Maths & Physics
Physics at Warwick
Joint Honours Courses
Mathematics and Physics
Introduction

“Mathematics and physics are a sensible combination to study at university, and provide the basis for a stimulating and enjoyable education.

Mathematics and physics are complementary subjects. Often, a way of thinking developed in one discipline leads to new insights into the other. The advances in the mathematical theory of dynamical systems and chaos are an example. Ideas from the theory are now applied in the modelling of physical systems such as the atmosphere, lasers and other complex systems.

In both subjects the emphasis is on learning how to recognise the surprising and how to reason. So, although the joint degree is the natural route into theoretical physics, the skills it teaches are universal and can lead to many different careers. Our former students have gone on to work in industry and in professions such as business, journalism and the financial sector.

There are two variants of the degree course: the three-year BSc and the four-year MMathPhys. You need to decide by the end of your second year which degree to aim for. BSc courses should be seen as part of a general rounded education, which should leave you numerate, articulate and employable. The four-year course should appeal most to you, if you intend to make direct use of your knowledge of mathematics and physics after you graduate.”

Danny Steeghs
Head, Undergraduate Admissions
The Warwick joint degree course is among the best established in the country and the course includes a number of modules from both contributing departments designed specifically for joint degree students. Each year around 65 students start on this course.

In the first year you take essential (core) modules in both mathematics and physics. You also take at least one additional module chosen from a list of options. At the end of the first year it is possible to change to either of the single honours courses, providing you satisfy certain requirements in the end of year examinations.

In the second and third years, there is considerable freedom to choose modules. By then you will have a good idea of your main interests and be well placed to decide which areas of mathematics and physics to study in greater depth. In effect you design your own degree. Some modules may also be taken from outside of both mathematics and physics. We encourage you not only to consider the ‘obvious’ outside modules in computing or statistics, but also modules introducing secondary school teaching or a modern language.

The optional fourth year continues to cover the main areas of mathematics and physics. You can continue to study a broad spectrum of topics within both subjects. However you may choose to concentrate on one or two areas. This can give time to take in and reflect on some of the recent developments in these areas.

Our research is strong in a number of branches of mathematics and physics, and we are well placed to offer authoritative and coherent accounts of those recent developments likely to be of most interest to you as a joint degree student.
The First Year

Currently the first year is:

Maths
Mathematical Analysis (60 Lectures), Sets and Numbers (30L), Linear Algebra (30L), Differential Equations (30L).

Physics
Physics Foundations (30L), Electricity and Magnetism (30L), Classical Mechanics and Relativity (30L), Quantum Phenomena (15L).

There is also a Computing Workshop. You choose at least on further module from:

Options
Abstract Algebra (15L), Astronomy (15L), Geometry (15L), Particle Physics (15L), Probability (30L), Programming for Scientists (30L).

Mathematics at university emphasises the importance of proof. All sciences test the validity of ideas and conjectures, usually by comparing with reality as seen in experiment. In mathematics, there are no experiments, so it is important to be able to construct watertight arguments or proofs.

Mathematics is also concerned with the generality of results. The process of figuring out the most general form of some result from an initial example is an important and rewarding part of the subject. It is often what suggests new results and can reveal connections with other areas within mathematics.

The modules Linear Algebra, and Sets and Numbers, treat concepts which you have met at school, but in a more abstract and general way. Analysis is another word for calculus but carries the implication that all results must have satisfactory proofs. Some of the material in the Analysis module should be familiar from A level, but it will be presented with the emphasis on proof. The Differential Equations module deals with the methods for solving the differential equations of motion, which describe the behaviour of various physical systems.

The central theme in physics is to identify the (relatively few) fundamental laws and show how they may be invoked to explain many natural phenomena. A good example is provided by Electricity and Magnetism, which were shown by Faraday, Maxwell and others to be manifestations of the same phenomenon - now called electromagnetism. As well as providing an introduction to astronomy, the module on Astronomy also illustrates this theme. Phenomena observed in the sun and planets are governed by the laws of mechanics and are usually closely related to phenomena, which are familiar from the terrestrial environment.

Most of the first year physics modules deal with familiar subjects, such as Newtonian mechanics and thermodynamics. The possible exceptions are the material on relativity and the module Quantum Phenomena. These deal with the breakdown of Newtonian physics at velocities close to the speed of light and at atomic length scales.

Computers are increasingly important in all of mathematics and theoretical physics. The Programming Workshop teaches Python programming and how to solve numerically the mathematical models of physical systems. In addition, you can opt to take the module Programming for Scientists. This is a Java-based module, which teaches object-oriented programming and algorithms. (The module assumes no prior knowledge of programming.)

THE UNIVERSITY OF WARWICK
The timetable for the first five weeks of the current first year (shown below) should give an idea of the typical weekly workload of lectures and tutorials. The tutorials involve smaller groups and a lecturer or postgraduate student. The idea is to work through examples sheets handed out in the lectures and to discuss any problems with the material. Wednesday afternoons are kept free of classes, as Wednesday is the main day for university activities such as sport, drama and music.

### First Year timetable (weeks 1-5): mornings

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<th>Time</th>
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<tbody>
<tr>
<td>09:05-09:55</td>
<td>Sets and Numbers</td>
<td>Mathematical Analysis</td>
<td>Classical Mechanics and Relativity</td>
<td>Intro to Geometry</td>
<td>Physics Tutorial</td>
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<td>10:05-10:55</td>
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<td>Intro to Geometry</td>
<td>Physics Tutorial</td>
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<tr>
<td>11:05-11:55</td>
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<td>Intro to Geometry</td>
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<td>12:05-12:55</td>
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<td>Physics Foundations</td>
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### First Year timetable (weeks 1-5): afternoons

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<td>14:05-14:55</td>
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<td></td>
<td>Mathematical Analysis</td>
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<td>15:05-15:55</td>
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The Second Year

In the second year there are core modules taken by everybody. These core modules complete the basic material assumed by other modules. There is then a broad range of optional modules covering all the main areas of mathematics and physics.

Currently the core modules are:

**Maths**
Analysis III, Methods of Mathematical Physics, Multivariable Calculus, Partial Differential Equations, Variational Principles.

**Physics**
Electromagnetic Theory and Optics, Physics of Fluids, Quantum Mechanics and its Applications, Thermal Physics II.

Analysis III and Multivariable Calculus extend ideas learnt in the first year and introduce the analysis of functions of more than one variable and of complex variables. The module, Variational Principles, is concerned with a surprising and useful connection between functions, which minimise the values of certain integrals, and many problems from physics.

The field of fluids is one of the richest in applied mathematics and physics. Although motions of fluids - water and air are two we meet every day - are complicated, many flow patterns have simple and intuitively appealing explanations. You will learn, for example, why power lines whistle in the wind and why aeroplanes use their engines just before landing.

You choose about eight further modules (not all modules are the same length and may change over time) from:

**Maths**

**Physics**

**Outside Options**
Interdisciplinary modules like The Challenge of Climate Change, and modules from WBS (Warwick Business School), the Language Centre (Arabic, Chinese, French, German, Japanese, Portuguese, Russian and Spanish), and the Centre for Education Studies (Introduction to Secondary School Teaching).
The Third Year - BSc

In the third year of the BSc you take a module on Communicating Science. You select modules from the lists of options, which currently are:

Maths
Complex Analysis, Continuum Mechanics, Control Theory, Fluid Dynamics, Functional Analysis, Geometry of Curves and Surfaces, Group Theory, History of Mathematics, Measure Theory, Qualitative Theory of ODEs, Theory of PDEs, Topics in Mathematical Biology.

Physics

Outside Options
Modules from WBS, the Language Centre, the Mathematics, and other, departments.
You can choose to carry out a research-style project worth 25% of the year’s credit. You choose a title from a list of titles suggested by supervising members of staff. A project brings you into contact with a research group, where you work with and alongside postgraduate students and research fellows. It can give fresh insight into the way research scientists work and think.

warwick.ac.uk/physics
The Third Year - MMathPhys

Opting for the MMathPhys allows you more time to explore the implications of what you have already learnt.

The third year, like the second year, consists of a core of compulsory modules covering material, which will be assumed by many of the fourth year modules, and modules chosen from lists of options. The core modules are:

**Physics**
- Quantum Physics of Atoms, Kinetic Theory, Electrodynamics;

**Mathematics**
- Fluid Dynamics.

There is a Laboratory and Skills module. As a member of a group of three students, you complete an experiment and a computer-based simulation of a physical system. You present your results both orally and in an extended written report.

Typically, you take a further six modules from the options listed for the third year of the BSc.
The Fourth Year

During the fourth year you join one of the research groups and work as a member of a pair on a research-style project.

The project work gives you experience of working more independently. This experience should be valuable to you in your subsequent career, whether you choose to work as a scientist or not, and can help you when you are making decisions about possible careers.

You also take between six and twelve of the following modules (not all modules are the same length) choosing at least two from the list of physics modules and two from the list of mathematics modules. The lists are currently:

**Mathematics**
- Advanced Partial Differential Equations
- Dynamical Systems
- Fourier Analysis
- Functional Analysis
- Quantum Mechanics: Basic Principles and Probabilistic Methods
- Statistical Mechanics

Modules from the third year lists can also be chosen.

**Physics**
- Advanced Particle Physics
- Condensed Matter Physics II
- Functional Properties of Materials
- Gauge Theories of Particle Physics
- General Relativity
- High Energy Astrophysics
- High Performance Computing in Physics
- Neutrino Physics
- Planets Exo-Planets and Life
- Quantum Theory of Interacting Particles
- Relativistic Quantum Mechanics
- Solar Magnetohydrodynamics
- Structure and Dynamics of Solids

You may also take modules from the third year, which you have not already taken.

**Outside Options**

There is no formal list of outside options. However, you can follow modules from outside the department provided that the timetable permits this.
Intercalated Year

You may also extend the BSc degree by inserting an extra year (usually) between your second and what would otherwise be your third year. You would spend this 'intercalated' year studying at a foreign university or working in a research laboratory.
If you have any questions or need further information after reading this guide, please contact:

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Cover image: creativity103