Ideas of Motion: Galileo to Einstein

The module provides you with an overview of the development of our understanding of how force and motion are related, from the ideas of Galileo through Newton’s laws of motion up to Einstein’s special theory of relativity. The module reinforces your ability to use mathematical techniques to model physical situations, and enhances your understanding of physical phenomena through laboratory experiments.

One of the aims is to give an understanding of how models of the physical world must be modified, or new models postulated, to explain novel phenomena.

Other aims are to introduce conservation laws, develop your ability to apply mathematical skills in a physics context, develop your appreciation of experimental design and your ability to produce good written laboratory records.

This module provides basic physics knowledge upon which higher level physics modules rely.

Matter: Evidence for Quantisation

The module introduces the experiments that led to the development of quantum mechanics, the basic structure and model of the nucleus and radioactive decay. The aims are to provide a basis of knowledge in elementary quantum ideas and nuclear physics, to develop your ability to understand and apply mathematical techniques in a scientific manner, and to provide you with an understanding of how science develops. In addition, it aims to develop your ability to produce good written laboratory records. The module is a core concepts module for the development of higher level physics modules.

Concepts of Astronomy & Cosmology

This module provides an introductory overview of key concepts in astronomy and cosmology. It lays the foundation for the Physics with Astrophysics pathway, as well as giving you a taste of the subject of Astronomy, whatever your chosen pathway.

The module has both theoretical and practical components.

Introduction to Laboratory Software

To introduce the basic concepts of program design, to provide you with the knowledge and skills to implement software solutions to scientific problems. To introduce graphical and traditional approaches to programming and to reinforce concepts through extensive practical sessions and short projects.
Laboratory Instrumentation & Physics Skills

The module aims to provide an underpinning in the essential professional, laboratory, IT and study skills relevant to students of physics. This will include an introduction to the physical principles of electronics-based measurement instruments.

The module aims to develop your appreciation of good experimental design and to hone your reporting skills, including your ability to assess experimental uncertainties. In the context of real experimental work, you will be introduced to the use of statistical, word-processing, spreadsheet and presentation packages that facilitate data analysis and the presentation of results. The applicability of such methods and resources in a physics context will also be showcased by staff presentations on current research topics.

In addition, you will receive an introduction to the facilities offered by the University’s Library & Learning Resources, the support available for Personal Development Planning, & to sources of scientific information and how to reference them. You will learn how to use standard laboratory instruments and a range of analogue signal processing techniques, and gain an appreciation of the underpinning theory of ac and dc electricity.

Mathematical Techniques

This module aims to provide you with some of the mathematical tools necessary to facilitate your studies in physics. The module will build on your previous knowledge of algebra, calculus and trigonometry and introduces the concepts of matrix and vector algebra and vector calculus.

Wherever possible, it will be shown where the mathematical techniques introduced are applicable in physics.

Foundation Mathematics

This module aims to provide you with many of the mathematical tools necessary to facilitate your studies in physics. Starting from the basics, such as logs and indices, and via one variable calculus, it finishes with vector algebra and calculus.

Wherever possible, it will be shown where the mathematical techniques introduced are applicable in physics.

Workshop

This module aims to provide support, in the form of seminars/tutorials, to you during your first year of studies at University, and to reinforce your knowledge and understanding of the core areas, in order to bring you to the standard of mathematical and problem solving skills required for you to enter the second year.
**Microscopy**

The aim of this module is to introduce the physical principles of optical, electron and scanning probe microscopy. This is achieved through an introduction to geometrical optics and using examples of forensic science specific equipment.

This module will form a platform of knowledge and conceptual understanding upon which later modules will develop.

**Sound**

The aim of this module is to introduce the physical principles of sound & the principles behind the technology for recording and analysis. This module will form a platform of knowledge and conceptual understanding upon which later modules will develop.

**Introduction to Forensic Science**

This module will review the history of forensic science and examine the importance of science and the law in the ‘forensic process’. Students will gain an insight into the procedures carried out at the crime scene and will follow the route taken by recovered evidence from the crime scene on to the forensic laboratory and ultimately through to presentation in a court of law. Emphasis is be placed on examining the role of the forensic scientist and law enforcement agencies.

**The English Legal System**

This module focuses on practice and procedure in the Criminal, Civil and Coroners Courts. The aim is to develop students with a knowledge and understanding of the English Legal System. The students will be able to appreciate the context within which the law operates. The students will, with guidance, be able to research independently including the identification and retrieval of primary and secondary sources of law/legal information.

**Fundamental Forces**

This module provides you with an overview of the fundamental forces of nature: electromagnetism, gravity, strong and weak nuclear forces. It aims to develop your understanding and appreciation of the principles and applications of fundamental forces and of the relationships between them.
Thermal & Environmental Physics

This module is concerned with the principles and applications of thermal physics, including: heat transfer processes; thermal expansion of materials; the behaviour of gases, liquids and solids; sources of energy; the physics of climate change.

The module has an extensive theoretical component and a small practical component, plus a requirement to write an essay, hence it will help to develop your written communication skills. It is underpinned by the mathematical skills developed at Level 1.

Optics & Semiconductors

This module covers a range of topics concerned with the principles and applications of geometrical and physical optics, and with the elucidation of the principles of operation of semiconductor devices through the application of solid state theory.

“Optics & Semiconductors” underpins the delivery of those programme aims associated with the development of theoretical knowledge and practical skills relevant to physics. Correspondingly, the module has both theoretical and practical components. Experiments are designed not merely to support the taught classes, but also to further develop those skills associated with the performance of accurate quantitative practical work, written communication, and the use of appropriate I.T. in data analysis.

This module is underpinned by the general theoretical classical and quantum physics concepts covered within the first year modules “Matter: Evidence for Quantisation” and “Ideas of Motion: Galileo to Einstein”, and by the laboratory skills developed within “Laboratory Instrumentation & Physics Skills”.

Digital Techniques

This module aims to introduce the concepts of digital electronics and digital data processing. It will provide an understanding of the structure of a computer and its modes of communicating with other systems within a laboratory environment, as well as an overview of the application of digital processing to scientific images.

The approach is applications oriented, with practical exercises in both digital electronics and image processing. However, these practical activities are underpinned by sufficient theory to ensure that the actions of circuits and algorithms are understood, rather than being treated as black boxes.
Ionising Radiation and Non-Invasive Imaging

This module covers three main topics:

1- The basic physics of the main types of nuclear disintegration is described, followed by the physical properties associated with each radiation type resulting from them. The way these radiations interact with matter is further explored, with an emphasis on the effect they have on biological tissue. The beneficial (radiotherapy) & detrimental (safety issues) effects of experiencing Ionising Radiations (IR) can thus be quantified. The principles of various detectors used for measuring IR is covered, in order to underpin the laboratory work (5 of 7 experiments are on IR) & the principles of Positron Emission Tomography.

2- The principles of Magnetic Resonance Imaging (MRI) are discussed, as well as the origin of the contrast that is obtained in the image. Again it is the nucleus of the atom that is being explored/exploited here, but only for the stable ones, and those carrying a non-zero spin. An experiment in the laboratory work covers NMR.

3- The principles of Ultrasound Imaging are presented. This relies on the physics of wave propagation, which represents a substantial part of the teaching/learning. An experiment in the laboratory work covers Ultrasounds.

The module has both theoretical and practical components, with experiments that not only support the taught material, but which also aid the development of the skills associated with the performance of accurate quantitative practical work, written communication, and the use of appropriate I.T. in data analysis. It is underpinned by the mathematical skills developed at Level 1.

Stars & Galaxies

This module aims to deepen your understanding of stars and galaxies. It forms a central part of the strand intended to deliver the programme aim to produce graduates with knowledge of the physical principles behind the various phenomena related to astronomical objects.

The module has mainly theoretical components as well as some data analysis components.

This module is underpinned by the basic astrophysics concepts covered within the first year modules “Concepts of Astronomy & Cosmology”.

The Quantum World

This module provides you with an introduction to quantum mechanics through the solution of the Schrödinger equation for model problems. The module includes, in an integrated manner, a review, reinforcement and extension of the necessary mathematics.

The aims are to reinforce your ability to deploy mathematical techniques, to develop a coherent understanding of quantum mechanics and to provide a foundation for study of advanced topics at final year of honours level.
Research Methods

This module aims to teach you the skills and techniques that you will require during your level 3 project (or M-level project). You will learn how to: understand the range of information sources that are useful in scientific research, search and collate information sources, select and report information relevant to a piece of research, be aware of Health and Safety issues and how they are tackled in a research environment, find out how to make a research poster and a scientific abstract.

Materials, NDE, Shielding & Safety

This module introduces various issues of great importance within the nuclear industry, and forges links to various other modules in the Physics with Nuclear Technology programme, especially Matter: Evidence for Quantisation (Level 1), Ionising Radiation & Non-Invasive Imaging (Level 2), & Physics & Technology of Nuclear Reactors (Level 3).

Topics covered include the selection of appropriate materials for the construction of reactor pressure vessels & pipework, nuclear fuels, Non-Destructive Evaluation (NDE) techniques, shielding of nuclear sources, and safety practices within the nuclear sector.

This module helps to deliver the Physics with Nuclear Technology programme aims that you should be able to: demonstrate a knowledge of Health & Safety issues & regulations associated with nuclear technology; demonstrate an in-depth knowledge of topics of a technological nature; use in a safe and competent manner laboratory equipment commonly employed in physics and its applications in nuclear science and technology, including radiation detection & measurement, and non-destructive evaluation of materials. In so-doing it will help to provide you with a knowledge & skills base relevant to the nuclear sector.

In addition to the theoretical components, the module is supported by practical experiments in NDE.

Forensic Audio

This module builds on the basic physical concepts of sound and looks at digital audio and in particular forensic applications and techniques for signal processing.

As part of this the extensive use of forensic audio analysis software and techniques will be investigated through laboratory work and an individual mini project.

The module has both theoretical and practical components, with experiments that not only support the taught material, but which also aid the development of the skills associated with the performance of accurate quantitative practical work, written communication, and the use of appropriate I.T. in data analysis.
**Photography and Forensic Image Processing**

This module provides you with a coherent overview of the capture and digital processing of images for forensic applications. The aims are to show how images can be captured to best effect and where necessary processed to enhance detail or obtain information without compromising image integrity. The focus is on applications and practical experience, but with sufficient theoretical underpinning to ensure that the ideas behind capture methodologies and processing algorithms are understood, rather than treated as black boxes.

**Crime Scene Investigation**

This module is concerned with the skills necessary to protect, record, process and interpret a crime scene. Students will adopt the role of the Scene of Crime Officer (SOCO)/Crime Scene Examiner (CSE) for the recovery of evidence from crime scenes for forensic examination. Particular emphasis will be placed on the examination of crime scenes relating to burglary, drug offences, crimes against the person and motor vehicles involved in the commissioning of a crime. The need for the avoidance of contamination of the crime scene and the physical evidence, and the subsequent continuity and integrity of the recovered evidence, forms an integral component of this module.

The aim is show best practice in crime scene investigation. Students’ appreciation of the subject is strengthened through practical and role-play exercises. The approach is skills oriented, but with sufficient scientific and legal underpinning to ensure that crime scenes are correctly processed and the forensic value of different forms of physical evidence is clearly recognised.

**Condensed Matter**

This module provides you with a background to the wide range of macroscopic properties of matter with an emphasis on the solid state form. The module begins with ideas of statistical mechanics and progresses to encompass the structure of matter, magnetic and transport properties. The module provides the basis for future graduate level studies in physics and materials science.

**Laboratory Interfaces and Control**

The aim of this module is to introduce a range of standard computer interfaces that are encountered within the science laboratory and develop ideas of instrument control and signal processing through an extensive range of laboratory exercises.
Experimental Techniques

This module aims to:
- develop your appreciation of good experimental design
- enhance your familiarity and understanding of physical phenomena through practical work
- give you an insight into a wide range of experimental techniques through both theoretical and practical work.
- develop your ability to produce journal style reports.

Advanced Modern Physics

This module develops the general principles and calculational methods of quantum theory and relativity beyond the elementary ones in introductory quantum mechanics and special relativity. The aim is to equip you with an understanding of mathematical tools and theoretical insights needed for graduate level research.

Cosmology: Theory and Observation

This module covers both observational cosmology & the theoretical background of cosmology, and hence will help you to gain a broad knowledge of modern cosmology.

The module has theoretical components with some data analysis exercises.

This module is underpinned by the basic cosmology concepts covered within the first year module “Concepts of Astronomy & Cosmology”.

Physics and Technology of Nuclear Reactors

The module aims to reinforce your knowledge and understanding of neutron-related processes and phenomena, and to give you an overview of the physics that underpins the design and operation of nuclear reactors. In addition, it aims to give an insight into design considerations and constraints of nuclear reactors, including fast breeders and fusion reactors, and into current issues in nuclear power including safety, decommissioning and radioactive waste. In doing so, it will provide you with a knowledge base and skills that are relevant to the nuclear industry.

Advanced Topics in Physics

This module aims to provide you with a basis of knowledge for graduate study and to develop independent and group learning for future work/graduate study. The module facilitates an investigation of a specific research-based area of physics/astronomy and develops your abilities to independently review research material and to discuss your findings with colleagues.
Project

To provide a framework within which you may work on an extensive problem in an aspect of special interest to you; you may perform this task either individually or as part of a small team in which each member considers a different aspect of the problem. To develop the advanced level of practical and/or theoretical skills required for you be able to solve real problems. To encourage you to show enterprise. To foster good skills of both written and oral presentation.

Ballistics and Firearms

This module is concerned with the principles and applications of ballistics and firearms. The study of ballistics will give an essential grounding in the physical processes involved in firing a projectile, the flight path of the projectile when it leaves the firearm, and the possible outcomes when the projectile interacts with the target. The study of firearms will deal with the different types of firearms and ammunitions with an emphasis on the types that would be typically encountered by a Forensic scientist working in the field. Both of these strands of study will be brought together in the Forensic and Criminological aspects of the module.

These studies will be underpinned by practical work on both the underlying physical principles and on the identification of ammunition and current best Forensic practice.

Biometrics & Forensic Databases

This module provides you with an overview of identification, authentication and verification techniques. The corresponding technologies used in both biometrics and surveillance applications are also disclosed.

The module builds upon image processing topics covered in either the Digital Techniques or the Photography & Forensic Image Processing module, and extends from recovery of evidence and identification into non-forensic applications based on verification and authentication.

The module provides an introduction to the theory of database systems and the coursework involves the development of a database for a forensic application. It looks at both the legal and moral implications of the use of databases with special reference to the DNA database.

Imaging for Security and Detection

This module provides you with an overview of the science and the technology of imaging, in the context of security and detection applications. The module is based on lectures and seminars, without a laboratory component.
MSci Research Project

This module is an advanced introduction to the tasks and associated skills that are essential to lead scientific research, as would be done in a Ph.D. degree project.

After having made a critical evaluation of the research literature relevant to a given project, in this module the aims are to plan and execute an investigation, under supervision, and to analyse critically the results and draw valid conclusions.

You will evaluate the level of uncertainty in your results, produce an error analysis and compare these results with expected outcomes, theoretical predictions or with published data, as would be the case for a piece of work aimed at being published in a peer reviewed scientific journal.

The final goal is to communicate your work to a scientific audience, both in a written and oral ways.

MRes Research Project

This module is an advanced and extended introduction to the tasks and associated skills that are essential to lead scientific research, as would be done in a Ph.D. degree project.

After having made a critical evaluation of the research literature relevant to a given project, in this module the aims are to plan and execute an investigation, under supervision, and to analyse critically the results and draw valid conclusions.

You will evaluate the level of uncertainty in your results, produce an error analysis and compare these results with expected outcomes, theoretical predictions or with published data, as would be the case for a piece of work aimed at being published in a peer reviewed scientific journal.

The final goal is to communicate your work to a scientific audience, both in a written and oral ways.

Research Methodology & Ethics

The module aims to provide an underpinning in research skills relevant to the independent study required for an MRes and MSci-level project in practical or theoretical physics. You will be introduced to the techniques required to formulate a research project and to carry out a literature review, and you will be given practice in the critical appraisal of published research work, as well as an introduction to some fundamentals regarding the history and philosophy of science which will help you to critically examine the scientific method.

Topics reviewed will be scientific writing and referencing, use of library and learning resources, presentation of results, including statistical analyses, and issues associated with plagiarism.

Where appropriate, you will receive training in the laboratory techniques required for successful completion of your project. The module will also consider the scientific method and ethical issues in relation to research in your chosen field, to provide you with a framework within which you can justify your decisions.
Medical Imaging

This module aims to introduce the principles underlying a range of techniques and tools used in Medical Imaging and related image processing research and to demonstrate their applications and limitations. Your knowledge will be reinforced by seminar sessions and case studies. This knowledge could act as a foundation for a research project in Medical Imaging, should you decide to base your research in this area.

Materials and Security Imaging

This module aims to introduce the principles underlying a range of techniques and tools used in Materials and Security Imaging and related image processing research and to demonstrate their applications and limitations. Your knowledge will be reinforced by seminar sessions and case studies. This knowledge could act as a foundation for a research project in Materials or Security Imaging, should you decide to base your research in this area.