Imperial College London

# Programme Specification (2022-23)

| Programme Information | | |
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| Programme Title | Programme Code | HECoS Code |
| Environmental Data Science and Machine Learning (EDSML) | H2G16 | 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 | 9 months | Full-time | N/A | 60 | 120 |
| The PG Diploma intermediate award is not available for entry. All students must apply to and join the MSc. | | | | | |

| Ownership | | | |
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| Awarding Institution | Imperial College London | Faculty | Faculty of Engineering |
| Teaching Institution | Imperial College London | Department | Earth Science and Engineering |
| Associateship | Royal School of Mines | Main Location(s) of Study | South Kensington Campus |
| **External Reference** | | | |
| Relevant QAA Benchmark Statement(s) and/or other external reference points | | Masters Awards in Engineering | |
| FHEQ Level | | 7 | |
| EHEA Level | | 2nd 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 |
| **Specification Details** | | | |
| Programme Lead | | Professor Matthew Piggott | |

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| Student cohorts covered by specification | 2022-23 entry |
| Date of introduction of programme | October 21 |
| Date of programme specification/revision | March 22 |

**Programme Overview**

The MSc Environmental Data Science and Machine Learning will educate future environmental scientists in data science, machine learning and associated computational technologies. The programme takes you through a curriculum that will enable a deepening of knowledge and skills associated with cutting-edge data science, machine learning and associated computational and observational techniques, and their application to a broad range of environmentally motivated applications.

The programme is aimed at three different groups of potential students:

- those with strong methodological backgrounds in mathematics or physical sciences who are wishing to move to, or specialise in, an applied field with an environmental slant;
- those with a more applied background in environmental science or engineering, wishing to learn about data science and machine learning (the underlying theory/algorithms and how to implement/utilise them in code) and how these can be used as modern data-driven problem-solving and analysis tools;
- those with a background in computer science wishing to expand their knowledge of applied data science, machine learning and associated computational and observational techniques in an environmental context, and to gain experience in the ways in which these can be utilised to solve large-scale environmental science and engineering problems.

The overall objective of the MSc programme is to ensure that you are able to use appropriate data science, machine learning and associated computational and observational techniques to understand, define and develop solutions to a range of environmental science and engineering problems. On successful completion of the the programme you will have acquired a strong background in (big) data science including cloud computing, remote sensing, environmental monitoring & modelling, machine learning, and the development of associated computer code and its application on high-performance and cloud computing resources.

The knowledge and experience gathered through completion of the programme will place you in an ideal position to:

- pursue academic careers (through a PhD for instance) in many fields: data and computational science, machine learning, environmental modelling and monitoring.
- work as an expert analyst in industry, for example in environmental consultancies, climate science, renewable energy, sustainability, natural hazards, earth resource exploration and extraction (including hydrocarbons and minerals), space and planetary science, Earth observation and remote sensing.

The programme consists of nine taught modules which are equally weighted, delivered over the first two terms of the academic year, followed by a research project. The nine taught modules will cover a range of data science, machine learning, modelling and monitoring topics including how these can be practically implemented and applied using rigorous scientific programming and best-practice software development principles. Each module will explore examples and applications to environmental science and engineering problems in order to explore the subject matter.

The programme will be taught by expert staff members who will draw on their research and industrial application experience at national and international level to ensure you are provided with an opportunity to engage with a broad range of modern techniques and applications. You will also have the opportunity to undertake research with academics within the top-rated Earth Science and Engineering Department from REF2014 and RAE2008.

The programme will be delivered on the South Kensington Campus, within the Earth Science and Engineering department's facilities in the Royal School of Mines Building. A fundamental component of the programme is the use of computing resources, for this you will have access to the College's high-performance computing resources, as well as the use of external cloud computing services. This will allow you to cement principles introduced on the taught part of the programme, as well as inspiring the future crop of experts in environmental data science in its broadest terms.

## Learning Outcomes

Upon successful completion of the programme, you will be able to:

1. undertake reproducible computational science, including data analysis and analytics
2. use a variety of programming languages to create, test, verify and validate contextually appropriate software
3. select between methods in mathematical modelling, data science, machine learning and remote sensing which are commonly used in environmental science and engineering applications
4. use systematic knowledge of high-performance, parallel and cloud computing to employ appropriate computational techniques when using these resources
5. modify standard data science, machine learning, computational modelling and monitoring techniques to solve new problems in a range of environmental science and engineering applications
6. appreciate the unique aspects of environmental data that make it challenging, e.g. that is tends to be uncertain, intermittent, occur over a wide range of spatial and temporal scales, and be able to apply methodologies to deal with these challenges
7. generate original thinking on how to use and combine existing data science, machine learning, computational modelling and monitoring techniques to address questions arising from environmental science and engineering applications
8. construct relevant and original research questions from existing data sets and models, and select appropriate techniques to address them
9. undertake original independent research in an area of environmental science and engineering using a range of data science, machine learning, modelling and monitoring techniques, under the guidance of academic staff
10. critically evaluate own work through the appropriate design of experiments and an acknowledgement of the limitations of data, algorithms and models
11. critically evaluate the work of others and propose alternative techniques, approaches or solutions
12. plan your individual work and your contributions to collaborative work
13. write technical reports and summarise your work using presentations

On successful completion of the PG Diploma[1] in Environmental Data Science and Machine Learning you will be able to:

1. undertake reproducible computational science, including data analysis and analytics
2. use a variety of programming languages to create, test, verify and validate contextually appropriate software
3. select methods in mathematical modelling, data science, machine learning and remote sensing which are commonly used in environmental science and engineering applications
4. use systematic knowledge of high-performance, parallel and cloud computing to employ appropriate computational techniques when using these resources
5. modify standard data science, machine learning, computational modelling and monitoring techniques to solve new problems in a range of environmental science and engineering applications.
6. appreciate the unique aspects of environmental data that make it challenging, e.g. that is tends to be uncertain, intermittent, occur over a wide range of spatial and temporal scales, and be able to apply methodologies to deal with these challenges
7. plan your individual work and your contributions to collaborative work

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

In accordance with these core competencies, set out below, our aim is for our graduates to:

- Demonstrate deep conceptual understanding of their chosen discipline
- Work effectively in multi-cultural, international teams and across disciplinary boundaries
- Approach challenges with curiosity, critical-thinking and creativity
- Innovatively apply their skills to tackling complex real-world problems

[1] Corresponding to the Autumn, Spring and Summer Term taught modules

- Understand and value different cultures and perspectives
- Have developed into independent learners with high self-efficacy
- Display a strong sense of personal and professional identity

| **Entry Requirements** | |
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| Academic Requirement | Normally a 2:1 UK Bachelor's Degree or equivalent, in an engineering or science-based discipline. |
| Non-academic Requirements | Applicants who do not meet the academic requirements above but who have substantial relevant industry experience may be admitted following completion of a 'Special Qualifying Exam' (SQE) |
| English Language Requirement | Standard Requirements: IELTS 6.5 with a minimum of 6.0 in each element or equivalent<br><br>Standard requirement (PG)<br><br>Please check for other Accepted English Qualifications |
| Admissions Test/Interview | Applicants will be invited to attend a post-application interview |

The programme's competency standards documents can be found at: https://www.imperial.ac.uk/media/imperial-college/faculty-of-engineering/civil/public/msc/Competency-Standards-MSc-Civil-2019-2020.pdf

**Learning & Teaching Approach**

**Learning and Teaching Delivery Methods**

- Lectures
- Seminars and practical coding activities
- Case studies
- Group work exercises
- Individual research
- Formal presentations

All the module content will be available online. The lectures themselves will have a strong emphasis on skills development, where short lectures will be punctuated by individual or paired exercises with the support of teaching staff.

Individual and group projects will run throughout the year. These will be primarily computational and data analysis based projects and will make use of automated assessment to enable self-assessment. These smaller projects also help prepare you for the independent project at the end of the year.

You will undertake your research project within a research group.

**Overall Workload**
Your overall workload consists of face-to-face sessions and independent learning. While your actual contact hours may vary, 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 2,250 (90 ECTS) hours per year.

The programme is structured with lectures and practical sessions in the morning, with the afternoons free for private or guided study. This structure spans 9 months punctuated with three week-long project sessions where you will have the opportunity to work in teams or individually.

Three months will be devoted exclusively to the summer individual research project.

| **Assessment Strategy** |
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| Assessment Methods |
| All assessment will be based on coursework with no formal written examinations.<br><br>Formative assessment to provide feedback and aid learning will be provided through the practical sessions that will run throughout each module. During project work, this will be provided through ongoing supervision from the faculty. The feedback will be provided in written form and orally by members of the faculty and graduate teaching assistants working on each module.<br><br>Summative assessment will be provided by at least two items of assessed coursework for each module which can be completed in class and at home. Dependent on the module, this may be a combination of written homework, solving problems, as well as numerical and coding exercises. For project work assessment will also be based on oral presentation of the work and from project reports.<br><br>A final thesis and presentation will also be required for the summative assessment of the final summer research project. 80% of the total mark will be based on written material and 20% on a presentation and demonstration of the software developed.<br><br>In group project work, team members will receive one mark, moderated to a limited extent by students individual contribution. Support for project work will be provided by graduate teaching assistants and faculty with tutorial staff available to guide you through difficulties in team working. |
| Academic Feedback Policy |
| Feedback on coursework will be provided in line with the College's Policy on Academic Feedback. The good practice guidelines of feedback being provided within two weeks of the submission date will be employed. The final numerical marks will be provided by the Registry after the Board of Examiner's meeting at the end of the academic year.<br><br>The College's Policy on Academic Feedback and guidance on issuing provisional marks to students is available at:<br>www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/ |
| Re-sit Policy |
| Mitigating Circumstances Policy |
| The College's Policy on Mitigating Circumstances is available at: www.imperial.ac.uk/student-records-and-data/for-current-students/undergraduate-and-taught-postgraduate/exams-assessments-and-regulations/ |

| Additional Programme Costs |
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| There are no additional costs. |

**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**[2] | | | | | |
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| **FHEQ Level 7**<br>**For the MSc you will need to complete all core and compulsory modules. For the PG Diploma you need to complete all modules except the last – Applied Computational/Data Science Project.** | | | | | |
| Code | Module Title | Core/ Elective/ Compulsory | Group | Term | Credits |
| | Numerical Programming in Python | Compulsory | | 1 | 5 |
| EART97038 | Computational Mathematics | Compulsory | | 1 | 5 |
| EART97040 | Applying Computational/Data Science | Compulsory | | 1,2,3 | 7.5 |
| | Machine Learning and Data Science | Compulsory | | 1 | 5 |
| EART97051 | Environmental Data | Compulsory | | 1 | 7.5 |
| EART97041 | Advanced Programming | Compulsory | | 2 | 7.5 |
| EART97052 | Big Data Analytics | Compulsory | | 2 | 7.5 |
| EART97043 | Inversion and Optimisation | Compulsory | | 2 | 7.5 |
| EART97044 | Deep learning | Compulsory | | 3 | 7.5 |
| EART97045 | Applied Computational/Data Science Project | Core | | 3 and 4 | 30 |
| | | | | Credit Total | 90 |

[2] **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.

| Progression and Classification |
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| The College regulations regarding credit compensation and promotion to higher degree classifications will be applied to this programme.<br><br>**Award of a Postgraduate Diploma (PG Dip)**<br>To qualify for the award of a postgraduate diploma you must have passed modules to the value of no fewer than 60 credits at Level 7 from the taught modules in the Autumn, Spring and Summer terms<br>1. and no more than 10 credits as a Compensated Pass;<br><br>**Award of an MSc**<br>To qualify for the award of an MSc in Applied Computational Science and Engineering you must have:<br>1. accumulated credit to the value of no fewer than 90 credits;<br>2. and no more than 15 credits as a Compensated Pass;<br><br>Compensation allows a marginal failure (i.e. between 40.00-49.99 inclusive for Level 7) of modules up to a maximum of 15 ECTS per academic level and awarding credit for them on the basis of good overall academic performance.<br><br>**Classification of MSc Award**<br><br>The class of MSc may be awarded as follows:<br>1. Distinction: You have achieved an overall weighted average of 70.00% or above across the programme.<br>2. Merit: You have achieved an overall weighted average of above 60.00% but less than 70.00%.<br>3. Pass: You have achieved an overall weighted average of 50.00% but less than 60.00%.<br><br>With the conditions that:<br><br>a. You must normally achieve a distinction (70.00%) mark in the Independent Research Project in order to be awarded a distinction.<br>b. You must normally achieve a minimum of a merit (60.00%) mark in the Independent Research Project in order to be awarded a merit<br><br>Clear criteria for marking written work, oral presentations and the research project will be used for assessments across all modules to ensure consistency in marking and requirements for Pass, Merit and Distinction grades.<br><br>The Board of Examiners, which considers cases for compensation and exceptional circumstances, will comprise of the Programme Director, Module Leaders and External Examiners, in line with College policy. |
| Programme Specific Regulations |
| None |

| Supporting Information |
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| 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: www.imperial.ac.uk/study/pg/apply/requirements |
| The College's Quality & Enhancement Framework is available at: www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance |
| The College's Academic and Examination Regulations can be found at: www.imperial.ac.uk/about/governance/academic-governance/regulations |
| 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". www.imperial.ac.uk/admin-services/secretariat/college-governance/charters/ |
| Imperial College London is regulated by the Office for Students (OfS) www.officeforstudents.org.uk/advice-and-guidance/the-register/ |
| 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 | | | |
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| **Description** | **Approved** | **Date** | **Paper Reference** |
| N/A | N/A | N/A | N/A |