Programme Information		
Programme Title	Programme Code	HECoS Code
Machine Learning and Big Data in the Physical Sciences	F3I4	For Registry Use Only

Award	Length of Study	Mode of Study	Entry Point(s)	Total Credits	
				ECTS	CATS
MRes	1 Calendar Year (12 months)	Full-Time	Annually in October	90	180
PG Diploma – F3I4D	N/A	N/A	N/A	60	120
PG Certificate - F3I4C	N/A	N/A	N/A	30	60
The PG Certificate and PG Diploma awards are not available for entry. Either may be awarded as an exit award at the discretion of the Board of Examiners. You must apply to and join the MRes.					

Ownership			
Awarding Institution	Imperial College London	Faculty	Natural Sciences
Teaching Institution	Imperial College London	Department	Physics
Associateship	Diploma of Imperial College (DIC)	Main Location(s) of Study	South Kensington
External Reference			
Relevant QAA Benchmark Statement(s) and/or other external reference points		Physics, Astronomy and Astrophysics	
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. D. Colling, Dr N. Wardle
Student cohorts covered by specification	2025-26
Date of introduction of programme	October 2021
Date of programme specification/revision	April 2023

Programme Overview

The MRes "Machine Learning and Big Data in the Physical Sciences" will cover the methodologies and specific toolkits related to research involving large data sets. In particular the course will focus on the use of machine learning and data-science techniques in the acquisition, curation and analysis of extremely large datasets which are common-place in modern Physics research. The challenges faced in Physics in particular, combined with both the very large datasets and data rates generated continue to make the field a unique development ground for machine learning and more generally artificial intelligence.

Understanding the science behind these methods and how they can be deployed in real research is the main theme of the MRes. During the course you will learn the common tools used in research both within academia and industry, and how to apply those tools to real-life experimental data. During your project, you will work with and learn from world-leading experts at Imperial on cutting-edge Physics research within your chosen project topic. The techniques used in the Physical Sciences are widely applicable elsewhere in other sciences and in a wide range of industries and the demand for graduates skilled in these techniques for data science roles is growing. This course will expand on your Physics education by adding this highly desirable skill set and knowledge base to your capabilities.

The main component of this MRes is an extended project where you will carry out original research embedded in a research group. You will have the opportunity to work on cutting edge physics research topics, by using cutting-edge data science technologies to enhance that research. The project will be two thirds of the course, allowing you to fully engage with a research group within the Physics Department. Prior to the project you will have two compulsory core courses. One in the theoretical aspects of data analysis, statistics and machine learning and the other in the practical aspects of carrying out data analysis using commonly used packages.

Alongside these core aspects you will be able to choose two elective modules from physics or (if available) other departments that are appropriate to your project. One elective that has been designed specifically for students on this MRes is "Accelerated processing for big data analysis".

The MRes is designed to prepare you for jobs in academic research - in particular those areas in the physical sciences where large datasets are produced and analysed, and in data science in industry where machine learning solutions to quantitative analysis of data and the overall understanding that data are key.

Learning Outcomes

The graduates will have a good theoretical and practical understanding of the approaches that can be used for data analysis including statistical and machine learning approaches. They will have carried out supervised original research using these techniques and will be capable of independent research in this area.

Please refer to the Teaching Toolkit for advice on the role and purpose of Intended Learning Outcomes (ILO):

www.imperial.ac.uk/staff/educational-development/teaching-toolkit/intended-learning-outcomes

Upon successful completion of the MRes, students will be able to

1. Apply the underlying principles of data analysis behind complex statistical, and Machine Learning and data science techniques, and apply them to an independent research problem.
2. Use one or more appropriate Machine Learning/Big Data techniques, selected from a number of techniques learnt, to real research problems within the physical sciences, and justify their use.
3. Use and/or develop software for analysis of large datasets.
4. Independently plan, execute safely and report the results of an experimental or computational research project.
5. Evaluate the results of the research project and critically compare them to theory.
6. Use a range of resources including the internet and library for sourcing relevant literature and demonstrate the ability to critically review current research and write about in a scientifically appropriate manner.
7. Read and understand research level (peer-reviewed) literature, in particular those in the field of Machine Learning and synthesize novel methods into their own research.
8. Describe and clearly report research methodologies and findings to a range of audiences including peers and experts within the physical science area of their project.
9. Interact constructively within an experimental research team, and logically defend their research outcomes within these teams.
10. Manage their own learning and personal development, and to contribute to research teams in both the technical and industry focused activities.

Exit awards

Students who attain a PG Certificate (30 ECTS) will have met outcomes 1-3. Students who attain a PG Diploma (60 ECTS) will have met outcomes 3-10.

The Imperial Graduate Attributes are a set of core competencies which we expect students to achieve through completion of any Imperial degree programme. The Graduate Attributes are available at: www.imperial.ac.uk/about/education/our-graduates/

Entry Requirements	
Academic Requirement	A high quality 2:1 degree or above in an appropriate STEM subject. For further information on entry requirements, please go to www.imperial.ac.uk/study/apply/postgraduate-taught/entry-requirements/accepted-qualifications/
Non-academic Requirements	3 years relevant work experience (or a comparable qualification recognised by the university) in quantitative disciplines such as finance, computer engineering, medical clinical and transportation.
English Language Requirement	Higher requirement (PG) Please check for other Accepted English Qualifications
Admissions Test/Interview	Admission is based on academic record with interviews in marginal or exceptional cases.

The programme's competency standards documents are available from the department.

Learning & Teaching Approach

Learning and Teaching Delivery Methods

The course will be a mixture of taught lectures, practical hands-on sessions and an extended research project. It may be possible for projects to be carried out partly or wholly at an external organisation and requests will be considered on a case by case basis.

Overall Workload

A minimum of 2250 hours.

1500 hours on the project

438 hours on the core modules

Minimum of 312 hours on elective modules (up to 375 depending on module choices)

Subject knowledge will be taught by a mix of formal lectures, exercises and practical work, including online classes for remote teaching where applicable, supported by independent study. The lectures will focus on the theory behind the machine learning and data science methods that you will learn how to apply during practical computer-based sessions. Class sizes are expected to be around 50 for lectures, with smaller groups for tutorials and practical hands-on sessions. You will be expected to submit and present assessed work to demonstrate learning throughout the taught courses and formal examinations will be set by the end of the first term.

The supervised project work will comprise the largest portion of your study and will demonstrate your analytical and self-management skills, as well as your capacity to undertake PhD level research. The first part of this will be a literature review to identify the main themes and directions for your research project.

Your research will be conducted in groups of 1-2 students within one (or more) of the Physics department research groups. You will be expected to present regularly within these groups and attend research group activities such as seminars and group meetings where appropriate to develop your abilities as an independent researcher. At the end of the project, each member of your group will submit an individual written report and present the research in the form of a poster and / or presentation to your peers.

To facilitate your data-intensive research, you will be provided with a laptop computer with the necessary programming software environments pre-installed. In addition, you will have access to video conferencing software on this computer.

Before the start of the course, online primer tutorials for those unfamiliar with programming in python will be made available. These can be worked through at your own pace before the start of the academic term and will not be assessed. Additionally, there are a number of short courses available through the Imperial College Graduate School on scientific research and programming skills to supplement the core taught modules, which you will be encouraged to take part in but are not assessed.

Assessment Strategy

Assessment Methods

Throughout the first and second terms, you will be assessed continuously through coursework to demonstrate your understanding of the material and capability in the technical & computational aspects of data analysis. You will sit formal written examinations based on material learned in the “Statistical Methods for Experimental Physics” course and any elective modules taken during the first and second terms.

During the second and third terms, and over the summer, the time will be focussed on the application of the knowledge gained to real-world physics research projects and will be supported by optional taught modules to be chosen from the relevant area(s) of physics to the project. Your understanding and abilities will be assessed through a literature review due towards the end of the first term, a written report by the end of the project and an oral examination (in the form of a poster or slide-based presentation) during the third term.

Your independent research project will be assessed formally through a written literature review, which you will submit by the end of term 1, before you start working with your supervisor and research group. In addition, you will be assessed through a presentation of your research in the form of a poster or oral presentation to your peers at the end of the project, and finally based on a written report (around 12,000 words) of your research. You will also be assessed during the project by your supervisor on your engagement with the research group that you will be attached to – you will be expected to attend any regular seminars of the group, engage in discussions around the research with PhD students and/or post-doctoral researchers within the group – and your ability to manage your time effectively during the project. This is intended to ensure you take full advantage of working with world leading researchers at the forefront of their research areas.

The exact ratio between written examination and coursework assessment depends on your elective module choices. The table below is however a typical representation of the breakdown.

Written exams	15%
Practical & coursework (including written assessments)	18%
Project (including written report, continuous assessment, literature review and presentation)	67%

Academic Feedback Policy

The course begins with a practical module on machine learning programming, and one on statistics and machine learning theory. Both of these modules are continually formatively assessed through fortnightly mini-projects with a short written report (for the practical module) and fortnightly problem sheets and a written examination (for the theory module) . Feedback will be provided within two weeks of submission/completion for these.

Your research project will be informally formatively assessed throughout the second and third terms through feedback from your research groups and project supervisor to ensure the research project is progressing as expected.

Imperial'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/

Re-sit Policy

Imperial's Policy on Re-sits is available at: www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/

Mitigating Circumstances Policy

Imperial's Policy on Mitigating Circumstances is available at: www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/

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
Laptop	Mandatory	Provided

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[1]

Year 1 - FHEQ Level 7

You will study all core modules. You must choose one elective module from Group A, and one more elective module from either Group A or B. The electives should be chosen to support the topic area of the Research Project module. Some elective modules from other programmes (including those within the Department of Physics) are subject to availability.

Code	Module Title	Core/ Compulsory/ Elective/	Group	Term	Credits
PHYS70021	Statistical Methods for Experimental Physics	Core		Autumn-Summer	7.5
PHYS70022	Applied Machine Learning	Core		Autumn	10
PHYS70023	Research Project	Core		Autumn-Summer	60
PHYS70071	Accelerated Processing for Big Data Analysis	Elective	B	Spring	5
	Any 5 Credit (ECTS) Level 6 or Level 7 module offered within Physics (or Maths/Engineering if appropriate)	Elective	B	Autumn-Spring	5
	Any 7.5 Credit (ECTS) Level 6 or Level 7 module offered within Physics (or Maths/Engineering if appropriate)	Elective	A	Autumn-Spring	7.5
				Credit Total	90 or 92.5

[1] **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

Award of a Masters Degree (including MRes)

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

1. accumulated credit to the value of no fewer than 90 credits across levels 6 and 7 (of which 75 credits must be at Level 7);
2. and no more than 15 credits as a Compensated Pass;
3. met any specific requirements for an award as outlined in the approved programme specification for that award.

Classification of Postgraduate Taught Awards

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

1. Distinction: 70.00% or above
2. Merit: 60.00% or above but less than 70.00%.
3. Pass: 50.00% or above but less than 60.00%.

For a Masters, your classification will be determined through:

- The Programme Overall Weighted Average and the designated dissertation or final major project module meeting the threshold for the relevant classification band.

Your degree algorithm provides an appropriate and reliable summary of your performance against the programme learning outcomes. It reflects the design, delivery, and structure of your programme without unduly over-emphasising particular aspects.

Exit Awards:

Award of a Postgraduate Certificate (PGCert)

To qualify for the award of a Postgraduate Certificate, you must have a minimum of 30 ECTS at Level 7, which may include a maximum of 7.5 ECTS at Level 6, where this is approved as part of the award. These credits must include the two taught core modules PHYS70021 and PHYS70022.

Award of a Postgraduate Diploma (PGDip)

To qualify for the award of a Postgraduate Diploma, you must have a minimum of 60 ECTS at Level 7, which must include the research project PHYS70023.

Programme Specific Regulations

N/A

Supporting Information
The Programme Handbook is available at: www.imperial.ac.uk/physics/students/current-students/taught-postgraduates/
The Module Handbook is available from the department.
Imperial's entry requirements for postgraduate programmes can be found at: www.imperial.ac.uk/study/pg/apply/requirements
Imperial's Quality & Enhancement Framework is available at: www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance
Imperial's Academic and Examination Regulations can be found at: www.imperial.ac.uk/about/governance/academic-governance/regulations
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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 you may reasonably be expected to achieve and demonstrate if you take 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.