Programme Information		
Programme Title	Programme Code	HECoS Code
Quantum Fields and Fundamental Forces	F3UG/F3UG24	For Registry Use Only

Award	Length of Study	Mode of Study	Entry Point(s)	Total Credits	
				ECTS	CATS
MSc – F3UG	1 calendar year (12 months)	Full-time	Annually in October	90	180
MSc – F3UG24	2 calendar years (24 months)	Part-time	Annually in October	90	180
PG Diploma	1 academic year (9 months)	Full-time	*	60	120
PG Diploma	2 academic years (18 months)	Part-time	*	60	120
PG Certificate	1 academic year (9 months)	Full-time	*	30	60
PG Certificate	2 academic years (18 months)	Part-time	*	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.					

Ownership			
Awarding Institution	Imperial College London	Faculty	Faculty of Natural Sciences
Teaching Institution	Imperial College London	Department	Physics
Associateship	Royal College of Science	Main Location(s) of Study	South Kensington Campus
External Reference			
Relevant QAA Benchmark Statement(s) and/or other external reference points		Master's Awards in Physics, Astronomy and Astrophysics	
FHEQ Level		Level 7	
EHEA Level		2nd Cycle	
External Accreditor(s) (if applicable) N/A			
Collaborative Provision N/A			

Specification Details	
Programme Lead	Professor Kellogg Stelle
Student cohorts covered by specification	2022-23 entry
Date of introduction of programme	October 87
Date of programme specification/revision	October 22

Programme Overview

This renowned MSc programme is designed to prepare students for PhD study in fundamental theoretical physics by bridging the gap between an undergraduate programme in physics or mathematics and the research frontier. The origins of the programme date back to the founding of the Theoretical Physics Group by Abdus Salam, one of Imperial's Nobel Laureates. The Theoretical Physics Group is internationally recognised for its contribution to our understanding of the unification of fundamental forces, the early universe, quantum gravity, supersymmetry, string theory, and quantum field theory.

The programme is highly oversubscribed with around thirty to forty-five students out of 120 applicants being awarded a place annually. Full-length lecture courses, of which students choose eight for examination, occupy the year up to June. Many of these courses are often also taken by postgraduate students from Imperial and other London colleges and by visiting European exchange students. They are followed by two weeks of short courses on topics of current interest. Students then spend the summer working on a supervised project in a specialist area. This can involve original research and leads to the writing of a Research Project Dissertation.

Learning Outcomes

At the conclusion of the QFFF MSc, students will be able to:

- Understand and have the resources to acquire deeper knowledge of the most fundamental laws and principles of theoretical physics across a broad range of fundamental topics.
- Understand and have the resources to acquire deeper knowledge of techniques for using mathematical tools to describe the physical world
- Understand and have the resources to acquire deeper knowledge of research techniques, which may include critical examination and summation of scientific literature, and designing appropriate mathematical models and computations to test physical principles
- Apply their theoretical knowledge of physical principles and advanced mathematical techniques to problems in quantum field theory, cosmology and other frontier areas of fundamental physical science
- Critically interpret mathematical models of physical behaviour
- Design, undertake and report on a programme of original work
- Critically evaluate and understand research-level scientific literature
- Communicate theoretical and computational results and analysis clearly, making any assumptions and approximations explicit
- Collaborate with peers to develop solutions to complex problems

At the conclusion of the PG Diploma, students will be able to:

- Understand and have the resources to acquire deeper knowledge of the most fundamental laws and principles of theoretical physics across a broad range of fundamental topics
- Understand and have the resources to acquire deeper knowledge of techniques for using mathematical tools to describe the physical world
- Apply their theoretical knowledge of physical principles and advanced mathematical techniques to problems in quantum field theory, cosmology and other frontier areas of fundamental physical science
- Critically interpret mathematical models of physical behaviour
- Collaborate with peers to develop solutions to complex problems

At the conclusion of the PG Certificate, students will be able to:

- Understand and have the resources to acquire deeper knowledge of the most fundamental laws and principles of theoretical physics in a range of fundamental topics
- Understand and have the resources to acquire deeper knowledge of techniques for using mathematical tools to describe the physical world

- Apply their theoretical knowledge of physical principles and advanced mathematical techniques to problems in quantum field theory, cosmology and other frontier areas of fundamental physical science
- Collaborate with peers to develop solutions to complex problems

Entry Requirements	
Academic Requirement	Normally a First class (1st) UK Bachelor's Degree with Honours in Physics or Mathematics with Theoretical Physics options (or a comparable qualification recognised by the College).
Non-academic Requirements	N/A
English Language Requirement	Standard requirement (PG) Please check for other Accepted English Qualifications
Admissions Test/Interview	N/A

The programme's competency standards documents can be found at: https://www.imperial.ac.uk/media/imperial-college/faculty-of-natural-sciences/department-of-physics/public/students/current-students/pgt/FoNS-Competence-Standards---Physics-PGT.pdf

Learning & Teaching Approach

Learning and Teaching Delivery Methods

Delivery is primarily through full-length lecture courses of about 30 lectures each. Each lecture course has problem sets and associated rapid-feedback sessions in which solutions to the problems are discussed. The Theoretical Physics Group has weekly seminars on topics of current research interest which are also aimed at the MSc students, with lecturers requested to present an introductory half-hour warmup session for students.

Following the April-May examination session, there is a two-week session of Special Topics short courses delivered by members of staff, Research Assistants and visiting academics. Students then must arrange with Research Project supervisors to work on their independent research projects during the following summer period, with Research Project Dissertations due for submission at the end of September of the corresponding academic year.

E-learning is provided via a mixture of Blackboard VLE with Panopto lecture recordings for review.

Overall Workload

The overall workload consists of face-to-face sessions and independent learning. While actual contact hours may vary according to the elective modules chosen to study, the following gives an indication of how much time is allocated to different activities at each level of the programme. Given each ECTS credit taken equates to an expected total study time of 25 hours, the expected total study time is 2250 hours per year.

Typically, in a complete (one-year full-time or two-year part-time) participation in the programme, a student will spend on the order of 20% in lectures, problem classes and seminars (around 450 hours) and on the order of 80% on independent study.

Assessment Strategy

Assessment Methods

Summative assessment is via written examinations in 4 compulsory and 4 elective modules, taken in the April-May examination session. The duration of exams organised by the QFFF programme is 3 hours; the duration of exams organised by the undergraduate Physics programme is 2 hours. The longer time for QFFF exams is warranted by the advanced nature of the subjects, requiring a more in-depth analysis.

Students normally submit their MSc Research Project Dissertation at the end of September of the corresponding academic year. Summative assessment of the Research Project Dissertation is undertaken by two readers. Overall standards are confirmed in agreement with the External Examiners.

Formative assessment is through problem sets in each QFFF module, coupled with Rapid Feedback (RF) sessions to discuss solutions (see below).

Academic Feedback Policy

Feedback follows the guidelines of the Department of Physics, where written feedback for minor pieces of coursework should be provided to the student within 10 working days of the work being submitted. For major pieces of coursework feedback should be provided within 20 working days, although marks may not be returned until after the Board of Examiners meeting.

The lecture modules each have classwork Rapid Feedback sessions which allow students to work through problems under the guidance of the lecturer and course assistants. Marking of student work by the RF session leaders is provided on a voluntary basis.

More formal feedback is provided in early January by a couple of recommended, but voluntary, tests of material from the compulsory modules. Students have the opportunity to discuss the results of these tests with their personal advisors.

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/

Re-sit Policy

In line with College policy, students who are unsuccessful in any of their examinations may usually be allowed an opportunity to re-sit at the discretion of the Board of Examiners.

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/

Mitigating Circumstances Policy

Students may be eligible to apply for mitigation if they have suffered from serious and unforeseen circumstances during the course of their studies that have adversely affected their ability to complete an assessment task and/or their performance in a piece of assessment.

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: **None**

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]

FHEQ Level 7
Students study all Compulsory modules. Students that engage in the course part time will agree their modules with the course director and when they will be taken over the two-year period.

Code	Module Title	Core/ Elective/ Compulsory	Group	Term	ECTS Credits
PHYS70011	Unification - the Standard Model	Compulsory**		1st	7.5
PHYS70008	Quantum Field Theory	Compulsory**		1st	7.5
PHYS70067	Quantum Electrodynamics	Compulsory		1st	7.5
PHYS70068	Particle Symmetries	Compulsory		1st	7.5
				Credit Total	30

**Students who have already taken these modules as part of the undergraduate programme at Imperial College will replace these modules with appropriate elective modules

Students choose 4 Elective modules, with at most two in total from Group B at FHEQ levels 6 or 7

FHEQ Level 6

Code	Module Title	Core/ Elective/ Compulsory	Group	Term	ECTS Credits
PHYS60015	Group Theory	Elective	B	2nd	7.5
PHYS60011	Foundations of Quantum Mechanics	Elective	B	2nd	7.5

FHEQ Level 7

Code	Module Title	Core/ Elective/ Compulsory	Group	Term	ECTS Credits
PHYS70069	Advanced Quantum Field Theory	Elective	A	2nd	7.5
PHYS70070	Black Holes	Elective	A	2nd	7.5
PHYS70066	Relativity and Cosmology	Elective	A	2nd	7.5
PHYS70065	Differential Geometry	Elective	A	1st	7.5
PHYS70064	Standard Model and Beyond	Elective	A	2nd	7.5
PHYS70063	String Theory	Elective	A	2nd	7.5
PHYS70062	Supersymmetry	Elective	A	2nd	7.5
PHYS70006	General Relativity	Elective	B	2nd	7.5

[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.

PHYS70009	Quantum Information	Elective	B	2nd	7.5
PHYS70018	Quantum Theory of Matter	Elective	B	2nd	7.5
PHYS70061	Research Project	Core		Summer	30
				Credit Total	90

Progression and Classification

Award and Classification for Postgraduate Students

Award of an MSc Degree
To qualify for the award of an MSc degree a student must have:

1. accumulated at least 90 ECTS credits at Level 6 or above, which must include a minimum of 75 ECTS credits at Level 7;
2. and no more than 15 credits as a Compensated Pass.

Award of a Postgraduate Diploma (PGDip)
To qualify for the award of a postgraduate certificate a student must have a minimum of 60 taught module credits at Level 7 (this may include a maximum of 15 credits from Level 6 where this is approved as part of the award).

Award of a Postgraduate Certificate (PGCert)
To qualify for the award of a postgraduate certificate a student must have a minimum of 30 taught module credits at Level 7 (this may include a maximum of 10 credits from Level 6 where this is approved as part of the award).

Classification of Postgraduate Taught Awards

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

1. Distinction:
    a. The student has achieved an overall weighted average of 70.00% or above across the programme.
    b. Students must normally achieve a distinction (70.00%) mark in the Research Project module in order to be awarded a distinction.

2. Merit:
    a. The student has achieved an overall weighted average of above 60.00% but less than 70.00%.
    b. Students must normally achieve a minimum of a merit (60.00%) mark in the Research Project module in order to be awarded a merit

3. Pass: The student has achieved an overall weighted average of 50.00% but less than 60.00%.

Modules taken at Level 6 as part of the programme specification for a named postgraduate award will contribute to the determination of pass, merit or distinction for any taught postgraduate award and are included in the calculation of the overall weighted average.

Scaling

The programme consists of modules run purely by the QFFF programme (Quantum Electrodynamics, Particle Symmetries, all “Group A” Level 7 Modules, and the Research Project) and modules run by the undergraduate Physics programme (all other modules). In order to ensure comparability across modules and appropriate mapping to the College’s degree classification system, modules may undergo a scaling procedure in accordance with the Regulations for Taught Programmes of Study. This process would be applied consistently to all students in the cohort and reported to External Examiners and the Board of Examiners.

Programme Specific Regulations

N/A

Supporting Information
The Programme Handbook is available at: http://www.imperial.ac.uk/natural-sciences/departments/physics/students/current-students/taught-postgraduates/
The Module Handbook is available at: http://www.imperial.ac.uk/natural-sciences/departments/physics/students/current-students/taught-postgraduates/
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			
Description	**Approved**	**Date**	**Paper Reference**
Curriculum Review	Programmes Committee	25/01/2022	PC.2021.38