Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

The School of Mathematics

M.Sc. in Quantum Fields, Strings and Gravity

Handbook
2025-2026

A note on this Handbook

This handbook applies to MSc in Quantum Fields, Strings and Gravity in the School of Mathematics. It provides a guide to what is expected of you on your programme, and the academic and personal supports available to you. Please review it carefully and retain it for future reference.

The handbook is intended to complement the regulations and information found in the Calendar (Part III) which governs all academic activity in Trinity College Dublin, the University of Dublin. Please familiarise yourself with both the Trinity College Dublin Calendar and this handbook, so that you are fully aware of all the information relevant to you and the rules and regulations that apply to your programme of study. The Trinity College Dublin Calendar may be consulted in the Berkeley library or at the following link: www.tcd/.ie/calendar.

The information provided in this handbook is accurate at time of preparation. Any necessary revisions will be notified to students via your Programme Blackboard page. Please note that, in the event of any conflict or inconsistency between the General Regulations published in the University Calendar and information contained in this handbook, the provision of the General Regulations in the Calendar will prevail.

This Handbook is designed to be an accompaniment to the more general Postgraduate Handbook available on maths.tcd.ie. This handbook will focus on academic and course specific information.

Table of Contents

Course Overview

The M.Sc. in Quantum Fields, Strings and Gravity offers a one-year M.Sc. course in modern High Energy Theory and Mathematical Physics. The topics include advanced courses such as String Theory, Conformal Field Theory, General Theory of Relativity & Cosmology, Quantum Field Theory and Lattice Gauge Theory. Students will have the opportunity to discuss and work on current research and perform their own M.Sc. dissertation work under the supervision of the staff of the School of Mathematics, who are experts in the field. The aim of the programme is to give undergraduate students an excellent opportunity to advance their knowledge and skills up to a level required for doctoral level research.

School Information

General School Information

The School of Mathematics can be found in a combined building of Houses 17 - 20 in the Hamilton Building, at the southern end of the Trinity Campus. The closest pedestrian and vehicular entrance are via Lincoln Gate, with Pearse Street pedestrian entrance also located close to the Hamilton Building. Access to the School can be gained on the ground floor through House 17 and 20 and on the first floor through House 17, 19, and 20.

School Management

Responsibility for the management of the School of Mathematics rests with the Head of School, Professor Katrin Wendland. The Head of School is responsible for the effective general management of the School, for ensuring the provision of academic leadership and vision, and for the quality of the student experience.

The School Executive Committee is the key decision-making body of the School and comprises of the Head of School (Chair), Director of Teaching and Learning (Postgraduate), Director of Teaching and Learning (Undergraduate), Director of Research, Head of Discipline (AMTP), Head of Discipline (Pure Mathematics), Director of Global Relations and a student representative (generally, this is the School of Mathematics convenor or a student nomination from the convenor to attend on their behalf).

School Opening Hours		
The School of Mathematics is open:	**Weekdays**	**08:00 - 18:00**
	Weekends	**Swipe access only**

Key Dates

Date	Event
August – September	Visit Academic Registry
	(Registration / Collect student ID, etc)
September	Welcome session with Programme Director
15/09/25	Semester 1 classes commence
15/12/25	Semester 1 examinations commence
24/12/25-1/01/26	Christmas Period (College closed)
19/01/26	Semester 2 classes commence
17/02/26	Semester 1 provisional results released (TBC)
20/04/26	Semester 2 examinations commence
24/08/26	Semester 1 & 2 supplemental examinations commence
~09/09/26 (TBC)	Semester 1 & 2 supplemental results released
	Deadline for dissertation submission
	Final official results published
	Graduation Ceremony (TBC)

Programme Structure

The Course consists of three terms. The first two terms are focused on taught modules courses, while the summer term is focused on the M.Sc. dissertation. The dissertation needs to be written under the supervision of a staff member of the School of Mathematics. It is strongly advised that students start to consider possible topics and supervisors already in the first term. All students must follow the following modules:

- Lattice Quantum Field Theory (MAP50005)
- Topics in Theoretical Physics (MAP50006)
- M.Sc. Student Seminar (MAP50007)
- Dissertation (MAP50009)

The remaining credits can be obtained by following one of the following four possible sequences. Trinity graduates from the School of Mathematics must take one of the *advanced* sequences.

Advanced formal (prerequisites: Quantum Field Theory, General Relativity)

- Introduction to Conformal Field Theory (MAP50001)
- String Theory (MAP50002)
- Modern Quantum Field Theory (MAP50003)
- Advanced Quantum Field Theory (MAP50004)

Advanced lattice (prerequisite: Quantum Field Theory)

- Numerical Methods (MAP55631)
- C programming (MAP55613)
- C++ programming (MAP55614)
- Case Studies in High-Performance Computing (MAP55672)
- Advanced Quantum Field Theory (MAP50004)

Fundamental formal

- Introduction to Conformal Field Theory (MAP50001)
- General Relativity and Cosmology (MAU44404)
- Standard Model (MAU44406)
- Quantum Field Theory (MA5441)

Fundamental lattice

- Numerical Methods (MAP55631)
- C programming (MAP55613)
- C++ programming (MAP55614)
- Parallel Numerical Algorithms (MA5636)
- Quantum Field Theory (MA5441)

Module Descriptions

The module data for the courses that are taught in the TCD undergraduate programme can be found in the corresponding handbook. Several courses associated to the lattice sequences can be found in the handbook for the M.Sc. of High Performance Computing also at the School of Mathematics of Trinity College Dublin https://www.tcd.ie/courses/postgraduate/courses/high-performance-computing-msc--pgraddip/.The data for the modules specifically associated to the course, in particular the advanced formal path are given below.

MAP50001: Introduction to Conformal Field Theory

Semester taught	Michaelmas Term
Module Coordinator	Nejc Ceplak
Credits	10 ECTS
Content	This course offers an introduction to conformal field theories. The students will study the definition of conformal group in general dimension. Primary fields ;The energy-momentum tensor; Radial quantisation; The operator product expansion (OPE); Normal ordered products; The CFT Hilbert space; Examples; Highest weight representations of the Virasoro algebra; Correlation functions and fusion rules
Learning Outcomes	• Define the conformal group in two and higher spacetime dimensions • Define the stress-energy tensor and write associated Ward identities • Define primary fields and explain the OPE • Compute simple correlation functions in Conformal Field Theories. • Provide examples of solvable two-dimensional CFTs and compute the OPE coefficients and the spectrum of operators.
Assessment detail	50% continuously assessment and 50% online examination

MAP50002: String Theory

Semester taught	Hillary Term
Module Coordinator	Marius de Leeuw
Credits	10 ECTS
Content	This course offers an introduction to string theory. The students will work with the Nambu-Goto and Polyakov actions for the bosonic and superstring. After this the string will be quantised and the string spectrum will be derived. Vertex operators will be introduced and scattering amplitudes derived. The Einstein equations will be derived by considering strings in background fields.
Learning Outcomes	• Formulate and solve the equation of motion and Virasoro constraints for the boson string. • Perform the canonical quantisation of the bosonic string. • Understand T-duality. • Define string vertex operators and compute scattering amplitudes.
Assessment detail	50% continuously assessment and 50% online examination

MAP50003: Modern Quantum Field Theory

Semester taught	Michaelmas Term
Module Coordinator	Manya Sahni O'Hara
Credits	5 ECTS
Content	Path integral methods for scalar, vector and spinor fields. Systematics of Renormalization: Wilsonian approach, Callan-Symanzik equation, anomalous dimensions. Non-Abelian Gauge theory: Yang-Mills Lagrangian, including gauge fixing and Faddeev-Popov ghosts. Perturbative Feynman calculations including computation of the one-loop beta-function and asymptotic freedom.
Learning Outcomes	• Derive Feynman rules from path integrals. • Carry out the one-loop renormalization of QED and similar theories. • Compute simple tree-level gluon amplitudes. • Compute the QCD one-loop beta-function.
Assessment detail	50% continuously assessment and 50% online examination

MAP50004: Advanced Quantum Field Theory

Semester taught	Hillary Term
Module Coordinator	Jan Manschot
Credits	5 ECTS
Content	The module begins with the BRST quantization of Yang-Mills theory, followed by the evaluation of the beta function using the background field method and asymptotic freedom. The module will continue with perturbative anomalies, and the strong/weak coupling behaviour of Wilson loops. Time permitting, the module will discuss monopoles and instantons in Yang-Mills theories, and exact results on these subjects in supersymmetric theories.
Learning Outcomes	• Qualitative and computational understanding of Yang-Mills theories. Analyse simple models for physical properties. • Evaluation of one-loop Feynman diagrams and their role for the beta function and perturbative anomalies. • Analysis of strong coupling dynamics using Wilson loops and other observables.
Assessment detail	50% continuously assessment and 50% online examination

MAP50005: Lattice Quantum Field Theory

Semester taught	Michaelmas Term
Module Coordinator	Stefan Sint
Credits	10 ECTS
Content	Introduction to discrete space-time formulations with an overview of the theoretical and computational tools, e.g. Monte Carlo simulations, used for quantitative study of quarks and gluons.
Learning Outcomes	• Construct a discrete lattice action for simple classical and quantum field theories. List the continuous and discrete symmetries and corresponding transformations of the fields. • Analyse simple models for physical properties • Derive Feynman rules on the lattice. • Derive quantities including e.g. the free quark propagator on the lattice and its dependence on the lattice spacing. • Programme simple lattice problems and analyse the results.
Assessment detail	50% continuously assessment and 50% online examination

MAP50006: Modern Topic in Theoretical Physics

Semester taught	Hillary Term
Module Coordinator	Andrei Parnachev
Credits	10 ECTS
Content	Basics of Anti-de-Sitter space and black holes, basics of higher dimensional CFTs, two and three-point correlation functions and the elements of holographic renormalisation, finite temperature correlation functions, tree-level Witten diagrams and the Mellin representation, decomposition of Witten diagrams in CFT blocks.
Learning Outcomes	• Determine whether a CFT may have a gravitational description via AdS/CFT. • Define the basics of the AdS/CFT dictionary • Compute two and higher-point correlation functions in a CFT at strong coupling via a simple exercise in gravity. • Compute tree level and some simple loop Witten diagrams
Assessment detail	50% continuously assessment and 50% online examination

MAP50007: M.Sc. Student Seminar

Semester taught	Michaelmas and Hillary Term
Module Coordinator	Marius de Leeuw
Credits	10 ECTS
Content	The module provides an overview of research literature and contemporary research topics, where the TP staff is involved. Each student is expected to prepare and deliver a presentation, guided by a TP staff member. This module will present an opportunity for the students to learn about the research directions represented at the School and to make a choice of their project supervisor.
Learning Outcomes	• Read research literature and formulate own opinion on it. • Prepare and deliver a presentation • Participate in discussions of research papers.
Assessment detail	Presentation and participation

MA5009: Dissertation

Semester taught	Trinity Term
Module Coordinator	Marius de Leeuw
Credits	30 ECTS
Content	The content depends on the topic chosen by the students for their dissertations. The dissertation may involve a reading project and may be done in small groups. Original research is not a requirement.
Learning Outcomes	• Critically appraise contemporary research literature. • In collaboration with a supervisor, formulate a research problem. • Carry out independent research or read contemporary literature and reproduce some results. • Make a presentation and prepare a report devoted to the selected research topic.
Assessment detail	General understanding 25%, Difficulty of topic 25%, Appropriate Research Methods/Appropriate calculations 25%, Poster presentation accessed by a second examiner 25%.

Assessment

To be eligible for the M.Sc. award, students must, within the period of registration, pass a prescribed set of taught modules of 60 ECTS and satisfactorily complete a dissertation of 30 ECTS. Students who do not wish or are unable to complete a Dissertation may apply for a Postgraduate Diploma in Quantum Fields, Strings and Gravity exit award. Such students must have an overall average mark of at least 50%, have passed taught modules amounting to at least 50 credits (50 ECTS) and achieved a minimum mark of 40% in any failed modules. To voluntarily avail of this option, students must inform the Course Director in writing within four weeks of the date on which the interim results of the last regular module results for the academic year are communicated to students.

Taught Modules

The taught modules will be assessed through a combination of formal written examination, graded continuous assessment assignments, class presentations and reports. To pass a taught module, students must satisfactorily complete any associated work for that module, and obtain a pass mark of at least 50% in each assessment components of the module. Students are allowed to sit repeat examinations and take repeat assignments in taught modules accounting for no more than 10 credits (10 ECTS) over the course of the registration period and remain eligible for consideration for the award of the M.Sc. Degree.

A student may fail modules amounting up to 10 credits and pass the taught component of the programme by compensation provided they have an overall average mark for the taught modules of at least 50%, pass core (mandatory) and optional modules amounting to at least 50 credits (50 ECTS) and achieve a minimum of 40% in any failed modules. Students who fail taught modules accounting for more than 10 credits (10 ECTS) overall will be required to withdraw from the programme. Similarly, any student who fails to pass, by compensation or otherwise, a repeat examination/assignment will be required to withdraw from the programme.

Dissertation

To pass the Dissertation module, students must submit their dissertation by the prescribed date and must obtain an overall weighted average mark of 50% for the assessed elements as specified in the Dissertation marking regulations. The M.Sc. dissertation will be submitted and examined in line with the General Regulations for Taught Graduate Courses stated in Part B (Section 3: Examination of Dissertation) of the University of Dublin Calendar part 3 for Graduate Studies and Higher Degrees for a given year.

Students who fail one or more modules are allowed to work on a dissertation project while preparing for the supplemental assessment. Note that as mentioned above, students can take supplemental examinations in the failed modules (excluding the dissertation). The total mark for such failed modules is then determined by their examination mark (i.e. the supplemental exam counts for 100% of the total mark of the module). Only one supplemental examination attempt is allowed for each module.

Marks and distinction

The School publishes interim examination results after each set of examinations. Final determination of results is on foot of a final Court of Examiners with the external examiner present. As part of the Court of Examiners the external examiner monitors assessment processes and moderates all module marks.

The final degree mark is based on a credit-weighted average of the marks awarded in each module. The M.Sc. with distinction may be awarded to students who pass all taught modules and achieve at least 70% both in the overall mark for the course and in the dissertation if they have not repeated any examinations that form part of their module results.

Students who fail the Dissertation will not be eligible for the award of the M.Sc. but will be eligible for the award of a Postgraduate Diploma, provided they have successfully completed 60 ECTS of taught modules.

School of Mathematics staff

A list of the School members and a brief overview of their research interests can be found at https://www.maths.tcd.ie/research/fields/amtp/.

All staff members involved in the programme will teach Theoretical Physics Student Seminar (MA5007) and supervise M.Sc. Dissertation (MA5009).

Contacts:

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