UNIVERSITY OF Southampton

Programme Specification

Mathematical Physics (2018-19)

This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities that are provided.

Awarding Institution	University of Southampton
Teaching Institution	University of Southampton
Mode of Study	Full-time
Duration in years	4
Accreditation details	None
Final award	Master of Mathematics (Honours) (MMath)
Name of award	Mathematical Physics
Interim Exit awards	Bachelor of Science (Ordinary)
	Certificate of Higher Education (CertHE)
	Diploma of Higher Education (DipHE)
FHEQ level of final award	Level 7
UCAS code	FF34
Programme code	6975
QAA Subject Benchmark or other external reference	Mathematics, Statistics And Operational Research 2007, Physics, Astronomy And Astrophysics 2008
Programme Lead	Nils Andersson (nils)

Programme Overview

Brief outline of the programme

There are many close links between mathematics and physics. Physics uses mathematics to make predictions about the world and many areas of mathematics have developed because of the need to solve physical problems. This four-year integrated Masters programme, run jointly between Mathematics and Physics, will provide you with the opportunity to gain an excellent grasp of both disciplines. The first two years of study will provide you with a solid base in mathematics and physics, allowing you to specialise in the last two years, with modules being available over a wide range of fields, including particle physics, astrophysics, condensed matter physics, and the more mathematical aspects of theoretical physics. As well as being a fascinating area of study, degree programmes in mathematical physics produce graduates who are both numerate and who have a high level of competence in problem solving skills, and so are in considerable demand in a wide variety of areas of employment.

While this is an integrated Masters programme, lasting four years, it is possible to graduate after three years with a BSc-level qualification. In order to be permitted to proceed on to the MMath in the fourth year, you are expected to have a provisional Upper Second or higher degree classification at the end of year 3. Transfer to this programme is normally only possible early in Semester 1 of the first year from a number of other programmes in the School.

Your contact hours will vary depending on your module/option choices. Full information about contact hours is provided in individual module profiles.

Learning and teaching

The Mathematical Sciences School uses a wide variety of modern learning and teaching methods involving small group tutorial work and computer based learning that builds on what you learn in lectures.

Assessment

Assessment is varied, enabling you to demonstrate your strengths and show what you have learnt. Students are provided with access to relevant software that they can use on their own personal computers to assist their studies.

Special Features of the programme

The final year of study includes options with a strong influence from the active research fields explored by Southampton academics. Examples include modules on Gravitational Waves and Coherent Light and Matter. This focus on research-led teaching is an important part of this degree programme.

Please note: As a research-led University, we undertake a continuous review of our programmes to ensure quality enhancement and to manage our resources. As a result, this programme may be revised during a student's period of registration; however, any revision will be balanced against the requirement that the student should receive the educational service expected. Please read our Disclaimer to see why, when and how changes may be made to a student's programme.

Programmes and major changes to programmes are approved through the University's programme validation process which is described in the University's Quality handbook.

Educational Aims of the Programme

The aims of the programme are to:

- Introduce you to the main basic areas of mathematics and physics;
- Develop your understanding of abstract mathematical concepts;
- Offer you the opportunity to study advanced mathematical concepts and techniques;
- Develop your modelling and problem solving skills;
- Offer you the opportunity to construct an individual programme of study within a coherent framework;
- Offer you the opportunity to study applications of mathematics in a variety of contexts which utilize mathematical and physical models;
- Offer you the opportunity to study mathematics of particular relevance to physical applications;
- Introduce you to some of the key developments of twentieth century physics;
- Develop your appreciation of the nature and importance of experimental data in physics;
- Develop your subject specific and transferable skills including an analytical approach to problem solving, logical argument and deductive reasoning, abstraction and generalisation, and written communication skills in mathematics;
- Provide some of the basic IT skills necessary for further study and employment, including word processing and use of the internet;
- Help you to develop key skills: personal organisation, teamwork, problem solving and analysis, finding and using information, and written and oral presentation.

Programme Learning Outcomes

Knowledge and Understanding

On successful completion of this programme you will have knowledge and understanding of:

A1. The fundamentals of calculus and linear algebra;

A2. The fundamentals of differential equations, both ordinary and partial;

A3. The principles of vector calculus and their applications;

A4. The fundamental concepts of classical physics, including electromagnetism and special relativity; A5. The fundamentals of quantum physics, and their applications.

Teaching and Learning Methods

Acquisition of knowledge and understanding of A1 through A5 is through structured exposition based on lectures, tutorial classes, workshops and private study, all of which are equally important. Increasing independence of learning is required as the programme progresses. Throughout the programme you are encouraged to use additional recommended reading material for private study to consolidate the formal learning process, and to broaden and deepen your understanding.

Assessment Methods

Assessment is undertaken in the first year by a mixture of unseen examinations, regular marked coursework, class tests and laboratory work. This variety of assessment relates to A1 through A5, and also to some of the skills described below. This varied approach to assessment continues in the remainder of the programme.

Subject Specific Intellectual and Research Skills

On successful completion of this programme you will be able to:

B1. The ability to identify the key areas of physics theory relevant to a given problem;

B2. The ability to construct a mathematical models of a given physical situations;

B3. The ability to identify and use appropriate mathematical techniques to solve the given problem;

B4. The ability to use computer packages as vehicles for exploration and understanding;

B5. An appreciation of the wide-ranging application of mathematics to physics.

Teaching and Learning Methods

Problem-solving is at the heart of all activity in mathematical physics, and so it is emphasised throughout the learning and teaching experience, as is the need for accurate calculation and logical argument. The use of specific mathematical techniques is a part of the curriculum, and the skills acquired there are used in later modules as appropriate.

Assessment Methods

The various methods of assessment described in section B relate to all of the skills listed above, with the project work specifically relating to B4.

Transferable and Generic Skills

On successful completion of this programme you will be able to:

C1. Communicate mathematical and physical ideas in written form;

C2. Undertake oral presentations;

C3. Demonstrate group-working skills

C4. Employ computational methods and show basic word processing skills;

C5. Use and obtain information from a variety of different sources including the internet, books and other printed material;

C6. Use the skills you have acquired (e.g. time-management, organisation, problem-solving, critical analysis, independent learning, etc.) for life-long learning.

Teaching and Learning Methods

The learning of transferable skills begins in the first year. In addition to the modules you take each semester, you will also be timetabled for weekly workshops. Some first year lecturers will set problems for which computing will be useful, thereby developing transferable skills alongside subject specific skills. Other IT skills such as basic word processing feature prominently in project work. Special classes devoted to study skills are offered during the first year, and extensive electronic resources on study skills are available through the Mathematics, Physics, and University websites.

Further development of IT skills, written communication and general skills such as organisation and time-management is associated to optional third and fourth year modules which may contain an element of coursework in their assessment. The second and third year project-based modules develop your portfolio of skills to include internet and library research, group working, and presentation skills, as does the core fourth year year-long individual project.

Assessment Methods

Throughout the programme the clear communication of mathematics and physics is part of the assessment criteria, either explicitly or implicitly. For project work, and for those modules which involve coursework assignments, a proportion of the assessment is allocated to communication (C1, C2, and C4).

Project work and coursework assessment also relate to C5, and where appropriate, C3. The skills referred to in C6 refer to problem-solving, an integral component of all work in mathematics and physics, and other learning skills are implicit.

Subject Specific Practical Skills

On successful completion of this programme you will be able to:

D1. Apply the fundamentals of experimental physical research.

Teaching and Learning Methods

The first year contains two core modules of laboratory work, in which you will learn the fundamentals of experimental physical research.

Programme Structure

The programme structure table is below:

Information about pre and co-requisites is included in individual module profiles.

Part I

Typical programme content

The mathematical part of this programme covers the fundamental areas of calculus and linear algebra, leading on to the important topics of vector calculus and partial differential equations once these basics have been mastered. The physics part of the course enables you to learn about many modern developments and theories, including key ideas of relativity, cosmology and astrophysics, applications of laser technology, atomic and particle physics, optoelectronics and many others. You are free to choose your set of optional modules in the third and fourth years, either maintaining a very broad skills base, or else specialising to a particular "pathways", in, for example, particle physics, astrophysics or condensed matter.

In addition to this, our Curriculum Innovation Programme offers our students the chance to take optional modules outside their core disciplines. This allows you to personalise your education, to develop new skills and knowledge for your future.

Programme details

The structure of the programme and the modules currently offered are set out below. Of the modules shown against each year of your programme, some are compulsory (ie enrolment is automatic) and others are option modules. Against each year, you are directed to which modules are compulsory and which are options. The option modules listed constitute an indicative list. There will always be choice but the options might vary between years. A complete list of option modules currently available on your programme can be found via the Student Record Self-Service system.

The programme comprises four parts, each corresponding to one year of full-time study. You will normally have to take 4 modules (30 ECTS/60 CATS) each semester i.e. 8 modules (60 ECTS/120 CATS) in each year of the programme. Each CATS point can be considered as the equivalent of approximately ten hours of study. Most modules offered in this programme are 7.5 ECTS/15 CATS modules. (The exception to this is the first year, where there are a number of 5 ECTS/10 CATS modules, and one double 10 ECTS/30 CATS module). This means that each module comprises around 150 hours of study divided into contact time (e.g. lectures, seminars, workshops) and non-contact time when you will be engaged in directed study (preparation for classes) and independent study when you will be involved in producing assignments and preparing and taking examinations.

Variation to Regulations: In order to progress to Part IV of the programme, students must achieve an average Pass Mark of 60% in Part III.

Part I Compulsory

Code	Module Title	ECTS	Type
MATH1049	Linear Algebra II	7.5	Compulsory
MATH1060	Multivariable Calculus	7.5	Compulsory
PHYS1017	Physics Skills 1	5	Compulsory
PHYS1019	Physics Skills 2	5	Compulsory

Part I Core

Code	Module Title	ECTS	Type
MATH1059	Calculus	7.5	Core
PHYS1022	Electricity and Magnetism	5	Core
PHYS1013	Energy and Matter	5	Core
MATH1048	Linear Algebra I	7.5	Core
PHYS1015	Motion and Relativity	5	Core
PHYS1011	Waves, Light and Quanta	5	Core

Part II

Part II Core

Code	Module Title	ECTS	Type
PHYS2006	Classical Mechanics	7.5	Core
MATH2039	Analysis	7.5	Core
PHYS2001	Electromagnetism	7.5	Core
MATH2038	Partial Differential Equations	7.5	Core
PHYS2003	Quantum Physics	7.5	Core
PHYS2024	Quantum Physics of Matter	7.5	Core
MATH2045	Vector Calculus and Complex Variable	7.5	Core
PHYS2023	Wave Physics	7.5	Core

Part III

Part III Compulsory

You must take have taken at least one of MATH3023, MATH3031, MATH3032 or MATH3087 during their programme

Code	Module Title	ECTS	Type
PHYS3008	Atomic Physics	7.5	Compulsory
MATH3023	Communicating and Teaching Mathematics	7.5	Compulsory
MATH3032	Mathematical Investigation and Communication	7.5	Compulsory
MATH3031	Mathematics Project	7.5	Compulsory

MATH3087	Maths and your Future	7.5	Compulsory

Part III Optional

The option modules shown below constitute an indicative list; there will always be choice but the options might vary between years. A full list of option modules and rules will be available to you via the Student Record Self-Service system once you enrol at the University.

Code	Module Title	ECTS	Type
MATH3032	Mathematical Investigation and Communication	7.5	Optional
MATH3087	Maths and your Future	7.5	Optional
PHYS3007	Theories of Matter, Space and Time	7.5	Optional
MATH3083	Advanced Partial Differential Equations	7.5	Optional
MATH3084	Integral Transform Methods	7.5	Optional
PHYS3003	Light and Matter	7.5	Optional
MATH3052	Mathematical Biology	7.5	Optional
PHYS3002	Nuclei and Particles	7.5	Optional
MATH3006	Relativity, Blackholes and Cosmology	7.5	Optional
PHYS3010	Stellar Evolution	7.5	Optional

Part IV

In order to progress to Part IV of the programme, students must achieve an average Pass Mark of 60% in Part III.

Part IV Core

Code	Module Title	ECTS	Type
MATH6144	MMath Project	15	Core

Part IV Optional

The option modules shown below constitute an indicative list; there will always be choice but the options might vary between years. A full list of option modules and rules will be available to you via the Student Record Self-Service system once you enrol at the University.

Code	Module Title	ECTS	Type
MATH6139	Advanced General Relativity	7.5	Optional
PHYS6003	Advanced Quantum Physics	7.5	Optional
PHYS6012	Coherent Light, Coherent Matter	7.5	Optional
PHYS6017	Computer Techniques in Physics	7.5	Optional
PHYS6005	Cosmology and the Early Universe	7.5	Optional
MATH6149	Modelling with Differential Equations	7.5	Optional
PHYS6011	Particle Physics	7.5	Optional
MATH6140	Structure and Dynamics of Networks	7.5	Optional

Progression Requirements

The programme will follow the University's regulations for ***Progression, Determination and Classification of Results: Undergraduate and Integrated Masters Programmes*** or the University's regulations for ***Progression, Determination and Classification of Results: Standalone Masters Programmes*** as set out in the General Academic Regulations in the University Calendar: http://www.calendar.soton.ac.uk/sectionIV/sectIV-index.html

Support for student learning

There are facilities and services to support your learning some of which are accessible to students across the University and some of which will be geared more particularly to students in your particular Faculty or discipline area.

The University provides:

- library resources, including e-books, on-line journals and databases, which are comprehensive and up-todate; together with assistance from Library staff to enable you to make the best use of these resources
- high speed access to online electronic learning resources on the Internet from dedicated PC Workstations onsite and from your own devices; laptops, smartphones and tablet PCs via the Eduroam wireless network. There is a wide range of application software available from the Student Public Workstations. • computer accounts which will connect you to a number of learning technologies for example, the Blackboard virtual learning environment (which facilitates online learning and access to specific learning resources)
- standard ICT tools such as Email, secure filestore and calendars.

- access to key information through the MySouthampton Student Mobile Portal which delivers timetables, Module information, Locations, Tutor details, Library account, bus timetables etc. while you are on the move.
- IT support through a comprehensive website, telephone and online ticketed support and a dedicated helpdesk in the Hartley Library.
- Enabling Services offering support services and resources via a triage model to access crisis management, mental health support and counselling. Support includes daily Drop In at Highfield campus at 13.00 – 15.00 (Monday, Wednesday and Friday out of term-time) or via on-line chat on weekdays from 14.00 –
16.00. Arrangements can also be made for meetings via Skype.
- assessment and support (including specialist IT support) facilities if you have a disability, long term health problem or Specific Learning Difficulty (e.g. dyslexia).
- the Student Services Centre (SSC) to assist you with a range of general enquiries including financial matters, accommodation, exams, graduation, student visas, ID cards
- Career and Employability services, advising on job search, applications, interviews, paid work, volunteering and internship opportunities and getting the most out of your extra-curricular activities alongside your degree programme when writing your CV
- Other support that includes health services (GPs), chaplaincy (for all faiths) and 'out of hours' support for students in Halls and in the local community, (18.00-08.00)
- A Centre for Language Study, providing assistance in the development of English language and study skills for non-native speakers.

The Students' Union provides
- an academic student representation system, consisting of Course Representatives, Academic Presidents, Faculty Officers and the Vice-President Education; SUSU provides training and support for all these representatives, whose role is to represent students' views to the University.
- opportunities for extracurricular activities and volunteering
- an Advice Centre offering free and confidential advice including support if you need to make an academic appeal
- Support for student peer-to-peer groups, such as Nightline.

Associated with your programme you will be able to access:

- module co-ordinators support. Module co-ordinators will be available at designated times during the week to discuss issues related to the particular modules you are studying at the time. This will be in addition to class contact time.
- Academic/personal tutor. As soon as you register on this programme, you will be allocated a personal tutor. S/he is a member of the academic team and will be available to discuss general academic issues related to the programme as well as offer advice and support on any personal issues which may affect your studies. · module handbooks/outlines. These will be available at the start of each module (often in online format). The Handbook includes the aims and learning outcomes of the module, the methods of assessment, relevant background material to the module and a session-by-session breakdown of the module together with appropriate reading lists.
- Within the Faculty, administrative support is provided by your Student Office which deals with student records and related issues and with queries related to your specific degree programme.

Methods for evaluating the quality of teaching and learning

You will have the opportunity to have your say on the quality of the programme in the following ways:

- Completing student surveys for each module of the programme
- Acting as a student representative on various committees, e.g. Staff Student Liaison Committees, Faculty Programmes Committee OR providing comments to your student representative to feed back on your behalf.
- Serving as a student representative on Faculty Scrutiny Groups for programme validation
- Taking part in programme validation meetings by joining a panel of students to meet with the Faculty Scrutiny Group

The ways in which the quality of your programme is checked, both inside and outside the University, are:

- Regular module and programme reports which are monitored by the Faculty
- Programme validation, normally every five years.
- External examiners, who produce an annual report
- A national Research Excellence Framework (our research activity contributes directly to the quality of your learning experience)
- Institutional Review by the Quality Assurance Agency

Further details on the University's quality assurance processes are given in the *Quality Handbook.*

Career Opportunities

We place great importance on the development of graduate skills vital for future employment, and include transferable skills in our learning and teaching.

More specifically, graduates whose degrees combine the mathematical skills of problem solving and analytical argument with those acquired through extensive study in the physical sciences are at a premium. It is no surprise therefore to find mathematical physicists working in a wide variety of jobs. For just one example it is well known that many of the financial analysts who work on Wall Street are physicists by training.

External Examiner(s) for the programme

Name: Professor Peter Duck - University of Manchester

Name: Professor John Parker - University of Durham

Name: Mr Peter J Savill - Fellow of the Institute of Actuaries

Name: Dr Lawrence Pettit - Queen Mary College University of London

Students must not contact External Examiner(s) directly, and external examiners have been advised to refer any such communications back to the University. Students should raise any general queries about the assessment and examination process for the programme with their Course Representative, for consideration through Staff: Student Liaison Committee in the first instance, and Student representatives on Staff: Student Liaison Committees will have the opportunity to consider external examiners' reports as part of the University's quality assurance process.

External examiners do not have a direct role in determining results for individual students, and students wishing to discuss their own performance in assessment should contact their Personal Academic Tutor in the first instance.

Please note: This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities that are provided. More detailed information can be found in the programme handbook.

Appendix 1:

Students are responsible for meeting the cost of essential textbooks, and of producing such essays, assignments, laboratory reports and dissertations as are required to fulfil the academic requirements for each programme of study. In addition to this, students registered for this programme also have to pay for:

Additional Costs

Type	Details
Stationery	You will be expected to provide your own day-to-day stationery items, e.g. pens, pencils, notebooks, etc). Any specialist stationery items will be specified under the Additional Costs tab of the relevant module profile.
Textbooks	Where a module specifies core texts these should generally be available on the reserve list in the library. However due to demand, students may prefer to buy their own copies. These can be purchased from any source. Some modules suggest reading texts as optional background reading. The library may hold copies of such texts, or alternatively you may wish to purchase your own copies. Although not essential reading, you may benefit from the additional reading materials for the module.
Approved Calculators	Candidates may use calculators in the examination room only as specified by the University and as permitted by the rubric of individual examination papers. The University approved models are Casio FX-570 and Casio FX-85GT Plus. These may be purchased from any source and no longer need to carry the University logo.
Printing and Photocopying Costs	In the majority of cases, coursework such as essays; projects; dissertations is likely to be submitted on line. However, there are some items where it is not possible to submit on line and students will be asked to provide a printed copy. A list of the University printing costs can be found here: http://www.southampton.ac.uk/isolutions/students/printing-forstudents.page. For students undertaking modules with a high mathematical content, some assessed work will be submitted in handwritten hard copy format. Students are advised that they will need to bear the costs of the required stationery.

In some cases you'll be able to choose modules (which may have different costs associated with that module) which will change the overall cost of a programme to you. Details of such costs will be listed in the Module Profile. Please also ensure you read the section on additional costs in the University's Fees, Charges and Expenses Regulations in the University Calendar available at www.calendar.soton.ac.uk.