

| Programme Information                |                |                       |
|--------------------------------------|----------------|-----------------------|
| Programme Title                      | Programme Code | HECoS Code            |
| Computing (Security and Reliability) | G5U21          | For Registry Use Only |

| Award          | Length of Study             | Mode of Study | Entry Point(s)      | Total Credits |      |
|----------------|-----------------------------|---------------|---------------------|---------------|------|
|                |                             |               |                     | ECTS          | CATS |
| MSc            | 1 Calendar Year (12 months) | Full-time     | Annually in October | 90            | 180  |
| PG Diploma     | N/A                         | N/A           | N/A                 | 60            | 120  |
| PG Certificate | N/A                         | N/A           | N/A                 | 30            | 60   |

The PG Diploma and PG Certificate are exit awards and are not available for entry. All students must apply to and join the MSc.

The Certificate and Diploma are offered in Computing and do not include the specialism in the title. This is due to the fact that it would be very difficult to identify if a student has indeed covered 30 or 60 ECTS worth of credit within the specialism. We want to help the students with the exit awards, so keeping this generic would only increase the flexibility of the awards.

| Ownership            |                         |                           |                         |
|----------------------|-------------------------|---------------------------|-------------------------|
| Awarding Institution | Imperial College London | Faculty                   | Faculty of Engineering  |
| Teaching Institution | Imperial College London | Department                | Computing               |
| Associateship        | N/A                     | Main Location(s) of Study | South Kensington Campus |

| External Reference   |   |
|--|---|
| Relevant <a href="#">QAA Benchmark Statement(s)</a> and/or other external reference points | QAA Subject Benchmark Statement: Computing <a href="http://www.qaa.ac.uk/quality-code/subject-benchmark-statements/computing">www.qaa.ac.uk/quality-code/subject-benchmark-statements/computing</a> |
| <a href="#">FHEQ Level</a>   | Level 7 – Master’s  |
| <a href="#">EHEA Level</a>   | 2 <sup>nd</sup> Cycle   |

| External Accreditor(s) (if applicable) |     |                        |     |
|--|-----|------------------------|-----|
| External Accreditor 1:                 | N/A |                        |     |
| Accreditation received:                | N/A | Accreditation renewal: | N/A |

| Collaborative Provision |                    |                          |                       |
|-------------------------|--------------------|--------------------------|-----------------------|
| Collaborative partner   | Collaboration type | Agreement effective date | Agreement expiry date |

|  |   |     |     |
|--|---|-----|-----|
| N/A                                      | N/A   | N/A | N/A |
| <b>Specification Details</b>             |   |     |     |
| Programme Lead                           | Dr Anandha Gopalan, Director of Taught PG Studies |     |     |
| Student cohorts covered by specification | 2023-24 entry                                     |     |     |
| Date of introduction of programme        | October 2010                                      |     |     |
| Date of programme specification/revision | February 2023                                     |     |     |

### **Programme Overview**

This degree specialises in the processes and mechanisms by which computer-based equipment, information and services are protected from unintended or unauthorised access.

This taught postgraduate programme is aimed at students who may not have studied computing exclusively, but who have studied a substantial amount of computing already. If you want to become a specialist in this area of computing, this degree will provide a first crucial step towards that goal.

The programme enables you to develop and master skills in a broad range of advanced computing concepts and technologies. You are given liberty to tailor the programme to your own needs and interests whilst engaging in modules delivered by world-renowned subject experts. Most of the subjects studied will be related to security and reliability, but you have the flexibility to supplement this with three modules from any of the master's level subjects taught in the Department of Computing, subject to timetable constraints. These range from blockchain to quantum computing, from formal program analysis to deep learning. It is expected that the modules build upon knowledge gained in a good first degree in computer science or a closely related subject such as electrical engineering. The expectation of graduates is that this programme enables them to have rewarding careers in computing or in a profession that has computing as a core component.

The programme is taken over 12 months, full-time, with a single entry point per year in October. In the Autumn and Spring terms, timetable permitting, you will study modules from a very large range (approximately 20 per term) of taught electives. This high level of choice will allow you to extend and deepen your knowledge in the areas of computing that fit best with your individual background and interests. Pre-session material as appropriate will be provided to help with any pre-requisites. To further enhance the flexibility and research proximity of the programme, you will have the option of replacing one taught elective with the Independent Study Option (ISO) module in the spring term. The ISO involves individual study of an advanced topic selected by you, under the supervision of a member of staff, culminating in a written report and presentation. The remainder of the degree, from May to September, is devoted to a major individual project, resulting in a written dissertation and oral presentation.

You will be taught by leading academic staff who are experts in their fields, and whose research has been recognised to be at the forefront of current advances in computer science. The teaching is also well-recognised to be informed by this research. The programme is delivered in the world-leading Department of Computing at Imperial College London. The Department has leading research groups in Programming Languages, Artificial Intelligence, Software Engineering, Data Science, Theory and Algorithms and Visual Computing. Many groups and members of our research staff are at the forefront of research in their respective fields: 56% of the research in the Department of Computing ranked at 4\*, for "Quality that is world-leading in terms of originality, significance and rigour" in the last Research Excellence Framework exercise. The department has many collaborations with other faculties at Imperial, and leading international institutions, as well as with industry. We also house dedicated research centres, including the Dyson Robotics Lab, the Data Science Institute, the Centre for Integrative Systems Biology and Bioinformatics, the Hamlyn Centre for Medical Image Computing and Robotics, and more.

Graduates from the Department of Computing have gone on to work in leading companies such as Microsoft, Amazon, DeepMind, Facebook, Google, and Twitter; many have also progressed to PhD research at Imperial and elsewhere. A graduate of the department recently had his company valued at \$1 billion, and two other graduates sold their AI startup to Twitter for \$150 million.

Throughout the year, leading companies visit the department to give presentations on the Applications of

Computing in Industry. These are on a broad range of industrially-relevant topics including AI, Data Science, Programming Languages, Natural Language Processing and Software Engineering. We pride ourselves in presenting you with a great opportunity to learn about the relevance and application of what you are studying and enabling you to speak directly with people working on industrial applications. You will also have the opportunity to attend dedicated extracurricular tutorials and seminars on computing from guest speakers, held at a time that does not overlap with elective modules.

All software packages required to undertake this degree programme are provided to the students as part of the programme fee. We use digital technology to bring further benefits to our education programmes, drawing from investments made and skills gained during the pandemic. We deliver our education as a useful blend of face-to-face and digital learning. This will also prepare our students well for a more hybrid work culture of the future.

### Learning Outcomes

Upon successful completion of the programme you will be able to demonstrate the following learning outcomes.

#### On achieving the PG Certificate:

1. To translate abstract and mathematical concepts into computer-based solutions for practical problems;
2. To effectively use state-of-the-art computing tools and techniques;
3. To develop and test software solutions to computational problems using a variety of programming languages and paradigms.

#### On achieving the PG Diploma, ILOs 1-3 above, and:

4. To apply mathematical methods and scientific reasoning to design secure and reliable software;
5. To design and engineer solutions to advanced computational problems using knowledge of multiple specialist areas of computer science and engineering;
6. To plan and conduct a programme of original research and software development related to security and reliability;
7. To communicate effectively through technical oral presentations and written reports.

#### On achieving the MSc, ILOs 1-7 above, and:

8. To develop computer-based systems in a manner that respects relevant legal, social, ethical and other professional practices;
9. To adapt, integrate and transfer methods and skills between established fields and emerging trends in computing;
10. To organise and successfully implement study of advanced research level information, from diverse sources, both within instructor-led and research-based educational settings;
11. To devise and conduct practical experiments in order to push the boundaries of understanding in computer science and its application to security and reliability.

The Imperial Graduate Attributes are a set of core competencies which we expect students to achieve through completion of any Imperial College degree programme. The Graduate Attributes are available at:

[www.imperial.ac.uk/students/academic-support/graduate-attributes](http://www.imperial.ac.uk/students/academic-support/graduate-attributes)

### Entry Requirements

|                              |  |
|------------------------------|--|
| Academic Requirement         | 1st class honours degree in a subject with a substantial computing component. The amount of computing studied should equate to two years of a computer science undergraduate programme.<br><br>For further information on postgraduate entry requirements, please visit:<br><a href="http://www.imperial.ac.uk/study/apply/postgraduate-taught/entry-requirements/">www.imperial.ac.uk/study/apply/postgraduate-taught/entry-requirements/</a> |
| Non-academic Requirements    | N/A  |
| English Language Requirement | <a href="#">Higher requirement (PG)</a><br>Please check for other <a href="#">Accepted English Qualifications</a>  |

|  |   |
|--|---|
| Admissions Test/Interview  | There are normally no admissions tests or interviews. |
| <p>The programme's competency standards documents can be found at:<br/> <a href="http://www.imperial.ac.uk/computing/prospective-students/courses/competence/">www.imperial.ac.uk/computing/prospective-students/courses/competence/</a></p>   |   |
| <b>Learning &amp; Teaching Approach</b>  |   |
| <p><b>Teaching</b><br/> You will be taught through a combination of interactive sessions, lectures, team-based learning, tutorials, computer laboratory sessions, guest lectures, and individual project meetings. Module lecturers employ a variety of these teaching methods, depending on the content of the module. A typical module might combine teaching by lectures, with tutorial sessions supported by the lecturer and their tutorial assistants. Tutorial sessions can involve practical coding tasks (run in our extensive computer laboratories), written exercises, or discussion groups.</p> <p><b>Assessed coursework</b><br/> Most modules set assessed coursework. This is sometimes to be completed in groups, and sometimes individual. It may consist of practical coding tasks, or written exercises, or a combination of the two. The portion of a module's final grade which is determined by assessed coursework typically ranges from 20% to 50%.</p> <p><b>Individual project</b><br/> The degree includes a substantial individual research project, which runs from mid-May to mid-September. You will choose your project in January from a wide list of topics. The academic proposing each topic will be available to discuss the idea with you and help decide if it is right for you. If you have chosen the Independent Study Option, then your project can be a continuation of the same work, enabling you to progress further down your chosen research path. The research project can be conducted with academics in the Department of Computing, or within other departments at Imperial College. Some students also elect to do a research project in collaboration with industry, jointly supervised by an academic in the Department of Computing. The project is evaluated with a final report and presentation.</p> <p><b>Independent learning</b><br/> You are expected to spend significant time on independent study outside of face-to-face contact time. This will typically include accessing resources online, reading journal articles and books, undertaking research in the library, reviewing lecture notes and watching lecture recordings, working on the individual project, working on coursework assignments and revising for exams.</p> <p><b>Overall workload</b><br/> Your overall workload consists of face-to-face sessions and independent learning. While your actual contact hours may vary according to the optional modules you choose to study, the following gives an indication of how much time you will need to allocate to different activities at each level of the programme. At Imperial, each ECTS credit taken equates to an expected total study time of 25 hours. Therefore, the expected total study time is 2250 hours.</p> <p>Typically, you will spend in the order of 12.5% of your time on lectures, tutorials, and similar; and in the order of 87.5% of your time on independent study.</p> |   |
| <b>Assessment Strategy</b>   |   |
| Assessment Methods   |   |
| <p>You can expect a variety of different types of assessment methods.</p> <p><b>Written assessment</b></p> <ul style="list-style-type: none"> <li>• Coursework exercises</li> <li>• Reports on practical coding</li> <li>• Short-form written answers</li> <li>• Essays</li> <li>• Written examinations</li> <li>• Report writing</li> <li>• Peer assessment reports</li> </ul>  |   |

## Programming

- Programming coursework (for taught modules)
- Programming examination

## Oral assessment

- Oral presentations

Modules provide a range of formative activities to allow you to test and develop your understanding of the subject, and the ways you are expected to demonstrate the intended learning outcomes, before you complete the summative assessments that count towards your final mark. Formative activities include tutorial exercises, coding tasks, quizzes, and worked in-class problems supported by discussion. There is summative assessment during and/or at the end of each module. Summative assessments demonstrate that you have met the intended learning outcomes for each module and contribute towards your achievement of the programme learning outcomes, detailed above.

## Balance of assessment

The percentages below are based on a typical pathway through the course and have been rounded to the nearest whole number.

|                                      |     |
|--------------------------------------|-----|
| Assessed coursework                  | 10% |
| Examinations (practical and written) | 40% |
| Individual project                   | 50% |

## Academic Feedback Policy

Feedback on formative exercises may be given in various forms. Automatic testing is commonly provided for programming exercises, both as files that you can run in a development environment and through the department's online pre-submission testing system. For both programming exercises and written problems, model solutions are commonly provided after the work is submitted. These can be used for self-assessment but will also be the subject of in-class group discussion. More individualised discussion is available during tutorial sessions and via online forums for each module.

For summative work, the department operates in accordance with the College policy on academic feedback, and procedures are consistent across all taught Computing programmes. Feedback will normally be provided on coursework within two weeks of submission. This will be in the form of, for example:

1. Marked-up coursework, laboratory exercises or tests
2. Personal discussion
3. Discussions in small-group tutorials
4. Verbal presentation, e.g. during or after lectures
5. Written class-wide summaries

Feedback on exams is provided in two forms: (i) numerically, as individual interim marks subject to ratification (approval) by the Board of Examiners; and (ii) in written form, as non-individual summary feedback on individual questions. In July you will also receive feedback on which degree grade (Pass, Merit, Distinction) you are on track for. Further, selected examination questions are routinely set as formative and/or summative assessments in later years, with model answers provided.

The College's Policy on Academic Feedback and guidance on issuing provisional marks to students is available at:

[www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/](http://www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/)

## Re-sit Policy

One resit is allowed per module, usually in the next instance when that module is examined. Determinations of results and mitigations will follow college policies and the academic regulations.

The College's Policy on Re-sits is available at: [www.imperial.ac.uk/student-records-and-data/for-current-students/undergraduate-and-taught-postgraduate/exams-assessments-and-regulations/](http://www.imperial.ac.uk/student-records-and-data/for-current-students/undergraduate-and-taught-postgraduate/exams-assessments-and-regulations/)

|  |
|--|
| Mitigating Circumstances Policy  |
| The College's Policy on Mitigating Circumstances is available at: <a href="http://www.imperial.ac.uk/student-records-and-data/for-current-students/undergraduate-and-taught-postgraduate/exams-assessments-and-regulations/">www.imperial.ac.uk/student-records-and-data/for-current-students/undergraduate-and-taught-postgraduate/exams-assessments-and-regulations/</a> |

|   |                    |                  |
|---|--------------------|------------------|
| Additional Programme Costs  |                    |                  |
| This section should outline any additional costs relevant to this programme which are not included in students' tuition fees. |                    |                  |
| Description   | Mandatory/Optional | Approximate cost |
| Personalised hardware/software tools to cater for individual preferences.   | Optional           | N/A              |

**Important notice:** The Programme Specifications are the result of a large curriculum and pedagogy reform implemented by the Department and supported by the Learning and Teaching Strategy of Imperial College London. The modules, structure and assessments presented in this Programme Specification are correct at time of publication but might change as a result of student and staff feedback and the introduction of new or innovative approaches to teaching and learning. You will be consulted and notified in a timely manner of any changes to this document.

| Programme Structure <sup>1</sup>  |   |                                  |       |      |         |
|---|---|----------------------------------|-------|------|---------|
| FHEQ Level 7<br>Students study the core module (individual project) and nine electives. At least six electives must be from Group S, with the remainder (up to three) from Group O. |   |                                  |       |      |         |
| Code  | Module Title                                  | Core/<br>Compulsory/<br>Elective | Group | Term | Credits |
| COMP70095   | MSc Computing (Specialism) Individual Project | Core                             | -     | 3    | 45      |
| COMP70086   | Advanced Computer Architecture                | Elective                         | S     | 2    | 5       |
| COMP70082   | Network and Web Security                      | Elective                         | S     | 2    | 5       |
| COMP70075   | System Performance Engineering                | Elective                         | S     | 2    | 5       |
| COMP70004   | Advanced Computer Security                    | Elective                         | S     | 1    | 5       |
| COMP70005   | Complexity                                    | Elective                         | S     | 1    | 5       |
| COMP70009   | Cryptography Engineering                      | Elective                         | S     | 2    | 5       |
| COMP70015   | Mathematics for Machine Learning              | Elective                         | S     | 1    | 5       |
| COMP70017   | Principles of Distributed Ledgers             | Elective                         | S     | 2    | 5       |
| COMP70018   | Privacy Engineering                           | Elective                         | S     | 1    | 5       |
| COMP70019   | Probabilistic Inference                       | Elective                         | S     | 2    | 5       |
| COMP70020   | Program Analysis                              | Elective                         | S     | 1    | 5       |
| COMP70021   | Quantum Computing                             | Elective                         | S     | 1    | 5       |
| COMP70022   | Scalable Systems and Data                     | Elective                         | S     | 1    | 5       |
| COMP70023   | Scalable Software Verification                | Elective                         | S     | 2    | 5       |
| COMP70024   | Software Reliability                          | Elective                         | S     | 2    | 5       |
| COMP70025   | Software Engineering for Industry             | Elective                         | S     | 2    | 5       |
| COMP70031   | Modal Logic for Strategic Reasoning in AI     | Elective                         | S     | 2    | 5       |
| COMP70068   | Scheduling and Resource Allocation            | Elective                         | S     | 1    | 5       |
| COMP70090   | Graphics                                      | Elective                         | O     | 2    | 5       |
| COMP70070   | Custom Computing                              | Elective                         | O     | 2    | 5       |
| COMP70071   | Distributed Algorithms                        | Elective                         | O     | 2    | 5       |

<sup>1</sup> **Core** modules are those which serve a fundamental role within the curriculum, and for which achievement of the credits for that module is essential for the achievement of the target award. Core modules must therefore be taken and passed in order to achieve that named award. **Compulsory** modules are those which are designated as necessary to be taken as part of the programme syllabus. Compulsory modules can be compensated. **Elective** modules are those which are in the same subject area as the field of study and are offered to students in order to offer an element of choice in the curriculum and from which students are able to select. Elective modules can be compensated.

|              |                                  |          |   |   |    |
|--------------|----------------------------------|----------|---|---|----|
| COMP70093    | Logic-Based Learning             | Elective | O | 2 | 5  |
| COMP70001    | Advanced Computer Graphics       | Elective | O | 2 | 5  |
| COMP70006    | Computational Finance            | Elective | O | 1 | 5  |
| COMP70007    | Computational Optimisation       | Elective | O | 2 | 5  |
| COMP70010    | Deep Learning                    | Elective | O | 2 | 5  |
| COMP70014    | Machine Learning for Imaging     | Elective | O | 2 | 5  |
| COMP70016    | Natural Language Processing      | Elective | O | 2 | 5  |
| COMP70028    | Reinforcement Learning           | Elective | O | 2 | 5  |
| COMP70030    | Knowledge Representation         | Elective | O | 2 | 5  |
| COMP70081    | Independent Study Option         | Elective | O | 1 | 5  |
| COMP70074    | Prolog                           | Elective | O | 1 | 5  |
| COMP70050    | Introduction to Machine Learning | Elective | O | 1 | 5  |
| COMP70089    | Computer Vision                  | Elective | O | 2 | 5  |
| COMP70067    | Robot Learning                   | Elective | O | 1 | 5  |
| Credit Total |                                  |          |   |   | 90 |



## Progression and Classification

### **Award of a Postgraduate Certificate (PG Cert)**

To qualify for the award of a postgraduate certificate a student must have:

- accumulated credit to the value of no fewer than 30 ECTS credits at Level 7 or above.

### **Award of a Postgraduate Diploma (PG Dip)**

To qualify for the award of a postgraduate diploma a student must have:

- accumulated credit to the value of no fewer than 60 ECTS credits at Level 7 or above;
- no more than 10 credits as a result of compensated passes.

### **Award of a Postgraduate Degree**

To qualify for the award of a postgraduate degree a student must have:

- accumulated credit to the value of no fewer than 90 ECTS credits at level 7 or above;
- no more than 15 credits as a result of compensated passes;
- met any specific requirements for an award as outlined in the approved programme specification for that award.

### **Classification of Postgraduate Taught Awards**

The College sets the class of Degree that may be awarded as follows:

- i Distinction: The student has achieved an overall weighted average of 70.00% or above across the programme.
  - ii Merit: the student has achieved an overall weighted average of above 60.00% but less than 70.00%.
  - iii Pass: the student has achieved an overall weighted average of 50.00% but less than 60.00%.
- 1 For a Master's, students must normally achieve a distinction (70.00%) mark in the dissertation or designated final major project (as designated in the programme specification) in order to be awarded a distinction.
  - 2 For a Master's, students must normally achieve a minimum of a merit (60.00%) mark in the dissertation or designated final major project (as designated in the programme specification) in order to be awarded a merit.

## Programme Specific Regulations

N/A

| Supporting Information  |
|---|
| The Programme Handbook is available at: TBC   |
| The Module Handbook is available at: TBC  |
| The College's entry requirements for postgraduate programmes can be found at:<br><a href="http://www.imperial.ac.uk/study/apply/postgraduate-taught/entry-requirements/">www.imperial.ac.uk/study/apply/postgraduate-taught/entry-requirements/</a>   |
| The College's Quality & Enhancement Framework is available at:<br><a href="http://www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance">www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance</a>  |
| The College's Academic and Examination Regulations can be found at:<br><a href="http://www.imperial.ac.uk/about/governance/academic-governance/regulations">www.imperial.ac.uk/about/governance/academic-governance/regulations</a>   |
| Imperial College is an independent corporation whose legal status derives from a Royal Charter granted under Letters Patent in 1907. In 2007 a Supplemental Charter and Statutes was granted by HM Queen Elizabeth II. This Supplemental Charter, which came into force on the date of the College's Centenary, 8th July 2007, established the College as a University with the name and style of "The Imperial College of Science, Technology and Medicine".<br><a href="http://www.imperial.ac.uk/admin-services/secretariat/college-governance/charters/">www.imperial.ac.uk/admin-services/secretariat/college-governance/charters/</a> |
| Imperial College London is regulated by the Office for Students (OfS)<br><a href="http://www.officeforstudents.org.uk/advice-and-guidance/the-register/">www.officeforstudents.org.uk/advice-and-guidance/the-register/</a>   |
| This document provides a definitive record of the main features of the programme and the learning outcomes that a typical student may reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities provided. This programme specification is primarily intended as a reference point for prospective and current students, academic and support staff involved in delivering the programme and enabling student development and achievement, for its assessment by internal and external examiners, and in subsequent monitoring and review.  |

| Modifications     |                           |            |                 |
|-------------------|---------------------------|------------|-----------------|
| Description       | Approved                  | Date       | Paper Reference |
| Curriculum Review | Programmes Committee/QAEC | 24/01/2023 | PC.2022.24      |