDEs
- Parabolic PDEs
- Boundary Problems and the Eigenvalue Analysis of Stability
- Cauchy problems and the Fourier Analysis of Stability
- Spectral methods

- Elliptic PDEs
- Computational Stencils and the associated algebraic systems
- Hockney Algorithm
- Multigrid methods
- Splitting
- Hyperbolic PDEs
- Advection and wave equation

Linear Systems [M12]

Dr Anita Briginshaw

Linear systems form an integral part of numerical methods, since continuous problems have to be linearised to be handled by a computer. At the end of the course students should be able to apply numerical techniques to solve linear systems with an understanding of their advantages and disadvantages. The contents are:

Linear systems

- Triangular systems and back substitution
- Gaussian elimination with pivotal strategies and its equivalence to a LU factorisation
- Choleski factorisation
- QR factorization
- Gram-Schmidt algorithm
- Givens rotations
- Householder reflections
- Over-determined systems and linear least squares and singular value decomposition
- Iterative methods and splitting
- Jacobi and Gauss-Seidel methods
- Spectral radius and relaxation
- Steepest Descent Method
- Conjugate gradient
- Krylow subspaces and pre-conditioning
- Eigenvalues and eigenvectors
- Power Method
- Inverse Iteration

Numerical solution of partial differential equations part 1 [M8]

Dr Nikolaos Nikiforakis (additional seminars by Dr Jennifer Ryan)

The objective of this course is to introduce students to numerical methods for partial differential equations, especially those of physical importance. It will be shown that many obvious methods are unsuccessful, and that the majority of the successful methods are guided by the physics and mathematics of the problem at hand. Simple model problems representing several major classifications are studied for the sake of the general messages that they convey. Relevant numerical techniques are discussed. In detail, the course will cover the following topics:

1. Classification of partial differential equations and physical behaviour and approximation levels. Scalar hyperbolic equations and the Riemann problem.
2. Discrete representation of continuous functions and operators. Finite difference methods for parabolic problems.
3. Difference schemes for scalar hyperbolic equations (first-order upwind, Lax-Wendroff, Lax-Friedrichs and Warming & Beam) and the modified equation.

4. The integral form of the equations and conservative, finite volume methods. Use of the Riemann problem for solving scalar linear and nonlinear conservation laws.
5. Monotonicity, total variation and Godunov's theorem. High-resolution methods, TVD schemes and second-order Riemann problem based methods for scalar conservation laws.
6. Extension to higher space dimensions and dealing with inhomogeneous laws.

Numerical solution of partial differential equations part 2 [M8]

Dr Nikolaos Nikiforakis (additional seminars by Dr Jennifer Ryan)

The second part of the course considers in detail nonlinear, multi-dimensional, inhomogeneous systems of partial differential equations and their numerical solution using contemporary numerical schemes. The aim is to cover systems which are employed by major science and technology disciplines (general fluid dynamics, combustion, earth system science, semiconductors, aerospace etc), so that students are well-equipped for research on the topic of their choice.

1. Nonlinear systems of partial differential equations; the Navier-Stokes equations and reduced systems.
2. Exact and approximate solutions of the Riemann problem for the compressible unsteady Euler equations and their use in Godunov-type methods.
3. Higher-order methods for the Euler equations. MUSCL reconstructions.
4. Other nonlinear hyperbolic systems and systems of mixed character; the pressure correction method.
5. Approaches for higher dimensions and non-Cartesian geometries.
6. Multi-component and inhomogeneous systems of equations.

Mesh generation and mesh adaptation for PDEs [M6]

t.b.c.

The course will offer a top-level overview of traditional and contemporary mesh generation and mesh adaptation techniques suitable for the solution of all types of partial differential equations. The course will cover issues of mesh quality, ease of generation and computational efficiency (in particular in the case of mesh adaptation).

1. Fundamentals of space discretisation (grid types and underlying considerations).
2. Structured grids part 1 (single block, algebraic mappings and differential equation mesh generation methods).
3. Structured grids part 2 (multi-block, and overlapping approaches).
4. Unstructured and embedded (Cartesian, cut cell) approaches.
5. Mesh adaptation and mesh movement.
6. Hierarchical Adaptive Mesh Refinement.

Foundation Course in QM and solid state physics [M10]

Professor Emilio Artacho

A brief self-contained pedestrian guide to QM starting from scratch, Bloch theorem and Bloch functions. This is very basic, adequate for people with a background not quite in physics or chemistry (materials, engineering, bio, geo etc). The course will include a practical exercise (mini-project): students with coding skills, will do a simple programme from scratch and plot simple tight-binding band structures of selected simple 3D solids. Students without coding skills, a couple of simple 1D (2x2) models can be used instead.

Quantum mechanics and basic approximations

1. Wave-function Ψ({**r**i,σi},t) and meaning. Particle density. Norm, scalar product, orthogonality. Operators and observables. Eigenfunctions and eigenvalues. Momentum, position and angular momentum operators. *Practical:* Short exercises and easy proofs during the session.
2. The Hamiltonian operator. Schroedinger's equation: time dependent and time independent. Quantisation vs confinement. Free particle. *Practical:* Particle in a box.
3. Probabilistic meaning and statistical characterisations: Expectation values, and matrix elements. Harmonic oscillator. 1D and 3D. Variational principle. *Practical:* Variational approach to harmonic oscillator. Degeneracies in 3D harmonic oscillator.
4. Hilbert space, Dirac's vector space and notation: Basis sets and matrix representation. Diagonalisation. Atomic orbitals. *Practical:* H2+ and chemical bond.
5. Translational invariance: Bloch theorem. Bloch functions. Bands. *Practical:* 1D tight-binding.
6. 3D Bravais lattices. Brillouin zones. Periodic boundary conditions. *Practical:* Miniproject: Tight-binding bands of selected 3D solids.

Electronic Structure (Theory of Condensed Matter) [M14]

Professor Emilio Artacho

Main purpose: Fundamentals and main approximations of DFT-based electronic structure; students should leave the course knowing:
1. how to run DFT calculations from a pre-existing programme;
2. how to converge the results with respect to technical parameters;
3. the capabilities and limitations of the methods, addressing the different approximations separately.

Practicals will be based on SIESTA (basis set as well), or/and CASTEP.

Lectures:
1. Many particle problem. Born Oppenheimer, Independent particles; *Practical:* Time for Mini-project coming from foundation course (see below). For students not doing the foundation course, exercise: 1D tight-binding ionic chain.
2. Indistinguishable particles, Spin, Pauli, Aufbau; *Practical:* Continue as in 1.
3. Hartree, SCF, double counting, Hartree-Fock, exchange, correlation; *Practical:* Band structure of diamond. Visualise: tools and graphics.
4. Correlation: CI & QC direction. Complexity exponential wall (Kohn RMP & Phys Today). *Practical:* Siesta: k-point sampling; Converging & DOS: Diamond, Al.
5. DFT: Intro; definition of density; local potential; Hohenberg-Kohn and Levy construction (Jones-Gunnarson). *Practical:* Siesta E(V) Diamond and Al. P(V). Murnaghan.
6. Kohn-Sham. LDA, Ceperly Alder; GGAs. Bands. Band-gap problem. *Practical:* Siesta E(V) Diamond and Al: compare LDA, PBE, WC
7. Forces, stress. -> MD & Relaxations. Hellman-Feynman. Variable cell; *Practical:* Siesta: relax H2O molecule & cell for MgSiO3 under strain (Ferro)?
8. Pseudos; atom: generate C pseudo. *Practical:* Generate Pseudo. Test it within atom and in bulk
9. Bases; generate basis and plot.*Practical:* Generate basis. Test in bulk.
10. PBC: cells & supercells. Practical calculations. Accuracies, limits (highly correlated, dispersion interactions); *Practical:* Start Mini-Project

Monte Carlo and Molecular Dynamics [M12]

Dr James Elliott

- Lecture 1: "Thermodynamics and statistical mechanics in materials modelling I"
- Lecture 2: "Thermodynamics and statistical mechanics in materials modelling II"
- Lecture 3: "Thermodynamics and statistical mechanics in materials modelling III"
- Lecture 4: "Monte Carlo method I"
- Lecture 5: "Monte Carlo method II"
- Lecture 6: "Force fields in materials modelling"
- Lecture 7: "Molecular dynamics method I"
- Lecture 8: "Molecular dynamics method II"
- Lecture 9: "Visualisation and quantitative analysis of molecular simulations"
- Lecture 10: Case study: Atomistic modelling of ionic conductors"
- Lecture 11: "Case study: molecular dynamics of solvent diffusion in polymers"
- Lecture 12: "Methods for simulating systems out of equilibrium"

Atomistic Materials Modelling [M12]

Dr P D Bristowe

This lecture course covers:

- Atomistic modelling using statistical methods
- An application of the Monte Carlo method
- Force fields for molecular systems
- Interatomic potentials for noble gas and ionic solids
- Interatomic potentials for covalent and metallic solids
- Atomistic modelling using deterministic methods
- Analysing and visualising data from atomistic simulations
- An application of the molecular dynamics method
- Atomistic modelling from first principles
- Performing first principles simulations
- An application of first principles modelling

Computational hardware [M8]

Dr Michael Rutter

The course will provide an overview of how the hardware design of a computer impacts its performance and therefore the optimal way to program it. Topics covered include:

- The CPU - An overview of how a CPU works. How numbers are stored. Pipelining and how to achieve peak performance. What a compiler does: assembler vs. higher level languages
- Memory - An overview of how DRAM works. Parity and ECC. Memory speed & bandwidth. Cache hierarchy and pre-fetching.
- Memory Management - An overview of memory management. The mapping between virtual and physical addresses. Page tables and the TLB. Paging and disk performance. Segmentation and the linux memory map.
- Parallel Computers - Amdahl's Law, MPP & SMP, NUMA, Multithreading, clusters.

Software Design [M6]

Nick Maclaren

This covers the basic principles of practical software engineering that are important for reliable and efficient scientific software. The topics will include:

1. Computer arithmetic (integer and floating-point)
2. Arithmetic exceptions, error handling and accuracy
3. Principles of program design
4. Coding style, commenting and documentation
5. Design of interfaces
6. Internal checking and diagnostics
7. Effective tuning
8. Use of external tools

Message Passing Interface [M10]

Nick Maclaren

This introduces parallel programming using distributed memory message-passing and the MPI (Message Passing Interface) standard. It covers the properties of the computing model, and the basic facilities of the MPI standard. No prior knowledge of parallel programming is assumed. The goal is to teach all of the facilities that are used in most MPI codes that are developed and used in scientific and engineering research organisations, and to be able to refer to the MPI standard on specific points or to use other facilities. The topics are likely to include:

1. Principles of message-passing
2. Basics of the MPI interface
3. Datatypes and collectives
4. Point-to-point transfers
5. Error handling
6. Communicators and process groups
7. Composite types and language standards
8. Attributes and I/O
9. Debugging, performance and tuning
10. Problem decomposition

Prerequisites: The ability to program in at least one of Fortran, C or C++, including familiarity with editing, compilation, debugging and running programs, preferably under a Unix-like system.

Literature: Parallel Programming with MPI, P. Pacheco, Morgan Kaufmann, 1997.

OpenMP [M6]

Nick Maclaren

This is an introduction to using OpenMP for writing parallel programs to run on multi-CPU (SMP) systems, for the purposes of "high-performance computing" (i.e. running programs faster than they can on a single CPU core). It covers all of the principles of OpenMP, and teach the use of all of the basic facilities, so that attendees will be able to write serious programs using it and update most of those that they get from other people. It concentrates on describing how to avoid problems, because shared memory programming and using OpenMP are less about knowing what to do than knowing what not to do. It covers Fortran, C and, to some extent, C++.

Scientific Programming with GPUs [M6]

Dr Philip Blakely

This course will introduce students to the principles of writing scientific software for the latest graphics cards, taking advantage of the highly-parallel nature of the hardware to attain significant speed-ups as compared to traditional CPUs. The course will begin by covering the hardware structure of modern GPUs, and how this relates to the software model. Students will then be introduced to the C-like CUDA programming language which has been developed by NVIDIA, and be shown how to develop efficient algorithms using this language. Students will be introduced to general strategies for optimising code. The main examples used in the course will be related to the numerical solution of PDEs.

Course structure:

1. Introduction to GPU hardware structure and CUDA programming model
2. Writing and compiling a simple CUDA code
3. Example application: 2D Euler equations
4. Optimization strategies and performance tuning
5. In-depth coverage of CUDA features
6. Combining CUDA with MPI

Scientific Programming in C++ [M12]

Dr Philip Blakely

This course will introduce students to C++ as a language widely used in scientific computing. The course will cover most aspects of C++ to an intermediate level, with the aim being to teach students sufficient C++ to program non-trivial algorithms in a robust and efficient manner. The course should be accessible to all students, irrespective of any prior programming knowledge.

Course structure:

1. Basic arithmetic, including types and overflow
2. Branching constructs
3. Loop constructs
4. Functions, pass by reference and value
5. Arrays, pointers, and heap allocation
6. Use of the pre-processor, include-files, and linking
7. Object-oriented programming: classes, inheritance, virtual functions, polymorphism
8. Function and operator overloading
9. STL containers and algorithms
10. Simple uses of templates

Appendix B: Elective Courses.

Links to the web pages of Part III & MASt courses at the University. Attending lectures or taking examination papers from these courses should be sanctioned by the project supervisor and the MPhil course director.

Part III & MASt in Theoretical and Experimental Physics
http://www.phy.cam.ac.uk/teaching/III.php

Part III and MASt (Master of Advanced Study) in Mathematics
http://www.maths.cam.ac.uk/postgrad/mathiii/

Part III & MASt in Materials Science and Metallurgy
http://www.msm.cam.ac.uk/teaching/partIII.php

Part III in Chemistry
http://www.ch.cam.ac.uk/teaching/course-guides

Part IIB in Engineering
http://www.eng.cam.ac.uk/teaching/index-iib.html

Appendix C: Regulations on plagiarism

Plagiarism is presenting the work of others as if it were one's own. If discovered by the Examiners, it will be treated as an attempt to gain credit under false pretences and may be referred to the University Court of Discipline. Plagiarism is treated by the University with the utmost seriousness, and severe penalties are imposed whenever it is detected. This may result in a candidate **failing the degree**, for which he or she is entered.

The Examiners will normally consider as plagiarism any instance in which the work/ideas of another person have been included in the submission of examinable work, whether or in paraphrase, without full acknowledgement to their author. This acknowledgement must include detailed bibliographic references (including Internet addresses where appropriate) to any sources from which information or ideas have been derived.

It is appreciated that candidates will often perform practical exercises together, and that they may wish to study in groups in order to learn from each other and to solve problems together. However, it is essential that any material finally submitted for marking is the work of the candidate or candidates making the submission, written in their own words, and presented in their own way, with proper acknowledgement of all sources from which information has been derived, and a clear indication of the extent to which use has been made of the work of others.

Each candidate who submits a project report, essay, dissertation or any other work for examination will be required to sign a declaration that the submission is his or her own work, unaided except as may be specified in the declaration, that all sources are fully acknowledged and referenced, and that the submission does not contain material that has already been used to any substantial extent for a comparable purpose. If two or more candidates submit work in collaboration, they will each be required to sign the declaration and will be held jointly responsible for adhering to it.

Any marks awarded will be conditional on the above requirements having been met. Coursework marks contribute significantly to your overall mark. Because this work is not carried under examination conditions the distinction between beneficial co-operation and deliberate cheating should be clear in everyone's mind.

The course team will be using plagiarism detection software.

Co-operation and teamwork

It is perfectly acceptable to discuss continuously assessed work with other students or supervisors. Such discussions are beneficial and we wish to encourage them. It is right that effective use of such discussions can lead to higher marks, always provided that it is the student who has made the main contribution to the work submitted and understands all of it.

Cooperation can go too far, however, especially if one student is effectively carried by another. Thus, while it may well be beneficial for students to discuss a problem, it is unacceptable for two students to submit effectively identical essays or other assignment work. The named author must have made the main contribution to the work submitted and the report must be in his or her own words.

Any attempt to pass off the work of others as being produced by the named author is cheating.

Web-based plagiarism

With the proliferation of easily accessible information on the internet there has been a steady rise in students using cut and paste techniques to import non-attributed material into their own work. Under no circumstances is this practice allowed and it is expressly forbidden. Sophisticated search engines are now available to staff to match passages suspected as having been plagiarised with the original source material. In circumstances where this confirms plagiarism from the internet the offending student will be immediately reported to the University authorities for disciplinary action.

The course team treats the issue of plagiarism very seriously. Integrity and responsibility in fulfilment of all course requirements is expected from all course participants.

Guidelines on plagiarism

In some cultures it may be seen as a form of flattery or respect to use someone else's words or ideas as part of your own material. However in many parts of the world, words and ideas are considered to be intellectual property, owned by the individual who created them, in the same way he or she might own land or a lap-top computer. In these communities it is believed that a person's intellectual property must not be used without permission. Deliberate and conscious copying is unethical and against the high standards set by scientific researchers, academic authors and professional engineers.

In constructing a written piece of work it is therefore essential that the reader is clearly informed where the source material has been derived from, and identify any ideas or forms of expression that are not your own. This means all sources must be accurately cited so that the person owning the intellectual property is given proper acknowledgement for the work they have done. These are the high standards which are strictly adhered to at Cambridge University and even if you try and express someone else's ideas in your own words this too is considered plagiarism.

Citing a source

This means including a reference in your text to show that material such as words, data, ideas, diagrams, software, *etc.* has been extracted from another source. This can be done easily by including in parenthesis the author's last name and date of publication e.g. (Smith, 2002). This reference is cross-referenced to a complete list at the end of your paper or report in the form of a Bibliography, which directs the reader to the location of the material (book, Journal, web-site page *etc.*). This information must be complete and accurately presented so the reader can find the source for himself. Not only does this approach properly acknowledge the work of others but it also allows the reader to judge how much you are relying on information from perhaps just one or two, as opposed to many, authors and how recent and up to date this information is.

In general, any specific information, which is not common knowledge, must be cited. If in any doubt whether a fact or other information is common knowledge then a source must be cited. Other people's ideas can be included in two ways: either by quoting the source directly within quotation marks, or by paraphrasing in your own words the idea. In both cases, the reference to the source material must be cited. However direct quotes should not be overused and it is best to only include them in your work if the author has made a point in a particularly insightful way. These quotations can complement, but cannot be a substitute for, your own line of reasoning.

It is possible to fall into the trap of unconscious plagiarism, usually arising from an over zealous direct use of notes when preparing written assignments and reports. It may also occur if an essay is based too closely on the highlighted passages of marked up texts or photocopies.

Including un-referenced material downloaded directly from the internet also constitutes plagiarism. Any web-based information should be respected and cited like any other more traditional source. Also there is far less quality control applied to much information which is posted on the internet and so the veracity of material obtained in this way should be treated with greater caution, doubt and uncertainty.

A piece of work, which merely cites the ideas and results of other author's endeavours, is not transformed into "original" work simply by the use of extensive referencing and footnotes. It is vital that your work adds a critical dimension to this material through your own judgement and analysis.

If in any doubt make it clear to the reader by citation and references where the original idea, material or data has come from. *If you don't, it will be considered as lying, cheating, stealing and an insult to the original author.*

More detailed advice on plagiarism is provided on the following web-sites:
http://www.admin.cam.ac.uk/offices/exams/plagiarism/students/
http://www.indiana.edu/~wts/wts/plagiarism.html
http://sja.ucdavis.edu/publications.html
look for the .pdf file "Avoiding Plagiarism: Mastering the Art of Scholarship".

Appendix D: The Department of Physics (Cavendish Laboratory)

Students of the *Master's Programme in Scientific Computing* will be based in the Department of Physics, JJ Thomson Avenue, Cambridge CB3 0HE. They will also have lectures at various Departments including Chemistry, Engineering, Mathematics and Materials Science and Metallurgy.

Lectures
Most of the lectures will take place in the Ryle Lecture Theatre, Rutherford building.

Office space for students of the MPhil in Scientific Computing
There are currently three open-plan offices at the Rutherford building, where students are allocated a desk and have access to **computing facilities.** Please consult Dr Philip Blakely for further information.

For an interactive map of the University see http://map.cam.ac.uk/