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Welcome to the College

Congratulations on joining Imperial College London, the only university in the UK to focus exclusively on science, medicine, engineering and business.

From Fleming’s discovery of Penicillin to Gabor’s invention of holography, Imperial has been changing the world for well over 100 years.

You’re now very much a part of this community of discovery and we hope you will take this opportunity to make your own unique contribution.

We’re committed to providing you with the very best academic resources to help you reach your true potential.

We also provide a dedicated support network and a range of specialist support services to make sure you have access to the appropriate help, whether that’s further training in an academic skill like note taking or simply having someone to talk to.

We actively encourage you to seek out help when you need it and try to maintain a healthy work-life balance. Our choice of over 380 clubs, societies and projects is one of the largest of any UK university, making it easy to do something different with your downtime. You also have access to gym and swimming facilities (following an annual fee of £30 in 2018-19) across our campuses.

Our Principles

In 2012 the College and Imperial College Union agreed ‘Our Principles’ a series of commitments made between students and the College. The Principles are reviewed annually by the Quality Assurance and Enhancement Committee and changes recommended for Senate approval.

**Imperial will provide through its staff:**
- A world class education embedded in a research environment
- Advice, guidance and support
- The opportunity for students to contribute to the evaluation and development of programmes and services

**Imperial will provide students with:**
- Clear programme information and assessment criteria
- Clear and fair academic regulations, policies and procedures
- Details of full programme costs and financial support
- An appropriate and inclusive framework for study, learning and research

**Imperial students should:**
- Take responsibility for managing their own learning
- Engage with the College to review and enhance provision
- Respect, and contribute to, the Imperial community

**The Imperial College Students’ Union will:**
- Support all students through the provision of independent academic and welfare assistance
- Encourage student participation in all aspects of the College
- Provide a range of clubs, societies, student-led projects and social activities throughout the year
- Represent the interests of students at local, national and international level

[www.imperial.ac.uk/students/our-principles](http://www.imperial.ac.uk/students/our-principles)
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Welcome from the Graduate School

**Professor Sue Gibson,**
**Director of the Graduate School**

The Graduate School has several roles but our main functions are to provide a broad, effective and innovative range of professional development workshops and to facilitate interdisciplinary interactions by providing opportunity for students to meet at academic and social events. Whether you wish to pursue a career in academia, industry or something else, professional skills development training will improve your personal impact and will help you to become a productive and successful researcher.

Professional development courses for Master’s students are called “Masterclasses” and they cover a range of themes, for example, presentation skills, academic writing and leadership skills (http://www.imperial.ac.uk/study/pg/graduate-school/professional-skills/masters/). All Masterclasses are free of charge to Imperial Master’s students and I would encourage you to take as many as you can to supplement your academic training. The Graduate School works closely with the Graduate Students’ Union (GSU) and is keen to respond to student needs so if there is an area of development training, or an activity that you would like us to offer, but which is not currently provided, please do get in touch (graduate.school@imperial.ac.uk).

The Graduate School also runs a number of exciting social events throughout the year which are an opportunity to broaden your knowledge as well as to meet other students and have fun. You should regularly check the Graduate School’s website and e-Newsletters to keep up to date with all the events and development opportunities available to you.

Finally, I hope that you enjoy your studies here at Imperial, and I wish you well.

---

**Dr Janet De Wilde,**
**Head of Postgraduate Professional Development**

I would like to welcome you to the Graduate School programme for postgraduate professional development. Our team of tutors come from a wide variety of experiences and we understand just how important it is to develop professional skills whilst undertaking postgraduate studies and research. Not only will this development improve success during your time at Imperial College, but it will also prepare you for your future careers. We are continually working to develop the courses we offer and over this year you will see a range of new courses including face-to-face workshops, interactive webinars and online self-paced courses. I encourage you to explore and engage with the diverse range of opportunities on offer from graduate school and I wish you well in your studies.

Janet De Wilde
The Graduate School

You automatically become a member of the Graduate School when you register as a postgraduate student at Imperial.

The Graduate School has been set up to support all postgraduate students at the College through:

- Training and development courses
- Networking activities, social and academic events to encourage cross-disciplinary interactions
- Forums to represent the views of postgraduate students throughout the College

‘Masterclass’ professional skills courses

You can see the full range of free professional skills courses for postgraduate students on the Graduate School website:

[www.imperial.ac.uk/study/pg/graduate-school/professional-skills/masters](http://www.imperial.ac.uk/study/pg/graduate-school/professional-skills/masters)

All courses can be booked online.

Contact us

Level 3, Sherfield Building, South Kensington Campus

020 7594 1383

graduate.school@imperial.ac.uk

[www.imperial.ac.uk/graduate-school](http://www.imperial.ac.uk/graduate-school)
Welcome from the Graduate Students’ Union (GSU)

I am delighted to welcome you to Imperial College! Let me introduce you to the Graduate Students’ Union (GSU). We are the representative body defending your interests as a post-graduate student in major decisions taken by the College. Beyond that, we work towards building a thriving post-graduate community that spans faculties and where students effectively communicate in an interdisciplinary way. Our committee is comprised by motivated post-graduate students like yourself, who have been appointed in university-wide elections and volunteer to make your experience at Imperial as fulfilling and enjoyable as possible.

So, what are we up to for this coming year 2018/19? We are going to focus on three major areas of action:

- Continue improving post-graduate well-being by increasing the quality of supervision and by creating strategies to tackle common mental health challenges in higher education.
- Develop the GSU to become central to the post-graduate community by improving the two-way flow of information, between the GSU and you.
- Organise exciting events around the topics of well-being, interdisciplinary research, and entrepreneurship.

As the GSU president, I would like to emphasise that Imperial College London is relying on its post-graduate students to maintain its position as a front-runner in world-class research and teaching. For us, the GSU, to be successful we need to receive as much of your input as possible. We want to work with you, for you!

Finally, I hope that you have a fantastic time here at Imperial and take advantage of the richness of opportunities that awaits you. If ever you have questions or ideas to share with us, please do not hesitate to get in touch with us and we are looking forward to seeing you at our events!

Ute Thiermann, GSU President 2018/19

gsu.president@imperial.ac.uk
1. **Introduction to the Department**

**Welcome from the Programme Director**

Professor Myungshik Kim,
Director, Quantum Systems Engineering Skills & Training Hub
EE1202 Electrical Engineering Department
020 759 47754
m.kim@imperial.ac.uk

Welcome to the MSc in Quantum Engineering.

The purpose of this handbook is to provide current and prospective students and staff with a detailed description of the MSc in Quantum Systems Engineering within the QSE Skills & Training Hub at Imperial College London. The programme is hosted by the Department of Physics with collaboration from a number of other College departments such as Electrical Engineering and Electronics, Materials and Imperial Business School.

**Administrative staff**

Indaka Weerasekera
QSE Hub Administrator
CDT Suite 407, Library Building
020 759 46359
i.weerasekera@imperial.ac.uk
**English language requirement**
If you are not a native English speaker you must meet the College’s English language requirements.

See the Admissions website for details:

[www.imperial.ac.uk/study/pg/apply/requirements/english](http://www.imperial.ac.uk/study/pg/apply/requirements/english)

For information on English language support available while you’re here, see page 29.

**Attendance and absence**
You must inform your Senior Undergraduate Tutor if you are absent from the College for more than three days during term. If the absence is due to illness you must produce a medical certificate after seven days. If you miss an examination through illness you must contact your Senior Undergraduate Tutor on the day and provide a medical certificate within five working days. If illness has impacted on your ability to take assessment, you should seek advice and support about making a claim for mitigating circumstances. Please note that there is a deadline of 5 working days from the date the assessment is due (hand-in date or examination date for example) to make a claim.

The Registry will be informed of all student non-attendances as the College is obliged to report the non-attendance of students on Tier 4 visas to the Home Office.

**Key dates 2017-18**

**Term dates**
- Autumn term: 29 September - 14 December 2018
- Spring term: 5 January - 22 March 2019
- Summer term: 27 April - 28 June 2019

**Closure dates**
- Christmas/New year: 24 December 2018 – 1 January 2019
  (College reopens on 2 January 2019)
- Easter holiday: 18 April – 23 April 2019
  (College reopens on 24 April 2019)
- Early May bank holiday: 6 May 2019
- Spring bank holiday: 27 May 2019
- Summer bank holiday: 26 August 2019

**Key events**
- Postgraduate Awards Ceremonies: tbc May 2019
- Imperial Festival and Alumni Festival: tbc May 2019
2. Programme Information

Introduction

The MSc will provide engineering and physical science graduates with the technical and entrepreneurial training necessary for successful careers in the growing quantum technology industry by:

- learning the underpinning science behind quantum technology and systems engineering;
- developing the entrepreneurial and business skills necessary to support the UK’s QT industry;
- acquiring laboratory and appropriate computational and modelling skills through advanced, supervised practical training;
- develop research skills by undertaking a supervised independent project;
- practising the professional skills necessary for working effectively in an academic or business environment via team exercises and specialised courses; including communicating their work to others, team working, organisational skills and effective time management.

This MSc course usually has a relatively small number of students (in comparison to many undergraduate courses) who have extensive access to the academic and support staff of the Hub. Students therefore should not hesitate to approach their Cohort Mentor, the Director, one of the Co-Directors or administrative staff for advice or assistance.

This handbook describes the framework of the course and its assessment but the Course Organiser and/or Course Committee 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.

The EPSRC Hub in Quantum Systems Engineering

The EPSRC Hub in Quantum Systems Engineering was established to provide multi-level interdisciplinary training and research in the field of quantum engineering (QE). The Hub supports a network of industry partners and other national centres (including the Imperial College hosted Centre of Doctoral Training in Controlled Quantum Dynamics). The training spans science, engineering, business and entrepreneurship and will focus on enabling graduates of the Hub to develop their careers in the emerging industries based on quantum engineering.
Key Staff

The staff primarily responsible for administering the courses are:

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Person</th>
<th>Room No</th>
<th>Tel Ext.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Organiser</td>
<td>Prof Myungshik Kim (m.kim)</td>
<td>EE1202</td>
<td>47754</td>
</tr>
<tr>
<td>Cohort 3 mentor</td>
<td>Dr Derek Lee (dkk.lee@)</td>
<td>B809</td>
<td>47602</td>
</tr>
<tr>
<td>QSE Management Board</td>
<td>Dr. Bruno Clerckx (b.clerckx)</td>
<td>EE816</td>
<td>46234</td>
</tr>
<tr>
<td></td>
<td>Dr. Mark Oxborrow (m.oxborrow)</td>
<td>RSM 2.04</td>
<td>41410</td>
</tr>
<tr>
<td></td>
<td>Dr. Mike Tarbutt (m.tarbutt)</td>
<td>B207</td>
<td>47741</td>
</tr>
<tr>
<td></td>
<td>Prof. Neil Alford (n.alford)</td>
<td>RSM 2.05</td>
<td>46724</td>
</tr>
<tr>
<td>Postgraduate Welfare Advisor</td>
<td>Dr. Arnaud Czaja (a.czaja)</td>
<td>726</td>
<td>41789</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Huxley)</td>
<td></td>
</tr>
<tr>
<td>Department Postgraduate Student</td>
<td>Cohort 1: Shane De Silva</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Representative</td>
<td>(shane.desilva16), Cohort 2:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Allan Pettipher</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(allan.pettipher13)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department Careers Advisor</td>
<td>Prof. Lesley Cohen</td>
<td>B912</td>
<td>47598</td>
</tr>
<tr>
<td></td>
<td><a href="mailto:ph.careers@imperial.ac.uk">ph.careers@imperial.ac.uk</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Department Director of Postgraduate</td>
<td>Prof. Stefan Maier</td>
<td>H903</td>
<td>46063</td>
</tr>
<tr>
<td>Studies</td>
<td>s.maier</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Email addresses are the name in brackets added to @imperial.ac.uk

To call a College number from outside, dial 020 759 plus the Internal phone number (above).

The Hub Management team will meet regularly with each cohort (during regular lunches in their 1st year and in 2-4 years). This has been established as a best practice among CDTs at Imperial. The Course Director will meet all 1st year students individually each term. The management team and student reps will convene monthly to discuss all matters of the Hub.

The Physics Masters Committee has overall responsibility for the Masters courses in the Department. The Director of Postgraduate Studies chairs the committee, and the course organisers and the student representatives are members of the committee. It meets twice a year.

Student Representation

There is one elected student representative of each cohort on the QSE 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.
Programme Structure

The general structure of the MSc is described below. For more information about the core and optional modules, please see Appendix A.

Term 1 Compulsory courses

- Introduction to Quantum Mechanics (Plato) – 6 ECTS;
- Tools for QE: Laboratory comprising Instrumentation, LabView and Mathematica (Sauer) - 5 ECTS;
- Systems Engineering (Fisk) - 6 ECTS;
- Quantum Information and Post Quantum Cryptography (Ling/Mintert) – 5 ECTS;
- Atoms and Photons (Kim) – 5 ECTS;
- QE Laboratory (Tarbutt) – 3 ECTS.

Term 1 Calendar

Week 1: Induction, Safety Briefing, Physics Reception, Introduction to CDT suite and fire safety; start of lectures.
Week 2: Election of Student Rep to QSE Board
End-Oct: Meeting with Cohort Mentor
End of Term 1: Project List provided to students
Weekly Cohort lunches

Term 2 Optional lecture courses

Students choose 18 ECTS from the list below:
- Platforms for Quantum Technology (Thompson) – 6 ECTS;
- Information Theory (Ling) – 6 ECTS;
- Metrology and Navigation for QE (Oxborrow) – 6 ECTS;
- Frontiers in Photonics Technology (Tisch/Popov) – 6 ECTS (comprising of Laser Technology and Fibre Optics Technology)
- Options offered elsewhere in the College (with the permission of the mentor and the director of the Quantum Engineering MSc) – 6 ECTS.

Term 2 Calendar

Week 1: Examinations; start of lecture courses
Weekly Cohort Lunches

Term 3 Compulsory courses and summer work

- Entrepreneurship & Innovation (QTIP) – 4 ECTS.
- Project literature review and project plan.
- Industry internship
- Full time project work - 38 ECTS.

Term 3 Calendar and summer period Calendar

Weeks 1- 3: Examinations (dependent on options). Note that for courses shared with other programmes, the examinations will be at the same time as those programmes.
Week 1: Start of Project Literature Review  
End of April: Submission of Literature Review  
Early June: Compulsory Entrepreneurship & Innovation (QTIP) programme  
Mid-July: Meeting with Cohort Mentor  
Aug-Sep (recommended): 2 week compulsory industry placement  
The **Summer Project** written report should be submitted by 20th September 2018. The presentations will be on Thursday 27th September 2018.  

Bi-weekly Cohort Lunches  

**Compulsory project work**  

Projects are offered by academic staff based on their current research, and may be offered together with other research organisations. All the projects involve industrial partners. The projects available will be known in Term 1 and students will get to make a choice in Term 2. The list below shows some of the related topics:  

- Laser development for quantum technology;  
- Quantum metrology;  
- Quantum communications;  
- Atom Interferometry for navigation and sensing;  
- Cavity-enhanced single photon sources for quantum information processing on waveguide chip;  
- Next generation ion chips for scalable ion quantum technology;  
- Quantum computing  
- Multiphoton interferometry.  

The principal assessment is through the written project report, which is marked independently by two members of staff. The project report should be a maximum of 40 pages long (or maximum of 20,000 words). 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 MSc 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.  

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  
  ‘Report submitted in partial fulfilment of the requirements of the degree of MSc of Imperial College London’  

- Title page followed by Abstract on a separate page (max 300 words)  
- Acknowledgement page
Graduate School Course

Students will also be expected to take relevant professional skills development courses offered by the Graduate School. These are usually offered in terms 1 and 2.

The timetable for the course will be distributed using iCalendar.

All Master’s students are required to undertake an online course in plagiarism awareness. More information about the course and how to enrol is available at:
http://www.imperial.ac.uk/study/pg/graduate-school/professional-skills/masters/plagiarism-online/.
Students on the MSc will need to have completed the course by November 30th 2018.

Imperial Mobile app

Don’t forget to download the free Imperial Mobile app for access to College information and services, including your programme timetable, College emails and a library catalogue search tool.

www.imperial.ac.uk/imperialmobile

Imperial Success Guide

The Imperial Success Guide is an online resource with advice and tips on the transition to Master’s level study. More than just a study guide, it is packed with advice created especially for Imperial Master’s students, including information on support, health and well-being and ideas to help you make the most of London.

www.imperial.ac.uk/success-guide
3. Assessment

Requirements for Programme Completion

The MSc in Quantum Engineering consists of three elements:

- Core courses (accounting for 38% of the overall course mark);
- Option courses (accounting for 21% of the overall course mark);
- Project (accounting for 41% of the overall course mark).

**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 with the course organiser immediately.

Formal feedback to the students in each activity is by way of a letter grade indicating the percentage band of their attainment. The grades are related to the marks by the following table:

<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>$70% \leq m \leq 79.9%$</td>
</tr>
<tr>
<td>B</td>
<td>$60% \leq m \leq 69.9%$</td>
</tr>
<tr>
<td>C</td>
<td>$50% \leq m \leq 59.9%$</td>
</tr>
<tr>
<td>D</td>
<td>$40% \leq m \leq 49.9%$</td>
</tr>
<tr>
<td>F</td>
<td>$M \leq 39.9%$</td>
</tr>
</tbody>
</table>

('E' is not used)

All assessments during the lecture courses and laboratory should be returned within two weeks with a letter grade and comments from the marker. The dissertation is marked after the end of the academic year; please contact the course organiser for details on how to get feedback on the report.

To pass the MSc, the candidate must achieve an aggregate mark of 50% or higher in each element. 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 an aggregate mark of ≥60%; and a mark of ≥60% for at least two of the elements and ≥50% for the other element.

A candidate can be considered for a Distinction if the candidate has achieved an aggregate mark of ≥70%; and a mark of ≥70% for at least two of the elements and ≥60% for the other element.

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

Although the pass mark for the MSc 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 QSE Skills Hub.

**Resits**

Resits for the written examinations will be held at the next available opportunity, usually the following academic year. College regulations allow only one resit, otherwise the student is deemed to have failed the course. Students will retake the examinations for the specific subjects they have failed.
Instruction to Candidates for Examinations

Students who are candidates for examinations are asked to note that all examinations are conducted in accordance with the College’s Academic Regulations, the Regulations for Programmes of Study and the Examination Regulations.

Instructions for exam candidates can be found here:


Academic Integrity and Academic Misconduct

As your programme of study continues, you will be taught the concept of academic integrity and how you can ensure that any work that you complete now, or in the future, conforms to these principles. This means that your work acknowledges the ideas and results of others, that it is conducted in an ethical way and that it is free from plagiarism.

Academic misconduct is the attempt to gain an academic advantage, whether intentionally or unintentionally, in any piece of assessment submitted to the College. This includes plagiarism, self-plagiarism, collusion, exam offences (cheating) or dishonest practice. Full details of the policy can be found at:


Definitions of the main forms of academic misconduct can be found below:

Plagiarism

Plagiarism is the presentation of another person’s thoughts, words, images or diagrams as though they were your own. Another form of plagiarism is self-plagiarism, which involves using your own prior work without acknowledging its reuse.

Plagiarism must be avoided, with particular care on coursework, essays, reports and projects written in your own time and also in open and closed book written examinations.

Where plagiarism is detected in group work, members of that group may be deemed to have collective responsibility for the integrity of work submitted by that group and may be liable for any penalty imposed, proportionate to their contribution.

Collusion:

This is the term used for work that has been conducted by more than one individual, in contravention of the assessment brief. Where it is alleged that there has been collusion, all parties will be investigated under the Academic Misconduct procedure.

Exam offences

Exam offences include behaviour such as bringing authorised material into an exam, attempting to communicate with others apart from the invigilator, trying to remove examination material without permission, taking an exam for someone else or getting someone else to take an exam for you.

Dishonest practice

Examples of dishonest practice include bribery, contact cheating (buying work from an essay mill or other individual to submit as your own), attempting to access exam papers before the exam, making a false claim for mitigating circumstances or providing fraudulent evidence, falsifying documentation or signatures in relation to assessment.
4. Board of Examiners

Board of Examiners

Professor Myungshik Kim
Professor Neil Alford
Dr Bruno Clerckx
Dr Mark Oxborrow
Dr Mike Tarbutt

External Examiners

Professor Hendrik Ulbricht, University of Southampton

It is common for Master’s level students to have some form of academic or social interaction with their external examiners at some point during or after their studies as well as during the assessment process itself.

It is inappropriate for you to submit complaints or representations direct to external examiners or to seek to influence your external examiners. Inappropriate communication towards an examiner would make you liable for disciplinary action.

A summary of External examiners reports from the previous academic year can be found here:

www.imperial.ac.uk/staff/tools-and-reference/quality-assurance-enhancement/external-examining/information-for-staff
Location and Facilities

Imperial has a number of campuses in London and the South East. All have excellent travel links and are easily accessible via public transport.

Your main location of study will be:

CDT Suite,
Imperial College London
South Kensington campus
London, SW7 2AZ
UK

Facilities

Computer access and printing is available at the CDT Suite where your desk is based. The Hub’s office is also located in the CDT Suite.

The Physics postgraduate contact is Loli Sanchez Rey who is located in Blackett 316.

Teaching and Supervision

The College standard working day is used, with 50-minute lectures commencing on the hour, starting at 09:00 at the earliest. Lectures are usually shared between the Whiteley Suite, CDT Suite and Blackett. The laboratory work is carried out in the MSc laboratory space in Blackett 418.

Maps

Campus maps and travel directions are available at:

[www.imperial.ac.uk/visit/campuses](http://www.imperial.ac.uk/visit/campuses)

Accessibility

Information about the accessibility of our South Kensington Campus is available online through the DisabledGo access guides:

[www.disabledgo.com/organisations/imperial-college-london-2](http://www.disabledgo.com/organisations/imperial-college-london-2)

Smoke-Free Policy

All Imperial campuses and properties are smoke-free. This means that smoking by staff and students is not permitted on or within 20 metres of College land. The policy covers all College properties, including student accommodation and sports grounds.

[www.imperial.ac.uk/smoke-free](http://www.imperial.ac.uk/smoke-free)
6. Placements

The College defines a placement as:

“work experience, assessed project work, a period of course-based study or a period of research (for which academic credit is awarded and/or where the student remains subject to College student regulations during the relevant period) and where there is a transfer of direct supervision of the student to a third party (i.e. where a member of staff at the third party acts as the day-to-day supervisor/manager) for a period of two weeks or more.”

Academic departments are responsible for managing any study or work placement which forms part of your degree programme. It is expected that you will contribute to the process of planning your placement.

For guidance on this, see the College’s Placement and Learning Policy and associated good practice:

www.imperial.ac.uk/about/governance/academic-governance/academic-policy/placement-learning

For more information on placements visit the Placements website:

www.imperial.ac.uk/placements

If you are considering/planning a placement outside the UK you should also refer to the Placement Abroad Handbook:

www.imperial.ac.uk/placements/information-for-imperial-college-students

**Further information about taking your compulsory two-week industry placement will be provided to you at the end of term 2.**
7. Working While Studying

If you are studying full time, the College recommends that you do not work part-time during term time. If this is unavoidable we advise you to work no more than 10–15 hours per week, which should be principally at weekends and not within normal College working hours.

Working in excess of these hours could impact adversely on your studies or health.

If you are here on a Tier 4 visa you can work no more than 20 hours a week during term time. Some sponsors may not permit you to take up work outside your studies and others may specify a limit.

If you are considering part-time work during term time you are strongly advised to discuss this issue with your supervisor or Personal/Senior Personal Postgraduate Tutor. If you are on a Tier 4 visa you should also seek advice from the International Student Support team regarding visa limitations on employment.

The College’s examination boards will not normally consider as mitigating circumstances any negative impact that part-time work during term-time may have had on your performance in examinations or in other assessed work. Examinations or vivas cannot be rescheduled to accommodate your part-time working arrangements.
8. Health and Safety

You are responsible for looking after your own health and safety and that of others affected by your College-related work and leisure activities. You must:

- comply with all local and College policies, procedures and codes of practice and with the arrangements which the College has in place to control health and safety risks.
- ensure that your activities do not present unnecessary or uncontrolled risks to yourself or to others.
- attend appropriate induction and training.
- report any accidents, unsafe circumstances or work-related ill health of which you become aware to the appropriate person.
- not interfere with any equipment provided for Health and Safety.
- inform your supervisor or the person in charge of the activity in cases where you are not confident that you are competent to carry out a work or leisure activity safely, rather than compromise your own safety or the safety of others.

The College’s Health and Safety Policy can be found at:


Lab Safety

In a course that makes use of high-voltage power supplies, lasers and chemicals, safety is of paramount importance. All students are issued with the current version of the Physics Department Safety Booklet at the start of the MSc course, and all students are required to attend the College Laboratory Safety lecture and to pass the online Laser Safety course http://www.imperial.ac.uk/safety/lasersafety/. This is necessary in order to be able to register for the use of lasers in the laboratory. The Risk Assessment Foundation Training course http://www3.imperial.ac.uk/staffdevelopment/safety/index/raft, which teaches how to assess the potential hazards of an experiment, is also compulsory and you will need to prepare a risk assessment for some experimental equipment you design as part of the laboratory course.

It is important to bear in mind safety issues when working in the laboratory, particularly when working with laser beams. Detailed guidance on safety in the MSc laboratory is issued to students with the rest of the laboratory details, and College guidance on safety may be found here.

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.

Your Departmental safety contact is:

Mr Stefan Hoyle,
Head of Health & Safety (FONS)
Room 518, Sir Alexander Fleming Building
Tel: 07872 850 018
E-Mail: s.hoyle@imperial.ac.uk

You will be required to attend both the introductory safety briefing and the laboratory safety briefing, which are held in the first three weeks of term.
The College Safety Department

The Safety Department offers a range of specialist advice on all aspects of safety. This includes anything which you feel might affect you directly, or which may be associated with teaching, research or support service activities.

The College’s activities range from the use of hazardous materials (biological, chemical and radiological substances) to field work, heavy or awkward lifting, driving, and working alone or late.

All College activities are covered by general health and safety regulations, but higher risk activities will have additional requirements.

The Safety Department helps departments and individuals ensure effective safety management systems are in place throughout the College to comply with specific legal requirements.

Sometimes the management systems fail, and an accident or a near-miss incident arises; it is important that we learn lessons from such situations to prevent recurrence and the Safety Department can support such investigations. All accidents and incidents should be reported online at:

www.imperial.ac.uk/safety

To report concerns or to ask for advice you should contact your programme director, academic supervisor or departmental safety officer in the first instance. You may also contact the Safety Department directly.

Occupational Health requirements

The College Occupational Health Service provides services to:

- protect health at work
- assess and advise on fitness for work
- ensure that health issues are effectively managed

The Service promotes and supports a culture where the physical and psychological health of staff, students and others involved in the College is respected, protected and improved whilst at work.

www.imperial.ac.uk/occupational-health
9. College Policies and Procedures

Regulations for Students
All registered students of the College are subject to the Regulations for Students, the College Academic and Examination Regulations and such other regulations that the College may approve from time to time.

www.imperial.ac.uk/about/governance/academic-governance/regulations

www.imperial.ac.uk/students/terms-and-conditions

Academic Feedback Policy
We are committed in providing you with timely and appropriate feedback on your academic progress and achievement, enabling you to reflect on your academic progress. During your study you will receive different methods of feedback according to assessment type, discipline, level of study and your individual need. Further guidance on the Policy of Academic Feedback can be found on the Academic Governance website:

http://www.imperial.ac.uk/media/imperial-college/administration-and-support-services/registry/academic-governance/public/academic-policy/academic-feedback/Academic-feedback-policy-for-taught-programmes.pdf

Provisional Marks Guidance
Provisional marks are agreed marks that have yet to be ratified by the Board of Examiners. These results are provisional and are subject to change by the Board of Examiners. The release of provisional marks is permitted except in certain circumstances. Further information can be found in the Guidelines for Issuing Provisional Marks to Students on Taught Programmes:


Late Submission Policy
You are responsible for ensuring that you submit your coursework assessments on time and by the published deadline. Any piece of assessed work which is submitted beyond the published deadline (date and time) would be classed as a late submission. Further guidance on Late Submission of Assessments can be found on the Academic Governance website:

https://www.imperial.ac.uk/media/imperial-college/administration-and-support-services/registry/academic-governance/public/academic-policy/marking-and-moderation/Late-submission-Policy.pdf

Academic Misconduct Policy and Procedures
It is important that you learn how to properly attribute and acknowledge the work, data and ideas of others. Plagiarism is scientific misconduct, and students whose assessments can be shown to contain plagiarism are subject to penalties as outlined in the College’s Misconduct Policy and Procedures.

www.imperial.ac.uk/about/governance/academic-governance/academic-policy/complaints-appeals-and-discipline
**Appeal and Complaints Procedures**
We have rigorous regulations in place to ensure assessments are conducted with fairness and consistency. In the event that you believe that you have grounds for complaint about academic or administrative services, or wish to appeal the outcome of an assessment or final degree, we have laid out clear and consistent procedures through which complaints and appeals can be investigated and considered:

- [www.imperial.ac.uk/about/governance/academic-governance/academic-policy/complaints-appeals-and-discipline](http://www.imperial.ac.uk/about/governance/academic-governance/academic-policy/complaints-appeals-and-discipline)

**Student Disciplinary Procedure**
The College has the right to investigate any allegation of misconduct against a student and may take disciplinary action where it decides, on the balance of probabilities, that a breach of discipline has been committed. The general principles of the Student Disciplinary Procedure are available on the College website:

- [www.imperial.ac.uk/admin-services/secretariat/college-governance/charters/ordinances/students/](http://www.imperial.ac.uk/admin-services/secretariat/college-governance/charters/ordinances/students/)

**Intellectual Property Rights Policy**
For further guidance on the College's Intellectual Property Rights Policy is available on the College website:

- [www.imperial.ac.uk/students/enterprising-students/intellectual-property/](http://www.imperial.ac.uk/students/enterprising-students/intellectual-property/)

**Use of IT Facilities**
View the Conditions of Use of IT Facilities:

- [http://www.imperial.ac.uk/admin-services/ict/self-service/computers-printing/staff-computers/conditions-of-use-for-it-facilities/](http://www.imperial.ac.uk/admin-services/ict/self-service/computers-printing/staff-computers/conditions-of-use-for-it-facilities/)

10. Well-being and Advice

**Student Space**
The Student Space website is the central point for information on health and well-being.

[www.imperial.ac.uk/student-space](http://www.imperial.ac.uk/student-space)

**Departmental support and College tutors**
Your Department has a system of academic and pastoral care in place to make sure you have access to the appropriate support throughout your time here. This includes:

**Personal Postgraduate Tutor**
The Department's Personal Postgraduate Tutor can offer pastoral support and advice. You can arrange to have a meeting with them at any time during your studies – what you discuss will be completely confidential.

If necessary they will direct you to an appropriate source of support.

Please add department-specific information.

**Advice services**
The tutor system is complemented by a College-wide network of advice and support. This includes a number of specialist services.

**Careers Service**
The Careers Service has strong links to your Department and you will have a named Careers Consultant and Placement and Internship Adviser who will run both group sessions and individual meetings within your Department. You can arrange to meet with your linked Careers Consultant or Placement and Internship Adviser either in your Department or centrally at the South Kensington Campus on Level 5, Sherfield Building where the Careers Service is based.

Visit the Career Service’s website to:
• Book a careers appointment
• Find resources and advice on successful career planning

www.imperial.ac.uk/careers

Counselling and Mental Health

The Student Counselling and Mental Health Advice Service offers short-term counselling to all registered students. The service is free and confidential. Counsellors are available at the South Kensington, Hammersmith and Silwood Park Campuses.

www.imperial.ac.uk/counselling

Financial support and tuition fees

If you’ve got any questions about student financial support (loans, scholarships and research council studentships, US and Canadian loans) then contact the Student Financial Support team:

020 7594 9014
student.funding@imperial.ac.uk

If you suddenly find yourself in financial difficulties or experience an unexpected change in circumstances, you may be eligible to apply for emergency financial help through the Student Support Fund. The Fund offers a one-off payment of up to £2,000 to cover such emergencies as last minute accommodation and travel necessities, equipment and childcare. It does not have to be repaid.

http://www.imperial.ac.uk/students/fees-and-funding/financial-assistance/student-support-fund/

For tuition fees queries, contact the Tuition Fees team:

020 7594 8011
tuition-fees@imperial.ac.uk

Imperial College Union (ICU) Advice Centre

Imperial College Union runs the Advice Centre independently of the College with advisers on hand to provide free, confidential, independent advice on a wide range of welfare issues including housing, money and debt, employment and consumer rights, and personal safety.

www.imperialcollegeunion.org/advice

Student Hub

The Student Hub represents a single point of contact for all key administrative information and support. The Student Hub team can help you with enquiries about:

• Accommodation (including checking contracts for private accommodation)
• Admissions
• International student enquiries
• Research degrees
• Student financial support
• Student records
• Tuition fees
Health Services

NHS Health Centre and finding a doctor

Even if you’re fit and healthy we recommend that you register with a local doctor (GP) as soon as you arrive in London. For help finding your nearest GP see the Student Space website:

www.imperial.ac.uk/student-space/here-for-you/find-a-doctor

There is the Imperial College Health Centre on our South Kensington Campus which you may visit during clinic hours if you’re feeling unwell. Students living within the practice catchment area are encouraged to register with the Centre.

www.imperialcollegehealthcentre.co.uk

NHS Dentist (based in the Imperial College Health Centre)

Imperial College Dental Centre offers a full range of NHS and private treatment options.

www.imperial.ac.uk/student-space/here-for-you/dentist

Disability Support

Disability Advisory Service

The Disability Advisory Service provides confidential advice and support for all disabled students and students with specific learning difficulties.

If you think you may have dyslexia or another specific learning difficulty but have never been formally assessed, the Disability Advisory Service offers initial screening appointments.

Room 566, Level 5, Sherfield Building, South Kensington Campus

020 7594 9755

disabilities@imperial.ac.uk

www.imperial.ac.uk/disability-advisory-service

Departmental Disability Officers

Departmental Disability Officers are the first point of contact within your department. They can apply for additional exam arrangements on your behalf, and will facilitate support within your Department.

More information on Departmental Disability Officers is available at:

www.imperial.ac.uk/disability-advisory-service/support/ddos
More information on procedures for the consideration of additional exam arrangements in respect of disability is available at:


Library and IT

Information and Communications Technologies (ICT)

If you’re having problems with technology (including computers, laptops and mobile devices), you can get help from ICT’s Service Desk.

020 7594 9000
www.imperial.ac.uk/ict/service-desk

Software shop

The Software shop offers a variety of general and subject specific software programs and packages for free or at a discounted price for Imperial students.

www.imperial.ac.uk/admin-services/ict/shop/software

Library services

The Central Library at South Kensington is open around the clock pretty much all year. Make sure you find out who your departmental librarian is as they’ll be able to help you find resources for your subject area. Also, don’t forget to check out the Library’s range of training workshops and our other campus libraries for access to specialist medicine and life sciences resources. Alongside these physical spaces and resources, the Library provides over 170,000 electronic books, journals and databases available both on and off campus and a free document delivery service to help you source books and articles from around the UK and the rest of the world:

www.imperial.ac.uk/library

Religious support

The Chaplaincy Multi-faith Centre has chaplains from many different religions, as well as prayer rooms and information on places of worship. In addition, it runs meditation classes and mindfulness workshops for stress management. There is a student-run Islamic prayer room on campus and separate areas available for male and female Muslims.

www.imperial.ac.uk/chaplaincy
Support for International Students

English language support

The Centre for Academic English provides free in-sessional English courses for international students while they are studying. These include classes and workshops on academic language, social language, the four skills of reading, writing, listening and speaking, 1-1 consultations with a tutor to work on a piece of academic writing or an oral presentation, self-study resources in the VLE Blackboard, and the Conversation Project, which partners students with a native-speaker volunteer to practise social and conversational English.

www.imperial.ac.uk/academic-english

International Student Support team

Students from outside the UK make up around half of our student population, so our International Student Support team offers year-round support to help our international students settle into Imperial life. This includes UK visa and immigration advice and trips to different places of interest.

www.imperial.ac.uk/study/international-students
11. Student Records and Data

The Student Records and Data Team are responsible for the administration and maintenance of the student records for all students studying at the College. This includes enrolments, programme transfers, interruption of studies, withdrawals and processing of examination entry for research degree students. The team also use this information to fulfil reporting duties to the Student Loans Company, Transport for London and the UKVI, as well as other external bodies.

The Team is responsible for the processing of student results and awards on the student record system as well as the production and distribution of academic transcripts and certificates of award.

The Student Records and Data Team produce a variety of standard document requests for both current and previous students including council tax letters, standard statements of attendance and confirmation of degree letters.

Student records and examinations

📞 +44 (0)20 7594 7268
✉️ records@imperial.ac.uk

Degree certificates

📞 +44 (0)20 7594 8037
✉️ certificates@imperial.ac.uk
12. Work-life Balance

The pace and intensity of postgraduate study at Imperial can be demanding so it's important to find time for outside interests.

**Imperial College Union**
The Union’s range of 380+ student-led clubs, societies and projects is one of the largest of any UK university, opening up lots of ways for you to enjoy your downtime.

[www.imperialcollegeunion.org/about-us](http://www.imperialcollegeunion.org/about-us)

**Graduate Students’ Union**
The Graduate Students’ Union is the postgraduate arm of Imperial College Union. The GSU works alongside the Imperial College Union President to ensure that the requirements of postgraduate students are catered for. It also organises a number of academic and social events during the year.

**Physical Activity Sport**
Imperial College has a wide range of sports and activities on offer that cater for all standards and abilities. We have a recreational activity offer, competitive sports teams and an elite sport programme. We are dedicated to ensuring we have a diverse, inclusive and exciting offer for all.

With an annual fee of £40 you will get use of the gym and swimming facilities on our campuses.

[www.imperial.ac.uk/sport](http://www.imperial.ac.uk/sport)
13. Student feedback and representation

**Feedback from Students**
The College and Union is committed to continually improving your education and wider experience and a key part of this is your feedback. Feedback is thoroughly discussed by your student representatives and staff.

**Student Representation**
Student Representatives are recruited from every department to gather feedback from students to discuss with staff. More information about the role, and instructions on how to become an academic representative, are available on the Imperial College Union (ICU) website.

[www.imperialcollegeunion.org/your-union/your-representatives/academic-representatives/overview](http://www.imperialcollegeunion.org/your-union/your-representatives/academic-representatives/overview)

**Staff-Student Committee**
Staff-Student Committees are designed to strengthen understanding and improve the flow of communication between staff and students and, through open dialogue, promote high standards of education and training, in a co-operative and constructive atmosphere. College good practice guidelines for staff-student committees are available here:

[www.imperial.ac.uk/about/governance/academic-governance/academic-policy/student-feedback](http://www.imperial.ac.uk/about/governance/academic-governance/academic-policy/student-feedback)
14. Student Surveys

Your feedback is important to your department, the College and Imperial College Union.

Whilst there are a variety of ways to give your feedback on your Imperial experience, the following College-wide surveys give you regular opportunities to make your voice heard:

- PG SOLE lecturer/module Survey or departmental equivalent
- Student Experience Survey (SES)

The PG SOLE lecturer/module survey or equivalent runs at the end of the autumn and spring term(s). This survey is your chance to tell us about the modules you have attended and the lecturers who taught them.

For PG SOLE (or equivalent survey) your lecturers will receive their individual numerical results and comments shortly after the survey closes. To make the most of your opportunity to give your feedback, please do not use offensive language or make personal, discriminatory or abusive remarks as these may cause offence and may be removed from the results. Whilst this survey is anonymous, please avoid self-identification by referring to personal or other identifying information in your free text comments.

The Student Experience Survey (SES) is another opportunity to leave your views on your experience. This survey will cover your induction, welfare, pastoral and support services experience.

The Postgraduate Taught Experience Survey (PTES) is the only national survey of Master’s level (MSc, MRes, MBA and MPH) students we take part in. This is the only way for us to compare how we are doing against the national average and to make changes that will improve our Master’s students’ experience in future. PTES covers topics such as motivations for taking the programme, depth of learning, organisation, dissertation and professional development. PTES last ran in spring term 2018 and will next run in Spring 2020.

All these surveys are anonymous and the more students that take part the more representative the results so please take a few minutes to give your views.

The Union’s “You Said, We Did” campaign shows you some of the changes made as a result of survey feedback:

www.imperialcollegeunion.org/you-said-we-did

If you would like to know more about any of these surveys or see the results from previous surveys, please visit:

www.imperial.ac.uk/students/academic-support/student-surveys/pg-student-surveys

For further information on surveys, please contact the Registry’s Surveys Team at:

surveys.registrysupport@imperial.ac.uk
Alumni Services
When you graduate you will be part of a lifelong community of over 190,000 alumni, with access to a range of alumni benefits including:

- discounts on further study at the College and at Imperial College Business School
- alumni email service
- networking events
- access to the Library and online resources
- access to the full range of careers support offered to current students for up to three years after you graduate
- access to our Alumni Visitor Centre at the South Kensington Campus, with free Wifi, complimentary drinks, newspapers and magazines, and daytime left luggage facility

Visit the Alumni website to find out more about your new community, including case studies of other alumni and a directory of local alumni groups in countries across the world.

www.imperial.ac.uk/alumni
## A. Module Information

<table>
<thead>
<tr>
<th>Module Name</th>
<th>Module Code</th>
<th>ECTS</th>
<th>Core/Option</th>
<th>Learning Outcomes</th>
<th>Assessment</th>
<th>Module Leader</th>
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</thead>
</table>
| Introductory Quantum Mechanics               | PH9-QQM     | 6    | C           | • Identify and describe the concepts of wave functions, operators, uncertainty principles and expectation values, enabling students from various undergraduate backgrounds to identify the key features of the nature and technology of quantum engineering systems.  
  • Explain how quantum mechanics can be used to interpret the properties of certain useful systems.  
  • Use the appropriate mathematical tools to describe physical systems and their dynamics in quantum mechanical terms.  
  • Construct quantum descriptions of simple physical phenomena. | 3 x Problem Sheets (33%, 33%, 34%)  | Dr Doug Plato |
| Tools for QE: Laboratory                     | PH9-CINSP/PH9-CLVIEW/PH9-CMATH | 5    | C           | • Describe the general principles of instrumentation and data acquisition;  
  • Explain the principles of computer control and automation of instruments and experiments;  
  • Demonstrate how the LabView programming environment can be used to build and control simple instrumentation;  
  • Develop well-structured and documented control software;  
  • Construct a computer control system for a small-scale experiment;  
  • Assess how instrumentation and data acquisition tools and techniques can be best applied to the design and control of experiments. | Electronics Lab (Report 50%, + Demo code 50%)  
Mathematica (4 x worksheets)  
LabView (mini project. 100%) | Professor Ben Sauer |
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<tr>
<th>Subject</th>
<th>Code</th>
<th>Credits</th>
<th>Level</th>
<th>Description</th>
<th>Assessment</th>
<th>Lecturer</th>
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<tbody>
<tr>
<td>Systems Engineering</td>
<td>PH9-QSE</td>
<td>6</td>
<td>C</td>
<td>Describe systems thinking as something that pervades the understanding of everything that can be done in a complex world; Identify the characteristics of systems and state the properties of systems and their interactions; Use systems thinking to assess of engineering viability of new technologies such as quantum technology; Develop original ideas; Construct radically new engineering systems (quantum engineering systems) and concepts.</td>
<td>3 x Class Exercises (33%, 33%, 34%)</td>
<td>Professor David Fisk</td>
</tr>
<tr>
<td>Quantum Engineering Lab</td>
<td>PH9-CGLABP</td>
<td>3</td>
<td>C</td>
<td>Demonstrate the practical laboratory skills for Quantum Engineering; Know how to work safely in a practical Quantum Engineering setting; Name the diagnostic tools available in a practical Quantum Engineering setting, and demonstrate how to use them; Demonstrate the approach to solving practical problems in Quantum Engineering; Demonstrate how to build instrumentation; Demonstrate how to stabilize the frequency of a laser; Demonstrate how to control the polarization, spatial mode and delivery of laser light; Describe the practical methods used to produce ultra-cold atoms; Describe the degree of control required to reveal quantum interference; Demonstrate good practice in recording and analysing data; Demonstrate good practice in writing up the results of laboratory work</td>
<td>3 x Lab reports (33.3% each)</td>
<td>Dr Mike Tarbutt</td>
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<tr>
<td>Course Title</td>
<td>Code</td>
<td>Credits</td>
<td>Grade</td>
<td>Course Description</td>
<td>Assessment</td>
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| Quantum Entrepreneurship & Innovation            | PH9-QBUS | 4       | C     | • Work on a series of case studies that will offer a unique opportunity to understand globally relevant applications of quantum technologies.  
                                                |                                                     |                                               |                                | • Develop an enterprising mindset and learn business concepts during a hands-on boot-camp delivered by Imperial Enterprise Lab.  
                                                |                                                     |                                               |                                | • Gain insights about converting an idea into an opportunity, commercialising an innovation and building a resilient business model.  
                                                |                                                     |                                               |                                | • Students will also work in teams to develop and pitch a business idea. Each team will be guided by experienced venture coaches from academia and industry, and participate in a rigorous course on the theory of entrepreneurship alongside their practical work. |
| Atoms & Photons                                  | PH9-QAP  | 5       | C     | • State the non-classical features of quantum systems;  
                                                |                                                     |                                               |                                | • Describe atom-photon interactions using a quantum-mechanical description;  
                                                |                                                     |                                               |                                | • Apply Dirac notations and matrix algebra for the atom-field interaction;  
                                                |                                                     |                                               |                                | • Criticise the experimental advancements in controlling atoms and photons and their interactions. |
| Quantum Information and Post-Quantum Cryptography | F342QIPQ | 5       | C     | • To explain basic notions of quantum information theory, such as qubits, quantum gates and readout;  
                                                |                                                     |                                               |                                | • To state the role of these elementary concepts in the functionality of a quantum computer;  
                                                |                                                     |                                               |                                | • To describe the basic protocols of quantum teleportation and quantum cryptography;  
                                                |                                                     |                                               |                                | • To describe the concept of quantum entanglement and its role in quantum cryptography;  
                                                |                                                     |                                               |                                | • To explain the basic concepts of classical cryptography; | 2 x Written exercises (25%) + Oral presentation (75%)                  | Dr Florian Mintert & Dr Cong Ling |
To discuss the implications of quantum computation on classical cryptography based on factorisation discrete-log problems;
To select new cryptography protocols that are resilient to quantum computing attacks, particularly those based on codes and lattices.

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<th>Code</th>
<th>Level</th>
<th>Exam</th>
<th>Tutor</th>
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<tbody>
<tr>
<td>Quantum Metrology</td>
<td>PH9-QMNQE</td>
<td>6 O</td>
<td>Written exam</td>
<td>Dr Mark Oxborrow</td>
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<tr>
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<td>(100%)</td>
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<tr>
<td>Describe the fundamental principles and techniques of metrology, and their extension to the quantum domain; Describe the key engineering techniques and processes necessary for a practical implementation of a classical or quantum system; List the S.I. unit system and its quantum extensions; Explain the fundamental technology of quantum devices; Critically dissect a specification sheet of a quantum device; Design solutions to practical 'real-world' problems in metrology and applications in positioning, navigation and timing using quantum devices, and explain the engineering issues (such as resilience and robustness); Explain the limitations of quantum devices and the techniques to mitigate the limitations (such as screening).</td>
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| Platforms for Quantum Technology               | PH9-CERCQD | 6 O | Written Examination + 5 x coursework | Professor Richard Thompson |
|                                                |           |     |                                           |                         |
| At the end of this module, students will have gained an understanding of the variety of physical implementations of Quantum Technology and Quantum Engineering including simple components and circuits. |

| Information                                    | EE4-40   | 6 O | Written Examination (100%) | Dr Cong Ling              |
|                                                |          |     |                             |                         |
| This course will set out the fundamental concepts of information theory. Expressions for the information generated by discrete memoryless sources and sources with memory will be established and the loseless source coding theorem will be proved and the asymptotic equipartition theorem will be presented. The practical significance of the source coding theorem will be examined and examples of source coding will be given. |
The concept of channel capacity will be introduced and the calculation of the capacity of important communication channels and systems will be dealt with. The capacity theorem will be proved for various cases and its practical significance will be examined, and simple examples of coding aimed at achieving the results promised by the capacity theorem will be outlined. The concept of source coding, subject to fidelity criteria, (rate distortion theory) will be introduced. Finally, the basics of network information theory will be given, which is presently the most dynamic research area in information theory.

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<th>Course</th>
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| Laser Technology              | PH9-OLT | 3     | O    | - To help students develop an understanding of the basic principles and practical implementations of commercially important laser technology and its “real-world” applications.  
- To learn the properties of important lasers and how these lend themselves to different applications.  
- To be able to perform both qualitative and quantitative analysis relating to laser design and key applications. | Written Examination (100%)    | Professor John Tisch |
| Fibre Optics Technology       | PH9-OFT | 3     | O    | - Understanding of the fundamental parameters and features of optical fibres  
- The ability to make simple calculations (number of modes, dispersion effects, non-linear thresholds etc)  
- Familiarisation with the key fibre optical components and their functions.  
- Understanding of basic types and architecture of fibre lasers, amplifiers and their applications | Written Examination (100%)    | Dr Sergei Popov        |