The University Of Sheffield.

Programme Specification

A statement of the knowledge, understanding and skills that underpin a taught programme of study leading to an award from The University of Sheffield

Programme Details

1. Programme title	Theoretical Physics
2. Programme code	PHYU16
3. QAA FHEQ level	Masters F7
4. Faculty	Science
5. Department	Physics and Astronomy
6. Other departments providing credit bearing modules for the programme	None
7. Accrediting Professional or Statutory Body	Institute of Physics
8. Date of production/revision	June 2022

Awards	Type of award	Duration
9. Final award	MPhys	4 years
10. Intermediate awards	BSc	3 years

Programme Codes

11. JACS code(s) *Select between one and three codes from the HESA website.*	F300	F340	
12. HECoS code(s) *Select between one and three codes from the HECoS vocabulary.*	100425	100426	

Programme Delivery

13. Mode of study	Full-time
14. Mode of delivery	On campus

15. Background to the programme and subject area

Physics is the most fundamental of all the sciences: not only is it a fruitful research discipline in its own right, but its ideas and techniques underpin developments in many other areas of science, technology and medicine. It is characterised by the use of a few basic principles, quantities and laws to describe, understand and predict the behaviour of relatively complex systems, both natural and artificial. The key features of physics are the modelling of natural phenomena by means of mathematical equations ("theory") and the making of experimental or observational measurements which both test existing theories and inspire new ones ("experiment"). The interplay of theory and experiment drives the development of the field, and requires a broad range of skills including mathematical modelling, problem solving, experiment design and data analysis, teamwork and communication. Thus, in addition to the intrinsic interest of the subject, a degree in Physics provides a wide range of analytical, problem solving and communications skills, which make Physics graduates highly employable across a broad spectrum of fields in industry, commerce, research and education.

Understanding and developing the interplay between deep mathematical ideas and a quantitative description of the physical world is the main goal of theoretical physicists. Theoretical physics has a long tradition of attracting students who not only enjoy the challenge of understanding new concepts, but also like to see the way in which physical phenomena are explained or predicted by mathematics. In recent years computational physics has added a new dimension to this subject, because the power of modern computers and software has made realistic simulations of complex phenomena possible. This has widened the areas that are accessible to theorists as well as introducing a new discipline, computational physics, into the curriculum. The widespread use of computer modelling in industrial, financial and managerial areas has meant that students with these skills are in very high demand.

Our programmes in Theoretical Physics aim to equip students with a thorough knowledge of the fundamental principles of theoretical physics. The Department of Physics and Astronomy has an international reputation for research and teaching. Combined with members of the Department of Applied Mathematics the research interests span a wide range of physics and theoretical physics including condensed matter, astrophysics, particle physics, quantum gravity and biophysics. Our aim is to prepare BSc students for careers as professional physicists including research work in any area of theoretical or experimental physics.

The MPhys in Theoretical Physics gives students the opportunity to study and research topics at the edge of the discipline and in doing so gives them the best preparation for PhD study, careers as a professional physicist or related technical careers. Particular emphasis is placed on contemporary physics in the fourth year of the MPhys degree and MPhys students also carry out a substantial research project in their final year, working within one of the research groups in the department.

16. Programme aims

The BSc Physics and Astrophysics Programmes aims to:	
A1	provide teaching that is informed and invigorated by the research and scholarship of the staff and is stimulating, useful and enjoyable to students from a wide variety of educational backgrounds.
A2	produce graduates with well-developed practical, analytical, communication, IT and problem-solving skills who readily find employment in industry, the professions and public service.

A3	encourage and develop students' interest in physics and to support them to become independent learners with the aid of appropriate sources.
A4	produce graduates with an understanding of most fundamental laws and principles of physics, along with their application to a variety of fields with a particular focus on mathematical and theoretical aspects.
A5	develop students' ability to design and execute open ended investigations, analyse the results using a variety of quantitative methods, and draw valid conclusions.
A6	ensure that students can investigate a topic independently with the aid of research articles and other primary sources, and report their findings clearly, concisely and accurately.
A7	to develop students' abilities to use theoretical modelling to solve problems and enhance physical understanding.

17. Programme learning outcomes

Knowledge and understanding

On successful completion of the programme, students will be able to demonstrate knowledge and understanding of:

		Links to Aim(s)
K1	fundamental laws and principles of physics to interpret the behaviour of natural phenomena and/or technology.	A1 & A4
K2	laws and principles along with experimental, mathematical and/or computational techniques to solve simple and open ended physics problems.	A2 & A3
K3	the empirical nature of physical science, the interplay between theory and experiment and the ethics of science in society.	A2, A4, A5
K4	experimental and/or computational investigations and interpret conclusions appropriately together with these error analyses.	A2, A5
K5	the basic areas of physics i.e. classical and quantum mechanics, thermal physics, wave phenomena, properties of matter, electromagnetism and statistical physics.	A3 & A4
K6	physics knowledge in (optional) specialised areas at, or informed by, the forefront of the discipline.	A3 & A4
K7	the theoretical framework that underpins modern physics.	A4, A6 & A7
K8	advanced topics in physics to a level appropriate for a foundation for postgraduate research.	A4, A6 & A7
K9	experimental, computational or analytical techniques (dependent on programme) and background literature to studies both in the subject area of their level 4 research project and more broadly.	A4, A5, A6 & A7

Skills and other attributes On successful completion of the programme, students will be able to:		
S1	analyse and solve problems in physics by identifying the appropriate physical principles, developing a mathematical model of the system and using appropriate mathematical techniques to obtain a solution.	A2 & A5
S2	use mathematics to analyse a physical system so as to deduce its behaviour and properties.	A2, A4 & A5
S3	create, plan and execute an authentic open ended research investigation, including quantitative analysis of the results in order to draw conclusions and compare with expected outcomes.	A2 & A5
S4	communicate scientific ideas and the results of investigations clearly and concisely, both orally and in writing, with consideration for the needs of the audience.	A2 & A5
S5	apply scientific computing (using languages such as Python or Labview) to analyse data, control experiments, undertake numerical simulation or analyse physical or mathematical systems.	A2, A4 & A5
S6	apply word processing, graphing and presentation software to communicate the results of an investigation through scientific written reports and oral presentations.	A2 & A5
S7	plan and manage personal learning, including time management skills, adapt to change, and demonstrate the ability to learn effectively using a wide variety of sources (lectures, textbooks, websites, etc.).	A2 & A3
S8	work effectively as a member of a group by taking due consideration of others in order to communicate, plan tasks and encourage and support the group.	A2, A3, & A5
S9	safely use laboratory equipment to make experimental observations and measurements in order to explore physics concepts and execute experimental investigations.	A5
S10	analyse, summarise and synthesise primary or review papers in scientific journals, as well as other appropriate sources as part of an investigation.	A2 & A6
S11	plan and execute independent project work to create new scientific knowledge in a research environment.	A2, A5 & A6
S12	summarise and present the results of research-level investigations both orally and in written reports.	A2 & A6
S13	use advanced, specialised laboratory equipment and/or apply computational techniques relevant to research areas at the forefront of the discipline and gain the ability to master, with training, new techniques.	A5 & A6
S14	Expertly apply high level computer languages to scientific programming problems and modelling of physical systems.	A2, A4, A5, A6 & A7

18. Learning and teaching methods

Development of the learning outcomes is promoted through the following teaching and learning methods:

Lectures
The standards required of a graduate in the physical sciences include the acquisition of a substantial body of knowledge. This is conveyed principally through traditional lectures, backed up by tutorials, problems classes, workshops and coursework (see below).

Tutorials
All students in Levels 1 and 2 have weekly small-group tutorials. The principal aim of tutorial classes is to develop students' problem-solving skills and to address any difficulties with the taught material. At level 1, homework problems are integrated into the tutorial system to help students to develop the ability to manage their learning and to assist tutors in diagnosing and addressing any difficulties.

Problems classes, computing classes and workshops
Workshops and problems classes are held in Level 1, Level 2 and Level 3 to facilitate development of problem-solving, planning, communication, programming and group skills and consolidate material taught in lectures.

In addition, several modules with designated learning outcomes that are highly skills-oriented (e.g. programming, enterprise) are taught predominantly through workshop and problems classes, with problem-solving fully integrated with the introduction of new material where relevant.

Teaching laboratories
The Level 1 laboratory curriculum is delivered within the core through weekly sessions addressing quantitative experimental work and data analysis, emphasising the significance of experimental error and the development of skills in these areas as well as in problem-solving. These practical classes are aimed at developing sound laboratory technique and familiarity with basic equipment, and they also include exercises on the writing of laboratory reports.

At Level 2, learning in the physics laboratory is included within the compulsory core element of the programme. These sessions build on the basic experimental knowledge and skills developed at level 1 and further develop these skills. Laboratory work develops naturally into project work at level 3.

Numerical and computational techniques are increasingly important in many areas of theoretical physics. At Level 2, all theoretical physics students take a Programing course and are encouraged to select a specially designed course to develop numerical and computational physics skills.

Projects and investigative learning
Skills-based learning at level 1 and 2 build towards independent project work at level 3, with all Physics students undertaking some form of independent open ended investigation. Students can choose from a variety of options that allow customisation of their degree programme towards specialist interests. We offer industrial projects, computing laboratories and projects, experimental research projects and education based projects. Learning in these capstone modules includes independent study skills, planning and management skills, team working and report writing. Projects are assessed by written reports, presentations and viva voce examinations. Students must pass a project-based module at level 3 to graduate with an Honours degree class.

At Level 4, MPhys students carry out a research project, preceded by a literature review. These projects are normally carried out in one of the department's research groups and involve ideas, techniques or data which are at the forefront of the discipline.

Seminars
Physics is an active field with exciting research going on in numerous areas ranging from pure curiosity driven study to important industrial applications. The Department hosts a variety of seminars and colloquia throughout the academic year, some organised by the department, some by the Yorkshire branch of the Institute of Physics (IoP), and some by the various research groups. Many of these, especially the departmental and IoP colloquia, are designed specifically to be suitable for

undergraduate students and are advertised by notices around the department.

Independent study
Learning at all levels contains large elements of independent study, which may involve consolidating taught material, by reading and solving problems, or specific independent learning assignments. These activities offer students the chance to develop their learning skills and, often, to pursue particular interests. All students pursuing independent study as part of a project have a named supervisor from whom they can seek assistance or advice if necessary.

19. Assessment and feedback methods

Opportunities to demonstrate achievement of the learning outcomes are provided through the following assessment methods:

1. Formal examinations
Knowledge and application of knowledge is primarily assessed by formal examinations typically accounting for between 60% and 80% of the module grade. The level of choice in an exam depends on whether the knowledge outcome being assessed forms part of the core of the programme. Questions are structured and are presented with an indicative marking scheme. A sample of exam scripts is double marked.

2. Coursework assessment (continuous assessment, homework, progress tests and other assignments)
Laboratory modules and laboratory components of taught modules are assessed principally through student lab diaries and formal laboratory reports. Written and oral feedback is provided on the spot by lab demonstrators, to enable students to address weaknesses immediately. This assessment is supplemented at level 1 by homework exercises on specific aspects of data analysis such as uncertainty calculations and statistics, and at level 2 by additional presentation methods such as posters and talks. Computing is often assessed by means of programming tasks carried out under controlled conditions during the semester.

Most taught modules have an element of coursework assessment accounting for a small proportion of the module grade, up to 20%. Feedback from these exercises allows the lecturer to monitor class progress and identify problems, as well as providing students with information to help them to manage their own learning.

3. Essays and reports
Some modules involving independent study are assessed partly through essays and reports. These are marked according to content, clarity of exposition, language and style, following marking schemes which are public and available to students. Written feedback is provided.

All essays and reports contributing more than 20% to a particular module are independently double-marked by two members of staff.

4. Project assessment
Level 3 and 4 project work is assessed according to a carefully structured scheme involving reports, log books and presentations and the supervisor's assessment of the quality of the work (measured against a well-defined set of criteria).

5. Portfolios
Portfolio assessment is used in levels 1-3 to track progress in terms of skills development and allows prompt feedback to be given. Students collect evidence in their portfolio of skills that have been developed. At L1 successful completion of the portfolio gains an automatic pass of the year but does not contribute to the final grade. At L2 a portfolio is used as part of the assessment within the core of the programme and a pass is required to proceed. At L3 a portfolio is used to support employability and is not assessed summatively.

20. Programme structure and student development

Taught material
Level 1 is designed to provide an overview of physics, ensuring that students acquire a basic grasp of all areas of the subject, regardless of differing A-level backgrounds. Since physics is a mathematical science, 30 credits of mathematics are required to ensure that all students develop the skills required to understand the theoretical structure of the discipline and to solve mathematical and numerical problems. Level 1 is designed for students with A levels or equivalent in Physics and Mathematics; a Foundation Year is available for able students who lack these qualifications.

Level 2 builds on the foundation established in level 1 to ensure that students acquire a thorough grounding in all key areas of physics. Additional mathematical content is taken to enhance students' knowledge of the relevant mathematical techniques and their applications in physics and astronomy. In Level 3 students extend their knowledge and understanding of some areas of the subject to a level which is consistent with participation in the work of a research group. A Level 3 module helps students to see the subject as a unified discipline, avoiding compartmentalisation, and also enhances problem-solving skills and group project skills.

Computational and experimental laboratory work
The laboratory and project curriculum provides a steady progression from basic skills to research-level project work. Level 1 equips students with grounding in basic laboratory equipment and techniques and introduces standard methods of data analysis, with a particular focus on the concept of experimental error and comparison with expected values. Level 2 extends this experience to longer and more complex experiments or investigations, leading naturally to the open-ended project work of level 3. All students follow the same basic laboratory programme in level 1. At level 2 and above mathematical and computational projects are provided for the more theoretically inclined students.

Independent study
The development of independent study skills is structured using coursework activities and portfolio development at level 1, self-directed mini-project work and portfolios at level 2 before culminating in independent open ended investigations at level 3. At all levels students are provided with additional reading lists, making use of eprints and library texts. Optional modules provide opportunities for additional independent learning through literature surveys and information retrieval exercises.

Personal Tutors
Students' progression through the programme structure is guided by their Personal Tutor, who also fulfils the pastoral role laid out in the University's 'Personal Tutors Policy Statement'. Students will normally keep the same Personal Tutor from entry to the department until graduation: the Personal Tutor thus develops a good overview of each student's strengths and aspirations. Tutors also assist students, if requested, with advice on career choices and support for applications for jobs or postgraduate study.

Personal Tutors and students meet regularly once per semester, with the possibility of additional meetings if requested by either party.

General aspects of progression
The final degree class for BSc is determined by a weighted mean of grades from years 2 and 3 in the ratio 1:2, with the award of an Honours degree requiring successful completion of a final year project.

Transfers between BSc and MPhys are possible at any time during years 1 and 2. Transfers from BSc to MPhys during year 3 are not recommended, but may be permitted in exceptional circumstances if the student concerned satisfies the requirements for the MPhys programme regarding core credits and grade average.

Students who obtain fewer than 100 credits overall may not proceed to level 2. Students require 120 credits at level 2 for automatic progression to level 3 but a conceded pass is considered for students with a minimum of 100 credits at the Examiners' discretion.

Detailed information about the structure of programmes, regulations concerning assessment and progression and descriptions of individual modules are published in the University Calendar available online at http://www.sheffield.ac.uk/calendar/.

21. Criteria for admission to the programme

Good A2 levels, or equivalent, in Physics and Mathematics (see website below for precise details).

Students who have demonstrated the academic ability necessary to complete a degree programme, but who lack the required subject qualifications, may enter the programme through the Science Foundation Year.

Detailed information regarding admission to the programme is available at http://www.shef.ac.uk/prospective/

22. Reference points

The learning outcomes have been developed to reflect the following points of reference:

Subject Benchmark Statements
https://www.qaa.ac.uk/quality-code/subject-benchmark-statements?indexCatalogue=document-search&searchQuery=physics&wordsMode=AllWords

Sheffield Graduate Attributes
https://www.sheffield.ac.uk/sheffieldgraduate

The accreditation criteria of the Institute of Physics
http://iop.cld.iop.org/education/higher_education/accreditation/page_43310.html#gref

Framework for Higher Education Qualifications (2014)
https://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf

University Strategic Plan
http://www.sheffield.ac.uk/strategicplan

Learning and Teaching Strategy (2016-21)
https://www.sheffield.ac.uk/polopoly_fs/1.661828!/file/FinalStrategy.pdf

23. Additional information

Physics is a wide-ranging subject, with applications ranging from the abstruse (e.g. superstring cosmology) to the everyday (e.g. smart materials, climate change modelling). The single honours degree programmes, both BSc and MPhys, draw on the related Dual Honours programmes and the Department's diverse research interests to offer a wide range of optional modules to complement the core curriculum. Students may select their options so as to specialise in a particular area, or may opt to increase their breadth of knowledge by choosing options covering a range of topics.

Physics graduates are equipped for a wide range of career paths. Common directions chosen by Sheffield graduates include IT (both hardware and software), the financial sector (accountancy, actuarial work, etc.), energy, research and development, consultancy and management, technology, data science and teaching. Many students choose to continue their studies by embarking on PhD programmes; this may be the starting point of a career in physics research, but it also imparts transferable skills in problem solving, communications and research methodology that are valued in industry and commerce.

This specification represents a concise statement about the main features of the programme and should be considered alongside other sources of information provided by the teaching department(s) and the University. In addition to programme specific information, further information about studying at The University of Sheffield can be accessed via our Student Services web site at http://www.shef.ac.uk/ssid.