MRes in Controlled Quantum Dynamics

Handbook

Revised 07 09 2015

A guide to all aspects of the MRes course in Controlled Quantum Dynamics.
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1. **Introduction**

1.1 **ABOUT THIS HANDBOOK**

The purpose of this handbook is to provide current students and staff with a detailed description of the MRes course on Controlled Quantum Dynamics (CQD) within the Centre for Doctoral Training (CDT) on CQD, including assessment and feedback mechanisms (where appropriate). This edition of the handbook applies to the academic year 2015-16 and is available for download from the course website. Any significant changes to its content will be communicated to you as the year progresses. The MRes course usually has a relatively small number of students (in comparison to many undergraduate courses) and they have extensive access to the academic and support staff of the CDT on CQD. Students therefore should not hesitate to approach their Cohort Mentor, the Director, one of the Co-Directors or any member of staff for advice or assistance.

This handbook describes the framework of the course and its assessment but the Course Director and/or CQD Board may make changes to detailed procedures if the circumstances indicate this is desirable. Similarly, the Board of Examiners has absolute discretion to modify the criteria described in this handbook, although in practice this would only occur in exceptional circumstances. Students will be notified of any changes prior to their introduction.

1.2 **AIMS AND OBJECTIVES OF THE MRes IN CONTROLLED QUANTUM DYNAMICS**

The formal aim of the MRes in Controlled Quantum Dynamics is:

“to teach the students the core theoretical concepts and experimental methods of the controlled quantum dynamics of small numbers of quantum systems, their multi-particle coherence and entanglement properties, and of methods for their preparation, control and read-out to the level enabling doctoral study in the field or for a technical career outside academia.”

This aim is fulfilled via the following formal objectives. The MRes in CQD will:

- attract well-qualified MSci/BSc level students and provide an intellectually challenging multi-disciplinary degree programme, equipping the students with the technical knowledge and skills necessary for postgraduate studies in controlled quantum dynamics;
- provide high quality advanced education in the relevant scientific skills, both theoretical and experimental, beyond undergraduate 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;

The key elements of the course that support these objectives are:

- Over 100 lectures in core and optional subjects in term 1, assessed by written examination and assessed problem sheets;
- Over 90 lectures in core and optional subjects in term 2, assessed by written examination, assessed problem sheets and a review article;
- Laboratory work assessed by written report and continuous assessment;
- Outreach projects, where the work of the MRes students is publicised to a non-specialist audience;
- A major six month project performed in a research group assessed by written report and a presentation;
1.3 THE CENTRE FOR DOCTORAL TRAINING IN CONTROLLED QUANTUM DYNAMICS

The Engineering and Physical Sciences Research Council (EPSRC) established the CDT in CQD in 2009, with the intention of training a cadre with a thorough understanding of the controlled quantum dynamics of small numbers of quantum systems, their multi-particle coherence and entanglement properties, and of methods for their preparation, control and read-out. The CDT in CQD also works closely with the other CDTs including the CDTs in Plastic Electronics and the Theory and Simulation of Materials, with the QOLS group in the Department of Physics and other academic departments and institutions working in the field.

1.4 LINES OF COMMUNICATION

A list of all academic staff involved in the CDT is given in Appendix 1: most contribute to the MRes Course either directly or indirectly. The following table lists those with administrative responsibility.

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Person</th>
<th>Room No</th>
<th>Tel Ext</th>
</tr>
</thead>
<tbody>
<tr>
<td>Director of the CDT in CQD</td>
<td>Prof Myungshik Kim</td>
<td>Electrical Engineering 1202</td>
<td>47754</td>
</tr>
<tr>
<td>Co-Director of the CDT in CQD</td>
<td>Prof Danny Segal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-Director of the CDT in CQD</td>
<td>Prof Terry Rudolph</td>
<td>Electrical Engineering 1203</td>
<td>47863</td>
</tr>
<tr>
<td>CDT Senior Administrator</td>
<td>Miss Miranda Smith</td>
<td>115 Whiteley Suite</td>
<td>40709</td>
</tr>
<tr>
<td>CDT Administrator</td>
<td>Miss Veena Dhulipala</td>
<td>115 Whiteley Suite</td>
<td>45609</td>
</tr>
<tr>
<td>Admissions</td>
<td>Prof Danny Segal</td>
<td>Blackett 308c</td>
<td>47779/47524</td>
</tr>
<tr>
<td>Examinations</td>
<td>Prof Danny Segal</td>
<td>Blackett 308c</td>
<td>47779/47524</td>
</tr>
<tr>
<td>Board of Examiners</td>
<td>Prof Myungshik Kim</td>
<td>Electrical Engineering 1202</td>
<td>47754</td>
</tr>
<tr>
<td></td>
<td>Prof Danny Segal</td>
<td>Blackett 308c</td>
<td>47779/47524</td>
</tr>
<tr>
<td></td>
<td>Prof Terry Rudolph</td>
<td>Electrical Engineering 1203</td>
<td>47863</td>
</tr>
<tr>
<td>Cohort Mentor cohort 7</td>
<td>Dr. Florian Mintert</td>
<td>Electrical Engineering 12th floor</td>
<td>40974</td>
</tr>
<tr>
<td>Cohort Mentor cohort 6</td>
<td>Dr Jony Hudson</td>
<td>Blackett 211</td>
<td>42986</td>
</tr>
<tr>
<td>Cohort Mentor cohort 5</td>
<td>Prof Richard Thompson</td>
<td>Blackett 620</td>
<td>43606</td>
</tr>
<tr>
<td>Cohort Mentor cohort 4</td>
<td>Prof John Tisch</td>
<td>Blackett 205</td>
<td>47710</td>
</tr>
<tr>
<td>Department Postgraduate Student Representatives</td>
<td>Tba</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department Careers Advisor</td>
<td>Prof Mark Neil</td>
<td>Blackett 608</td>
<td>46611</td>
</tr>
<tr>
<td>Department Director of Postgraduate Studies</td>
<td>Prof Stefan Maier</td>
<td>Blackett</td>
<td>46063</td>
</tr>
<tr>
<td>MRes External Examiner</td>
<td>Dr Pieter Kok</td>
<td>University of Sheffield</td>
<td></td>
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The Director and Co-Directors of the MRes in CQD and other staff will provide information to students through one of several channels, depending upon the nature of the information (e.g. confidential or not):

- E-mail;
- On the MRes course webpage;
- Letter tray;
- Notice boards;
- Letter to your home address;
• Personal communication before/after lectures.

It is important that students regularly check their email accounts and act promptly when action is required. They should also regularly check the course website and the notice boards.

1.5 STUDENT REPRESENTATION

There is one elected student representative of each cohort on the CQD Board, and students are encouraged to raise general or specific matters through this channel. Any concerns of a more urgent or personal nature should be discussed with the cohort mentor. Each student is asked to complete a questionnaire about the courses towards the end of Terms 1 and 2. The results of this are discussed at the CQD Board with a view to addressing any concerns in the future.

1.6 YEARLY CALENDAR

TERM 1

Week 1  Introduction to the MRes (1st Monday of term)  
CTD Lunch (Tuesday)  
MRes Safety Briefing and Physics Reception (Wednesday)  
Lectures Start (1st Thursday of term)  

Week 2  Election of Student Rep on CQD Board  
Week 10  Laboratory Safety Briefing  
Week 11  Compulsory Ethics course  
Hand in Instrumentation Laboratory Report

TERM 2

Week 1  Written Examinations – QPCCM, QI, Maths Modules for TCQD  
Week 2  Start of lecture courses  
Start of Outreach project  
After Advisory board mtg  Receive project proposals, start to contact potential supervisors  
Week 8  Hand in project choices (choose 3 in ranked order)  
Week 10  Projects decided, contact supervisor for reading list  
Week 11  Hand in ERCQD Essay

TERM 3

Week 1  Start of Project  
Early in Term 3  Written Examinations ERCQD, and AQI Courses  
May  Written Examinations QO and other Option Course(s).  
Writing and submitting Project literature review to supervisor  
SUMMER  Project Progress Check  
End-September  Project Thesis submission  
Project Talks (last Friday of September)  
Early October  Examiners' Meeting  
Day of Examiners Meeting  Informal Notice of Results (usually by 17:00)
2 General Information on the Course

2.1 ADMINISTRATION

The MRes in CQD is administered on a day-to-day basis by the CQD Board which oversees the course and makes changes to the course content and organisation as appropriate. It meets roughly fortnightly. The members of this committee are:

Prof. Myungshik Kim (Director)
Prof. Danny Segal (Co-Director)
Prof. Terry Rudolph (Co-Director)
Prof. John Tisch (Cohort Mentor - cohort 4)
Prof. Richard Thompson (Cohort Mentor – cohort 5)
Dr. Jony Hudson (Cohort Mentor – cohort 6)
Dr. Florian Mintert (Cohort Mentor – cohort 7)
Dr. Simon Foster (Outreach Officer)
Miss Miranda Smith (Senior Administrator)
Miss Veena Dhulipala (Administrator)
Student Representatives

2.2 TIMETABLES AND THE WORKING DAY

The MRes term dates are the same as those for undergraduate courses at Imperial College (except for the summer term). Lecture courses run for the first two terms. Examinations are held at the start of the second and third terms. The Quantum Optics course and other options courses are examined in May. Work on the projects starts in the first week of the Summer Term and continues into the undergraduate summer vacation, finishing in September. Timetables for each term are prepared in time for the start of term and are distributed to all students. These contain details of all lectures, laboratory work, project work, examinations and presentations.

The College standard working day is used, with 50-minute lectures commencing on the hour, starting at 09:00 each day. There are approximately 18 timetabled hours a week on average throughout terms 1 and 2. Wednesday afternoons are generally kept free for other activities. Lectures are usually held in the Whiteley suite, rooms 113 and 114. Some lectures are held in the lecture theatres or other rooms in the Physics department.

2.3 SAFETY

Safety is of paramount importance. All students are issued with the current version of the Blackett Laboratory Safety Booklet at the start of the MRes course, and all students are required to attend both the introductory safety briefing and the laboratory safety briefing, which are held in the first three weeks of term.

Summer projects may be taken in research group laboratories where high-power laser beams or other potentially dangerous equipment such as high-voltage power supplies are routinely in use. Students must read, sign and follow the safety guidelines agreed for each laboratory covering electrical, chemical and laser safety as appropriate. All students who will be working in designated laser areas will need to be registered as laser users and will need to attend the college laser safety briefing. There will be a safety briefing by the QOLS group Safety Officer Mr. Brian Willey in the first week of the summer term. Students intending to do experimental projects should make the necessary arrangements with Brian Willey during the second term so that they can begin project work immediately in the summer term.

The Building Evacuation signal is a fire alarm. If you are in the Whiteley suite when this goes off you must leave immediately by the nearest fire exit and assemble at the front of RCS 1 Building until a fire officer has given an all clear to return to the building. There is a map along the suite corridor showing the exit points.
2.5 THE CURRICULUM

2.5.1 Overview

There are three main components to the MRes course, with the following contributions to the final mark:

Lectures and Laboratory. These are assessed by written examinations, assessed problem sheets and an essay for part of the ERCQD course. The laboratory work is assessed by written reports. The optional course is examined in the same manner as for other (non CQD CDT students). The lecture courses and laboratories are arranged in two elements, and the structure of the elements and their contribution to the final mark is indicated in Section 3.1.

Outreach Project. The outreach project is assessed by presentation, and counts for 7% of the provisional final mark.

Project. This is assessed by a presentation and a written report at the end of the project, and counts for 50% of the provisional final mark.

To be awarded an MRes, students are required to achieve the requirements explained in 3.9. This section also explains the requirements for the award of a “Merit” and “Distinction”.

2.5.2 Lectures

Four compulsory lecture courses run during the first term:

- Quantum Physics and Chemistry of Cold Matter (5 ECTS);
- Introductory Quantum Information Theory (6 ECTS);
- Quantum Optics (6 ECTS);
- Tools for CQD - Mathematics for Control of Individual Quantum Systems and Attosecond Processes / Instrumentation and Laboratory Work (6 ECTS)

In the second term there are two compulsory lecture courses arranged by the MRes

- Experimental Realisations of Controlled Quantum Dynamics (5 ECTS)
- Advanced Quantum Information Theory (5 ECTS) and Laboratory for CQD (3 ECTS)

Option course: In addition you will be assessed in one other appropriate Masters level course offered by the MSci programme or by one of the other Masters courses in the Department of Physics or Mathematics. (6 ECTS). You may take this course in either term 1 or in term 2. Many students attend more than one option course. If you choose to be assessed in more than one option course your highest grade will be used in calculating your provisional final mark.

Many courses on the Quantum Fields and Fundamental Forces MSc programme may be of interest. Quantum Field Theory and Foundations of QM are particularly popular amongst our students https://www.imperial.ac.uk/study/pg/physics/quantum-fields-fundamental-forces/

The Laser Optics, Laser Technology and Nonlinear Optics courses within the Optics and Photonics MSc programme are also popular (Options only in 2nd term), particularly with those students with a more experimental leaning. Note these courses are half the length of other courses so for instance the combination Laser Optics + Laser Technology counts as a single full-length option course. http://www.imperial.ac.uk/study/pg/physics/optics-photonics/

Some final year Physics Undergraduate courses may be of interest (year 3 and 4 options) http://www.imperial.ac.uk/natural-sciences/departments/physics/
Another course that has been of some interest is a course on classical Information Theory run by the Electrical Engineering department [http://www.commsp.ee.ic.ac.uk/~cling/IT/InformationTheory.htm](http://www.commsp.ee.ic.ac.uk/~cling/IT/InformationTheory.htm)

An outreach project is conducted throughout the first year and counts for 5 ECTS

The MRes project accounts for 46 ECTS.

Altogether this amounts to 90 ECTS

Details of the courses organised by the CDT in CQD can be found in Appendix 2. Information on the courses offered elsewhere can be found on the Physics Department website. Options should be chosen in consultation with the course Director, co-Directors or Cohort Mentor. Once you have chosen your option you should inform the CDT administrator of your choices. Typically a course will be given by a single lecturer and a course associate will oversee the activity and help with assessment. However some CQD courses are modular, with modules being taught by different lecturers. Modular courses will have an identified person who takes overall responsibility for the activity.

2.5.3 Project

Project proposals will be circulated in late January/early February. Students may suggest their own projects and look for an appropriate supervisor. Students should approach potential supervisors during term 2 in order to discuss the projects on offer and help them in making their choice. The project starts at the end of term 2 and must be completed by late September (the precise date is published in the second term). It may be carried out at Imperial College or at a partner institution in the CDT or at another academic institution, where appropriate arrangements exist. All students have a project supervisor at Imperial College and those carrying out their project elsewhere also have a local supervisor.

Students give a progress report (normally a poster presentation during the summer school). Feedback is provided on the oral progress report: all academic staff present fill in an assessment sheet and any comments are passed to the speaker. This assessment does not contribute to the provisional final mark.

The principal assessment is through the written project report, which is marked independently by two members of staff. The project reports are typically around 40-50 pages long (a maximum of 30,000 words is suggested). If you are concerned about the length of your report discuss it with your supervisor. The report must be submitted to Imperial College by 5pm on the date specified. Please note this deadline is strictly enforced. Students need only submit an electronic copy (in PDF format), which will be added to the archive of MRes reports. In addition there is a final project presentation, usually the week after the report is submitted, which contributes to the assessment of the project; all academic staff present complete an assessment sheet and their weighted marks contribute 20% to the marks for the report. The mark for the oral project presentation is denoted Totaloral in the relevant assessment section below (section 3.6)

For the project report, follow the synopsis below:

- Document double spaced or 1.5 spacing
- Use a normal font such as 12 point Times (serif) or 11 point Arial (sans-serif).
- A4 page size
- Pages should be numbered sequentially
- There should be a Title page with:
  - Title of the Thesis
  - Your full name, as registered
  - Imperial College London, the name of your department
2.6 Course Questionnaire

Students are asked to complete a questionnaire at the end of terms 1 and 2. The purpose of the questionnaire is to help identify strong and weak points of the lectures and laboratory work. The CQD Board considers the responses to the questionnaire and acts appropriately to correct any perceived weaknesses.
3 Assessment of the Course Components

3.1 OVERALL ASSESSMENT OF THE MRes

This section details the assessment procedures for each element of the MRes course. The distribution of marks between the different elements of assessed work is summarised as follows:

<table>
<thead>
<tr>
<th>Element</th>
<th>Component</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Courses Basics</td>
<td>QI</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>QO</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>Tools for CQD</td>
<td>7%</td>
</tr>
<tr>
<td></td>
<td>Option Course</td>
<td>6%</td>
</tr>
<tr>
<td>2. Courses Advanced</td>
<td>QPCCM</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>ERCQD</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>AQI/Advanced Lab.</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>Outreach Project</td>
<td>7%</td>
</tr>
<tr>
<td>3. Project</td>
<td>MRes Project</td>
<td>50%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>100%</td>
</tr>
</tbody>
</table>

The percentage under each heading indicates the weighting used in calculating Final Mark (see section 3.9). These notes are intended to assist students, by showing the basis and criteria on which marks are awarded, and staff in standardising the assessment procedures as applied from student to student, and from year to year.

The Examiners nevertheless reserve the right to make adjustments to the procedures given in this section in exceptional circumstances.

Note*: The QI, AQI, ERCQD and QPCCM core courses will be assessed by a combination of written examination and assessed coursework. The Quantum Optics course will be assessed by written examination only (100%). For the purposes of assessment the Mathematics for CQD and Instrumentation courses are bundled together and collectively called Tools for CQD (TCQD). The courses are detailed below with a certain number of 'module points' attributed to each module. The rule is that you need to accrue 6 module points for TCQD and 5 module points for AQI/Lab. The exact breakdown of the marking scheme will therefore depend on the choices you make. In the table below C=compulsory, O=Optional.

### Tools for Controlled Quantum Dynamics

<table>
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<tr>
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<tbody>
<tr>
<td>Mathematica (C)</td>
<td>1</td>
</tr>
<tr>
<td>Mathematics for CQD modules</td>
<td></td>
</tr>
<tr>
<td>Module I. Linear Algebra (O)</td>
<td>1</td>
</tr>
<tr>
<td>Module II. Maths for ultrafast quantum dynamics (O)</td>
<td>2</td>
</tr>
<tr>
<td>Module III. Maths for quantum light fields (O)</td>
<td>2</td>
</tr>
<tr>
<td>Instrumentation modules</td>
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</tr>
<tr>
<td>Module I Standard Instrumentation Lab (O)</td>
<td>1</td>
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<tr>
<td>Module II Instrumentation Lab Project (O)</td>
<td>2</td>
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### AQI and Laboratory for CQD

<table>
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<tr>
<td>AQI modules</td>
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</tr>
<tr>
<td>Basic Module (C)</td>
<td>2</td>
</tr>
<tr>
<td>Advanced Module (O)</td>
<td>3</td>
</tr>
<tr>
<td>Laboratory for CQD modules (O)</td>
<td>3</td>
</tr>
</tbody>
</table>
The main purpose of attending the instrumentation lectures is to prepare you for the laboratory sessions. You will not be assessed on the lecture material. There are eight three hour instrumentation laboratory sessions on the timetable. The instrumentation lab project in term 1 is not dependent on the lecture material and the script is very brief. You will be set some problems and given a good deal of freedom as to how to tackle them. The project will be led by a Lecturer/Demonstrator who will spend some of the laboratory time giving instruction. The Instrumentation lab project will involve you spending approximately a further 15-25 hours of unscheduled time on the project work. You will work in pairs for all of the laboratory sessions so you will need to choose lab partners.

You may do Instrumentation Module I or II or All. Neither is a prerequisite for the other. You are encouraged to attend all of the Mathematics and Instrumentation modules but, as described above, you will only be assessed on a subset. The compulsory parts of the course are indicated in the table above. If you wish you can be assessed on more than the minimum number of modules and your highest marks can be used to make up your required module points. Instrumentation module I will be assessed continuously and by handing in your annotated Labview code. Instrumentation module II will be assessed continuously and via a laboratory report. Each mathematics module will be assessed by a problem sheet (40% of that module’s mark) and one question on the final exam (60% of that module’s mark). The Mathematica module, which is compulsory, will be assessed on the basis of your completed worksheets.

The examination for the mathematics modules of the TCQD course will be divided into two papers and will operate as follows:

**Paper 1**
50 minutes module I  
10 minute break  
50 minutes module II  
10 minute break  
50 minutes module II

**Paper 2**
50 minutes module III  
10 minute break  
50 minutes module III

Questions will be handed out one module at a time and answers will be taken in at the end of each module. You may sit as many modules as you wish. All the answers will be marked and you will be credited with the highest marks you achieve to make up the required number of module points.

The ERCQD course is also modular. The assessed modules are

I  Trapped Ions (R. Thompson)  
II  Photonic CQD (B. Smith and J. Nunn)  
III  Optical Lattices (D. Jaksch)  
IV  Attosecond Control (J. Marangos)

Module I (Trapped Ions) is compulsory and is assessed through a review article written in teams of 3-4 students. The other modules are assessed in the usual way (problem sheets and examination). The examination will be run in a similar manner to that for TCQD except that there will be only one paper comprising the three examinable modules. You only need to be assessed on two of these, but you may sit all of them if you wish and we will use your best two marks. To arrive at a final mark first of all your best two optional continuous assessment marks will be added together and then your best two marks in the examination will be added together. The provisional final mark for the optional parts of ERCQD will then be calculated with a weighting ( provisionally, 60% exam, 40% continuous assessment). This mark will then be added to the mark for Module 1 with a 67:33 weighting (67% optional parts, 33% for Module 1) to arrive at the provisional final mark for ERCQD. The lecturing of module II (photonic CQD) is shared by three lecturers. In addition to the
assessed lectures ERCQD contains ~8 hours of guest lectures which are non-examinable.

The QPCCM and AQI courses are also given by a number of different lecturers but all of the course material is examinable. There are written exams for QPCCM and AQI. The QPCCM exam covers all of the material in the course. The AQI exam is modularised to provide an option to replace some modules with Laboratory for CQD (see below).

The Laboratory for CQD is composed of three lab suites: femtosecond laser dynamics, atoms in MOT and twin photon generation. Each lab suite is worth 1 ECTS and students can replace the advanced AQI modules with the Laboratory for CQD.

Formal feedback to the students in each activity is by way of either a percentage mark or a letter grade indicating the percentage band of their attainment. The definition of the letter grades is given in section 3.8 below. The examination marks are reviewed by meetings of the internal assessors (all staff involved in the MRes course), who may suggest that the examiners take into account any special factors or who may provide advice on individual students. The marks are then forwarded to the External Examiner for information. The Board of Examiners meets in October to review all the marks and make final recommendations to the College. It is traditional to send a copy of the project reports to the External Examiner in advance of this meeting, to provide additional information that might assist the decision process.

Imperial College Statement regarding Plagiarism

Students should be aware of the need to give proper credit for the work of others when writing papers, reports, theses, etc. This is particularly important when the work is in collaboration with other persons. The College definition and policy regarding plagiarism can be found at http://www3.imperial.ac.uk/studenthandbook/advice/plagiarism, which for convenience is repeated here:

You are reminded that all work submitted as part of the requirements for any examination (including coursework) of Imperial College London must be expressed in your own words and incorporate your own ideas and judgements.

Plagiarism, that is, the presentation of another person's thoughts or words as though they were your own, must be avoided, with particular care in coursework, essays and reports written in your own time. Note that you are encouraged to read and criticise the work of others as much as possible. You are expected to incorporate this in your thinking and in your coursework and assessments. But you must acknowledge and label your sources.

Direct quotations from the published or unpublished work of others, from the internet, or from any other source must always be clearly identified as such. A full reference to their source must be provided in the proper form and quotation marks used. Remember that a series of short quotations from several different sources, if not clearly identified as such, constitutes plagiarism just as much as a single unacknowledged long quotation from a single source. Equally, if you summarise another person's ideas or judgements, figures, diagrams or software, you must refer to that person in your text, and include the work referred to in your bibliography. Departments are able to give advice about the appropriate use and correct acknowledgement of other sources in your own work.

The direct and unacknowledged repetition of your own work which has already been submitted for assessment can constitute self-plagiarism. Where group work is submitted, this should be presented in a way approved by your department. You should therefore consult your tutor or course director if you are in any doubt about what is permissible. You should be aware that you have a collective responsibility for the integrity of group work submitted for assessment.

The use of the work of another student, past or present, constitutes plagiarism. Where work is used without the consent of that student, this will normally be regarded as a major offence of plagiarism.
Failure to observe these rules may result in an allegation of cheating. Cases of suspected plagiarism will be dealt with under the College's Examination Offences Policy and may result in a penalty being taken against any student found guilty of plagiarism.

Use of Calculators in Written Examinations

The College Board of Graduate Studies has determined that only College-owned approved non-programmable calculators can be used in the written examinations. The Physics Department has approved and can provide calculators, which use algebraic logic. Appropriate arrangements will be made for students wishing to use RPN calculators. However, in all cases, only College-owned calculators may be used in the written examinations and therefore students are advised to either purchase an appropriate calculator or practise on a College-owned calculator before the written examinations.

Use of Computers in Written Examinations

Some lecturers may allow the use of laptop computers in examinations. This is done under strict supervision to ensure that students do not connect to the internet during the examination.

Written Reports

There are some general comments which are applicable to all MRes reports. All reports should be word processed. Use 25-30mm margins all round and number all pages. Use 1.5 spacing, except perhaps for the Contents page and References where you may wish to use single spacing. Use a normal font such as 12 point Times (serif) or 11 point Arial (sans-serif). Do not use fonts smaller than these as this impacts the standard of presentation and makes them more difficult to read. Make sure diagrams, figures and graphs are clearly laid out with clear labels and captions.

DEADLINES: Deadlines are absolute. The Board of Assessors reserve the right not to mark reports submitted late. Computer difficulties will not be accepted as excuses for late submission. Any extenuating circumstances (e.g. illness) should be discussed the Cohort Mentor immediately.

3.2 EXAMINATION – CORE COURSES

Draft examination papers are prepared by the lecturer, moderated by a second member of staff and sent in advance to the External Examiner who reviews them and suggests changes. After discussion with the course lecturers, these changes are usually incorporated into the final papers.

Each examination question is marked by the course lecturer, the mark being moderated by a second marker. The total mark for each paper is converted to a percentage, the corresponding letter grade being fed back to the student.

3.3 ASSESSED COURSEWORK

Worksheets will be handed out by the lecturer giving a deadline for submission of the completed work. The college policy is that work submitted late will be awarded a zero mark. This penalty can only be waived if there are extenuating circumstances. It will be marked by the lecturer and moderated by the course associate. One copy of the work will then be returned to you for the purposes of feedback. The other copy will be retained and archived with the examination scripts.

The percentage marks for each examination paper and the coursework are combined (according to the weightings noted above) to produce the Course Mark.
3.4 EXAMINATION – OPTION COURSES

Students on the MRes in CQD will study one course at Masters level not primarily designed by the CQD CDT. For examination purposes, the appropriate examination, and regulations, for that course will be followed.

3.5 OUTREACH PROJECT

The outreach project will be assessed by a team presentation, and graded by the Outreach Officer, the Course Director and Co-Directors and other appropriate academic staff.

3.6 PROJECT

The project is assessed via oral presentation and a report.

The final mark for the project is the weighted average of the oral presentation and the written report (weighting 1:4).

The project report is marked by the lead supervisor and an independent assessor who both complete the report mark sheet in Appendix 3. The project report mark is calculated as the average of the two marks (Total\textsubscript{rep}). The project presentation is marked by academics from the CDT and the mark is the average of the assessors marks (Total\textsubscript{oral}).

The final project mark is in turn calculated as:

\[ \text{ProjectTotal} = 0.8 \times \text{Total}_{\text{rep}} + 0.2 \times \text{Total}_{\text{oral}} \]

3.7 PROFESSIONAL SKILLS

This course involves advice on and activities valued in a working environment (i.e., careers advice, presentation skills). The Graduate School offers a range of courses and these will be publicised during the year. Details can be found at [http://www.imperial.ac.uk/study/pg/graduate-school/](http://www.imperial.ac.uk/study/pg/graduate-school/)

You are welcome to do up to three half-day courses or their equivalent if you wish to, but this is not a requirement. You are required to undertake the Ethics course in the second week of term. Students progressing to the PhD will also be required to undertake a set number of professional skills courses prior to their Early Stage Assessment in the first year of PhD.

3.8 LETTER GRADES

Letter grades are produced by the assessors for the purposes of student feedback. A letter grade is determined from a numerical mark, $m$, according to the following scheme:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Mark Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A*</td>
<td>$m \geq 80%$</td>
</tr>
<tr>
<td>A</td>
<td>$79.9% \geq m \geq 70%$</td>
</tr>
<tr>
<td>B</td>
<td>$69.9% \geq m \geq 60%$</td>
</tr>
<tr>
<td>C</td>
<td>$59.9% \geq m \geq 50%$</td>
</tr>
<tr>
<td>D</td>
<td>$49.9% \geq m \geq 40%$</td>
</tr>
<tr>
<td>E</td>
<td>$39.9% \geq m \geq 30%$</td>
</tr>
<tr>
<td>F</td>
<td>$m &lt; 30%$</td>
</tr>
</tbody>
</table>
3.9 REQUIREMENTS FOR PASSING THE MRES AND CALCULATING THE FINAL MARK

The MRes in Controlled Quantum Dynamics consists of three elements:

- Courses - Basics (25% of the total course mark), consisting of the components:
  - Quantum Information;
  - Quantum Optics;
  - Tools for CQD;
  - an optional lecture course

- Courses – Advanced (25% of the total course mark) consisting of the following components:
  - QPCCM;
  - ERCQD;
  - AQI/Lab for CQD
  - Outreach Project.

- Project (50% of the total course mark).

The Final Mark

Marks are collated by the Course Co-Directors and reviewed internally before being sent to the external examiner for external inspection. An Examiners’ meeting is held in October at which the Final Marks are agreed. The Final Marks are then sent to the College administration.

To pass the MRes, the candidate must achieve a mark of 50% or higher in each element of the MRes. In addition, they must have passed each component with a mark of 40% or higher.

A candidate can be considered for a Merit if the candidate has achieved a final mark of $\geq 60\%$; and a mark of $\geq 60\%$ for two of the elements and $\geq 50\%$ for the other element.

A candidate can be considered for a Distinction if the candidate has achieved a final mark of $\geq 70\%$; and a mark of $\geq 70\%$ for two of the elements and $\geq 60\%$ for the other element.

Please note that the Board of Examiners may consider candidates for promotion if their mark is close to a boundary, or if exceptional circumstances apply.

Although the pass mark for the MRes is 50% a final mark of 60% or greater is needed to allow transfer to the 1st year of the PhD programme associated with the CQD CDT.
4. Academic Support

General: The academic support for the MRes students comes primarily from the course lecturers, the other academic staff associated with the CDT and project supervisors. The number of students on the MRes course is normally around 10 - 15 and this is a small enough group that they are actively encouraged to go directly to course lecturers and other staff with academic questions on an informal basis.

Projects: There is a member of staff allocated to each student as a supervisor.

Outreach: The CDT Outreach Officer runs the outreach programme and is available for consultation on all matters concerning outreach.

Writing and Communication Skills: There is written support material for writing skills and for the verbal presentation of coursework – courses are arranged by the Graduate School and details will be given early in the course. Communication skills are assessed on a continuous basis throughout the course and students submit written work and public verbal presentations which are assessed and whose assessment counts towards their final degree result. Feedback to students is available on all submitted work and oral presentations.

4.1 ABSENCES AND ILLNESS

The College monitors the attendance of all its students. Students are requested to notify lecturers and the Course Organiser if they become ill. Students are required to provide a medical certificate if they are absent for 3 days or more, including during the summer project. If a student misses an examination because they are ill it is essential that they obtain a medical certificate.

All students have access to the College Health Centre at 40 Princes Gardens. Details of their services can be found at http://www.imperialcollegehealthcentre.co.uk

Mitigation and Extenuating Circumstances

The College will consider requests for mitigating and extenuating circumstances that may have affected a student’s performance in examinations or other areas of their course. Please note that claims for mitigating or extenuating circumstances should be made before, or no later than five days after, the examination and should be supported by documented evidence, if that is available.

Please note that the information regarding your claim for mitigation or extenuation will remain confidential and will only be viewed by the advisory panel which will make a recommendation to the Board of Examiners about your request. You may indicate if there is any information which you DO NOT wish to be released to the Board of Examiners but bear in mind that the more information that is received by the Board the better able they will be to reach an informed decision.

Please contact the course organiser or your tutor for further information.

4.2 HOW TO COMPLAIN

Imperial College aims to give the highest specialised instruction and service to all its students, however, in some cases it recognises that students may not always be satisfied with the service that they have received. If you wish to raise a concern, you should first seek advice from your student representatives and raise the matter with the individual concerned. If you are not satisfied with the outcome, you should consult the College’s Registry website which provides clear and consistent procedures that indicate how you can take your comments further: http://www3.imperial.ac.uk/registry/proceduresandregulations/policiesandprocedures/complaintsappeals
4.3 STUDENTS WITH DISABILITIES, SPECIFIC LEARNING DIFFICULTIES OR LONG-TERM HEALTH ISSUES

At Imperial College we recognise that studying at university can be a challenge, especially if you have a disability. We are keen that you have every opportunity to fulfil your potential and graduate with the degree you deserve. It is therefore important that you let us know about any disability, specific learning difficulty or health problem as soon as possible so that we can give expert advice and support to enable you to do this.

Some people never think of themselves as having a disability, but students who have experienced any of the issues listed below have found that a little extra help and support has made all the difference to their study experience.

- Specific learning difficulties (such as dyslexia, dyspraxia, AD[H]D)
- Autistic spectrum disorder (such as Asperger’s)
- Deafness or hearing difficulties
- Long term mental health difficulties (such as chronic anxiety, bipolar disorder, depression)
- Medical conditions (such as epilepsy, arthritis, diabetes, Crohn’s disease)
- Physical disabilities or mobility impairments
- Visual difficulties

Where to find help:
1. **Your Disability Liaison Officer**
   (Andrew Williamson (Blackett 316), andrew.williamson@imperial.ac.uk)
   Andrew Williamson is your first point of contact within your department and is there to help you with arranging any support within the department that you need. Andrew is also the person who will apply for Special Examination arrangements on your behalf. You need to contact him without delay if you think that you may need extra time or other adjustments for your examinations. http://www3.imperial.ac.uk/registry/exams/specialexamarrangements

2. **Disability Advisory Service**: [http://www3.imperial.ac.uk/disabilityadvisoryservice](http://www3.imperial.ac.uk/disabilityadvisoryservice)
   The Disability Advisory Service works with individual students no matter what their disability to ensure that they have the support they need. We can also help if you think that you may have an unrecognised study problem such as dyslexia. Our service is both confidential (information about you is only passed on to other people in the university with your agreement) and individual in that any support is tailored to what you need.

   - Being an advocate on your behalf with others in the College such as your departmental liaison officer senior tutor or exams officer, the accommodation office or the estates department
   - Checking that your evidence of disability is appropriate and up-to-date
   - Arranging a diagnostic assessment for specific learning difficulties
   - Help with applying to the College for the cost of an assessment
   - Help with your application for the Disabled Students Allowance (DSA) see below
   - Helping students not eligible for the Disabled Students Allowance in obtaining support from other sources
   - Help with arranging extra Library support
   - Supporting applications for continuing accommodation for your second or later years

3. **Disabled Students Allowance**:
   [http://www3.imperial.ac.uk/disabilityadvisoryservice/supportatimperial/funding](http://www3.imperial.ac.uk/disabilityadvisoryservice/supportatimperial/funding)

   Students who are registered as home students and who have a disability can apply for a grant called the Disabled Students Allowance which can pay any extra costs that are a direct result of disability. This fund is not means-tested and is also a grant not a loan so any home student with a disability can apply and will not be expected to pay it back. Remember students with unseen
disabilities such as mental health difficulties, dyslexic type difficulties or long term health problems are also eligible for this fund.

4.4 OUR PRINCIPLES

At its June 2012 meeting the Senate approved a Student Charter for the College, entitled Our Principles. The Principles were developed by a College Working Group including representatives of all Faculties and undergraduate and postgraduate students.

The Principles define the guiding principles of the College community and cover all students, both undergraduate and postgraduate. They are not a legal contract but rather an easily accessible, concise source of information and a clear display of staff, student and ICU collaboration. They will be reviewed annually by the Quality Assurance and Enhancement Committee.

The Principles are available at: http://www.imperial.ac.uk/students/student-support/our-principles/. Each Principle is accompanied by ‘drop-down’ text, which elaborates upon the overarching statements and provides links to further information.

Employment during Studies

Please note the College’s policy regarding part time employment during your MSc course:


5. General Information about Life in the Doctoral Training Centre

This section is intended to supply all new MRes students with some essential information about the CDT in CQD and Imperial College.

5.1. BEFORE YOU ARRIVE

Prior to arriving at Imperial College, you should have received joining instructions, a timetable and the details on the introductory lecture where you shall be given further details of the course, briefings and documents on your course and the CDT (such as safety information) and the opportunity to meet your colleagues. It will be useful if you give some thought to the option course you might wish to attend before you arrive. Details of option courses available are given in section 2.5.2 above.

5.2. WHERE TO FIND US

Imperial College is located just behind (south of) the Albert Hall in South Kensington. The nearest tube stations are South Kensington and Gloucester Road on the District/Circle Line and High Street Kensington on the Circle Line. South Kensington and Gloucester Road are also on the Piccadilly Line which goes directly to Heathrow Airport.

The CDT in CQD is located in the Whiteley Suite, in Chemistry RCS1 Building along the Imperial College Road

The Department of Physics is located at the Blackett Laboratory, on the corner of Queens Gate and Prince Consort Road (the entrance is on this road).

5.3. WHEN YOU ARRIVE

You should first register online (http://www3.imperial.ac.uk/registry/currentstudents/howtoregister). When you arrive at college go to the CDT Administrative Office (115 Whiteley Suite) for any introductory material or instructions. The first activity will be an introductory briefing. After this you
will be given a laptop computer for your personal use throughout the MRes. You will be allocated a locker which you may use to store your personal belongings. You will also be allocated a desk for use during the MRes year. The majority of you will be staying on to do a PhD in the CDT in CQD, and you will retain this laptop for the duration of your PhD course.

5.4. ID CARDS

One of the very first things you need to do when you arrive is obtain an identity card. Instructions on how to obtain an ID card will be sent to you in the PG welcome packs. The ID card is essential for a number of purposes, including access to the Central Library. It is also used as a swipe card to get in and out of the building.

5.5. MAIL

The CDT address is:

CDT in CQD,
115 Whiteley Suite, RCS 1 Building
Imperial College London
South Kensington campus
London, SW7 2AZ
UK

If you have any work related mail to be delivered to the CDT, please use the above address. The mail will be delivered in the incoming tray in the admin office. You will be emailed if mail arrives for you.

5.6. TELEPHONES

The general college number is 020 7589 5111 (+44 20 7859 5111 from overseas). The College operator may be obtained by dialling 0. Five-figure internal numbers may be dialled directly on the phone. All extension numbers prefixed with a 4 may be dialled directly by external callers using 020 7594-XXXX. Extension numbers prefixed with a 5 do not have the directly dialling facility. Use the college directory (http://www.imperial.ac.uk/collegedirectory) on the College website to find telephone numbers and offices of members of College. Microsoft Outlook also has contact details for the staff and students.

5.7. SECURITY AND EMERGENCIES

Emergencies of all types may be reported to Ext.4444. There are First Aid boxes around the Department and in the laboratories, and your safety induction and literature should give you details on First Aid procedures.

Petty theft happens from time to time. Don't leave valuables lying around and always close and lock the door, even if you go out for just a short time.

More seriously, there have recently been a number of cases of large-scale computer theft from Imperial College. Make sure that the doors to any rooms containing computers are properly locked if you are one of the last to leave in the evenings or at weekends. Unfortunately, some thefts have been from locked offices so either take your laptop home each night or lock it in a secure place. If you see anyone at all suspicious, call security at the above number.

Building access hours are 7a.m. to 11 p.m. seven days a week. It is recommended that people sign the book at the RCS1 entrance on weekends and when they are working during late hours from say 9p.m. (This is in case there is an emergency, security will know how many people to evacuate).
5.8 LIBRARY FACILITIES

The Central Library is next to the Sherfield Building. The catalogue may be accessed from terminals in the Central Library and over the web (starting from the College home page). The Central Library also houses the Haldane Library, with a good general collection (fiction and non-fiction) and a music library.

Electronic journals are available via the library website:

http://www3.imperial.ac.uk/library/digitallibrary

5.9 PHOTOCOPYING, PRINTING, SCANNING, OFFICE SUPPLIES

The printers in the Whiteley suite are accessed via the network. You can send printing jobs to the printers and then collect the output by swiping your college security card through the card reader on the front panel of the printer. These printers also act as a photocopier and as a scanner. You can scan documents and send them to your email address. Stationery is available from the Administration Office (room 115). The office also has a guillotine, paper shredder and laminator for general use.

5.10 ACCOMMODATION

The College has a number of offices which may provide you with help in finding accommodation. Short-term accommodation, either in the form of a College guest room or a local hotel, may be booked through the College Conference Office. For long-term accommodation, students should go to the Accommodation Office at 15 Prince's Gardens (Ext.5-9444, 5-9445, 5-9446 or from outside, 0207 594 9444). Other long-term visitors should go to HUB, at 355 Sherfield (Ext.4-8741).

Outside the College, two of the most useful sources of listings are The Evening Standard and Loot, both published on six days of the week. Websites such as Gumtree are increasingly being used as a resource for accommodation hunting.

5.11 FOOD AND DRINK

Lunch can be bought in the Student Common Room, h-bar, or downstairs in the Main Dining Room. Tea and coffee making facilities are available in the Whiteley suite. Many of our colleagues in Physics buy lunch in the level 8 common room in the Blackett Laboratory or in the Level 5 common room in the Huxley building. It is perfectly acceptable to take your own food along to these common rooms.

A number of sandwich shops, restaurants and pubs, at a range of prices, may be found on Gloucester Road (one block west of Queen's Gate), and around the tube station at South Kensington. Beit Quad and Southside have student bars.

5.12 HEALTH

The College Health Service may be found at 40 Princes Gardens SW7 1LY (on Southside). Their telephone numbers are Ext.49375/49376 or 020 7584 6301. Students, local residents and those visitors from overseas who are entitled to NHS care may all use the Health Service free of charge. The Health Service is open from 8:00am to 6pm during term time, 8:00am to 5pm out of term. Appointments may be made by calling the above numbers or on line, if you have registered to do so. If you need to be seen before the next available appointment, there is a triage clinic between 8:30am and 10am, Monday to Friday. The clinic operates on a queuing system and may involve a wait. You will be asked to complete a brief questionnaire and a doctor will use the information you provide to decide who it is most appropriate for you to see. In addition to general practitioners and nurses, an extensive range of other services are offered, including free condoms, contraceptive advice, physiotherapy, psychotherapy, exam stress workshops, vaccinations and treatment for
sports injuries. Complementary therapies are also available at the Health Centre. These are not part of the NHS service, but some free slots are available.

If travelling elsewhere in the European Union, you would be advised to obtain an EHIC card

https://www.ehic.org.uk/Internet/home.do

prior to your travel, as this will enable you to receive medical treatment at reduced cost. The EHIC is available to all persons resident in the United Kingdom, but non European Union students will need longer to apply.

Emergency assistance (Medical, Security and Fire, Police, Ambulance) Internal Tel. 4444 (internal)

The Health Centre 020 7584 6301/49375

(https://www.imperialcollegehealthcentre.co.uk)

The Student Accommodation Office 49444

(http://www3.imperial.ac.uk/residences)

The Student Counselling service 49637

(http://www3.imperial.ac.uk/counselling)

Careers Service 48024

(http://www3.imperial.ac.uk/careers)

Chaplaincy (Religious support, including other major faiths) 49600

(http://www3.imperial.ac.uk/chaplaincy)

Students Union 48060

(http://www.imperialcollegeunion.org/)

5.13. SPORTS FACILITIES

The College Sports Centre can be found at 7 Prince's Gardens. Details of facilities, opening time, etc can be found at http://www3.imperial.ac.uk/sports/ethos.

5.14. BANKING

Students are recommended to open a bank account in London. The four largest banks in the UK are National Westminster, Barclays, Lloyds and HSBC. Many banks are attentive to the special needs of students. There is a branch of the Santander Bank on the walkway and other banks have branches at South Kensington and Gloucester Rd. Students opening accounts there should bring a Certificate of Registration at Imperial College. Students from abroad should also bring their passport.

5.15. PARKING

Parking is extremely limited in the College. Permits for short visits (a day) can sometimes be obtained. If you require such a permit approach the CDT administrator in the first instance.

5.16. TRAVEL

All staff and students travelling on College business are automatically covered by the College's insurance policy so long as they register their trip before they travel. It is worth taking with you a copy of the cover note, obtainable from the accounts office on level 3 of the Blackett Lab. If you do plan to go away during term time, even if only for a few days, please speak to one of the course Co-Directors beforehand and leave details indicating where you can be contacted.
5.17. LIFE IN LONDON

Time Out, published weekly, has extensive listings of much that is going in London. It can bought at a discount at the student shop on the walkway outside the Sherfield Building.

The Student Union organises many events, details of which can be found at http://www.imperialcollegeunion.org/ or from posters on the notice-boards.

5.18. MOVING ON FROM IMPERIAL

Most of the students on the MRes in CQD will go on to do a PhD in the CDT in CQD. People who, for whatever reason, do not take up a PhD in the CDT may wish to approach the Co-Directors in the first instance for some informal careers advice. On a more formal level the Careers Advisory Service http://www3.imperial.ac.uk/careers/about/careersserviceatimperial provides training on important skills like CV writing and interview techniques as well as careers advice and information from potential employers.

5.19. AND WHEN YOU LEAVE ...

Make sure you return all keys, copy cards, ID card, books and other College material. Please either provide details of how you can be contacted or monitor your College email account as we may need to contact you afterwards (with your final result, for instance). If, as will be the case for most of you, you are staying on for the further three years of the CDT in CQD then you should retain your ID card and any other College material for the duration of your PhD. During the three years of your PhD training you will retain access to the Whiteley suite and you will be welcome to use its facilities, although you will not retain a desk space.
Appendix 1  Staff of CDT in CQD

Academic Teaching Staff (Room Number)

V Averbukh  6M04 Huxley Building
C Di Franco  12th floor Electrical Engineering
S Foster, Outreach Officer  313 Blackett
J Hudson  211 Blackett
EA Hinds FRS  214 Blackett Laboratory
MY Ivanov  Blackett Laboratory
D Jennings  12th floor Electrical Engineering
M Kim  1202 Electrical Engineering
J Marangos  208 Blackett Laboratory
F. Mintert  12th floor Electrical Engineering
T Rudolph  1203 Electrical Engineering
B Sauer  213 Blackett Laboratory
DM Segal  Blackett Laboratory
M Tarbutt  207 Blackett Laboratory
RC Thompson  620 Blackett
J Tisch  205 Blackett Laboratory
T. Tufarelli  Blackett Laboratory

CDT office in Whiteley Suite

Miss. Miranda Smith, CDT Senior Administrator  115 Whiteley
Miss Veena Dhulipala, CDT Administrator  115 Whiteley
Appendix 2  Syllabus of course

The following brief descriptions of the content of the courses are indicative and changes may be made by the lecturer before each course starts. The descriptions given here may not always match the College Prospectus exactly, since the Prospectus is prepared up to 18 months before a course is given.

(i) Mathematics for Controlled Quantum Dynamics (Term 1): In these lectures important advanced mathematical tools and concepts will be presented, including linear algebra, time-dependent Schrödinger equations, attosecond dynamics, operator algebra, quasiprobabilities and quantum interaction models as well as basics of Mathematica.

(ii) LabVIEW and Instrumentation (Terms 1): The Labview module will introduce students to data acquisition and lab automation concepts. At the end of the course the students will be comfortable automating a small scale experiment by themselves. The course will use the LabVIEW programming environment and will be practically based.

The Instrumentation course (not assessed for MRes CQD students) will cover the following topics:
1. Sensors transducers and signals. General characteristics, departure from ideal behaviour and some examples.
2. Electronics for interfacing to sensors, conditioning signals, and amplifiers
3. Noise: types of, and design techniques for minimising.
4. The instrument as a System. Characterising sensor systems, mathematical description of behaviour and predicting input/output characteristics
5. Sampled signals, digital signal processing
Non-CQD students doing this course do laboratory sessions associated with the course. For CQD students these are replaced by our own laboratory activities.

Two optional practical projects will be undertaken. One of these will concentrate more on labview and its application (see above), the other more on optics, electronics and interfacing to microprocessors.

(iii) Introductory Quantum Information Theory (Term 1): Basic concepts will be introduced. The quantification and efficient verification of quantum correlations will be discussed. Applications and theory of quantum communication and simulation will be developed and algorithms for quantum computing devices will be presented. Architectures and physical requirements for possible implementations will be discussed. This course focuses on the conceptual framework underpinning the principles of quantum information theory.

(iv) Quantum Optics (Term 1): The course covers the following areas: Blackbody formula, Semiclassical tom-field interaction, Tw-level atoms and three-level atoms, Field quantisation, Various quantum states of light fields, Quasiprobabilities, Quantum atom-field interaction, Minimal coupling, Jaynes-Cummings model, Phononic motion, Quantum state reconstruction.

(v) Quantum Physics and Chemistry of Cold Matter (Term 1): In this lecture course you will learn the physics of cold atoms, ions and molecules. The course will cover both the theory and the modern experimental techniques of the field. The course will begin with lectures on atomic physics and atom-photon interactions, and will then cover a set of advanced topics including laser cooling, magnetic and optical trapping of atoms, formation and manipulation of quantum degenerate gases, ion trapping, cold molecules and collision physics at low temperatures.

(vi) Experimental Realizations of Controlled Quantum Dynamics (Term 2): Building on the introduction in earlier courses a thorough discussion of a variety of physical implementations for CQD will be taught, including matter based systems such as trapped atoms and ions, superconducting devices, quantum dots and photonic systems such as optical cavities, polarization and photon number degree of freedom of travelling light. Matter-light interfaces and their realizations will be discussed and strategies for combating noise will be discussed.
(vi) **Advanced Quantum Information** *(Term 2):* Building on Introductory Quantum Information theory, mixed states and general measurement theory will be described. The focus will be on advanced entanglement theory, advanced quantum algorithm theory, mechanisms of error correction and applications in areas such as many body physics.

(v) **Laboratory for Controlled Quantum Dynamics** *(Term 2):* All the students will be involved in the following three experiments: twin photon generation, atoms in magneto-optical trap and femto-second laser dynamics.
MRes IN CQD - PRELIMINARY PROJECT REVIEW FEEDBACK

Name of Presenter: -
Title of Project: -

THIS SHEET IS DESIGNED TO BE FILLED IN AT THE PROJECT REVIEW POSTER SESSION, YOU MAY NOT BE ABLE TO FORM AN OPINION ABOUT SOME OF THE QUESTIONS. DO NOT WORRY ABOUT THIS, JUST LEAVE THE RESPONSE BLANK

<table>
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<tr>
<th>Question</th>
<th>Yes</th>
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<td>• Definition of objectives clear?</td>
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<td>• Literature readily accessible?</td>
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<td>• Any progress problems so far?</td>
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Suggestions please:

Resources?
Equipment?
Literature?

Assessor's Name
MRes FULL PROJECT
ORAL PRESENTATION APPRAISAL SHEET

Name of Presenter: -

Title of Project: -

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Please circle the marks you wish to give the presenter.

Total (out of 40)

Assessor’s Name:
# MRes Project Report Assessment Form

Name of Student: 

## 1. Project Achievement
Mark out of 20 the project achievements, considering that the students are meant to spend around 600 hours in total on the MSc Project.

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## 2. Scientific Quality of the Work Done
Mark out of 20 the scientific quality of the work done. This includes the depth of the understanding shown and the quality of explanations of pertinent scientific background.

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## 3. Use of Skills
Mark out of 20 the level of skill shown by the student in carrying out the Project, based upon the content of the MSc Report. This might include skills in computing, experimental work, electronics, etc - whatever is appropriate for the individual MSc Project.

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## 4. Scientific Quality of the MSc Report
Mark out of 20 for the appropriate background material, choice and review of relevant literature, the clarity of the scientific aims, the clarity of the discussion and associated results, and justification of any conclusions.

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## 5. Presentation of the MSc Report
Mark out of 20 for the logical structure and presentation of the work, the use of English and the quality of the figures and graphs. Consider also the overall effectiveness of the MSc Report as a scientific document.

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**TOTAL MARK:** _______ out of 100.

P.T.O.
Comments. Please give written feedback to justify the marks awarded. *These written comments (which need not be typed) may be passed on to the student.* Please highlight the aspects that the student did well and provide constructive criticism and guidance on how to improve, if necessary.

Printed Name:

Signed Name:

Date:

Please return the completed form to the CDT Admin Office.