AS3013 Computational Astrophysics

SCOTCAT Credits:	15	SCQF Level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	To be arranged			

The aim of this module is to introduce students to computational methods in astrophysics. Based on a general introduction to the programming language Fortran-90, students are shown how to apply simple numerical algorithms to calculate integrals, iteratively find the roots of non-linear equations, solve systems of ordinary differential equations, and to develop tools for statistical data analysis. Further emphasis is put on the development of skills to make convincing plots from the calculated data. The practical exercises include applications to the initial mass function in star formation, the calculation of orbits for N-body gravitational problems and in mean galactic potentials, and planet transition light-curves. Students gain experience with the basics of numerical accuracy, and the development of problem-solving algorithms in general.

Pre-requisite(s):	Before taking this module you must pass PH2011 and pass PH2012 and pass MT2501 and pass MT2503	
Learning and teaching methods of delivery:	**Weekly contact**: 2 x 3.5-hour supervised or taught sessions (x 10 weeks). Mostly hands-on guided work on computers, but with occasional presentation.	
	Scheduled learning: 70 hours	**Guided independent study:** 80 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%	
	As used by St Andrews: Coursework (practical work, the submission of computer code and computational solutions to given problems) = 100%	
Re-assessment pattern:	No Re-assessment available - laboratory based	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

AS4010 Extragalactic Astronomy

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			

This module introduces the basic elements of extragalactic astronomy. This includes the morphological, structural and spectral properties of elliptical, spiral, quiescent and star-forming galaxies. We study how galaxy populations change from the distant galaxies in the early Universe into those observed in our local neighbourhood, including the coincident growth of super massive black holes at the centres of massive galaxies. Galaxy formation theory is introduced in relation to the growth of structure in a cold-dark matter Universe, and galaxy evolution in regions of high and low density is investigated. The module includes a look at modern instrumentation used in extragalactic astrophysics. Specialist lecturers from within the galaxy evolution research group will provide a direct link between material learnt in lectures and research currently being undertaken at the University of St Andrews.

Pre-requisite(s):	Before taking this module you must (pass AS2001 or pass AS2101) and pass PH2011 and pass PH2012 and pass MT2501 and pass MT2503	
Anti-requisite(s)	You cannot take this module if you take AS3011 or take AS4022	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures occasionally replaced by tutorials	
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 90%, Practical Examinations = 0%, Coursework = 10%	
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework (10% Class Test, 10% Computer Based Assignment) = 20%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

AS4011 The Physics of Nebulae and Stars 1

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
This module introduces the physics of astrophysical plasmas, as found in stars and interstellar space, where interactions between matter and radiation play a dominant role. A variety of absorption, emission, and scattering processes are introduced to describe exchanges of energy and momentum, which link up in various contexts to control the state and motion of the matter, to regulate the flow of light through the matter, and to impress fingerprints on the emergent spectrum. The theory is developed in sufficient detail to illustrate how astronomers interpret observed spectra to infer physical properties of astrophysical plasmas. Applications are considered to photo-ionise nebulae, interstellar shocks, nova and supernova shells, accretion discs, quasar-absorption-line clouds, radio synchrotron jets, radio pulsars, and x-ray plasmas. Monte-Carlo computational techniques are introduced to model radiative transfer.				
Pre-requisite(s):	Before taking this module you must (pass AS2001 or pass AS2101) and pass PH2011 and pass PH2012 and (pass MT2001 or pass MT2501 and pass MT2503) and pass PH3081 or pass PH3082 or pass MT2003 or (pass MT2506 and pass MT2507)			
Anti-requisite(s)	You cannot take this module if you take AS4023 or take AS3015			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures occasionally replaced by whole-group tutorials.			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%			
	As used by St Andrews: 2-hour Written Examination = 75%, Coursework = 25%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

AS4012 The Physics of Nebulae and Stars 2

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
This module develops the physics of stellar interiors and atmospheres from the basic equations of stellar structure introduced in AS2001/AS2101 using the radiative transfer concepts developed in Nebulae and Stars I. Topics include: the equation of state that provides pressure support at the high temperatures and densities found in normal and white-dwarf stars; the interaction of radiation with matter, both in terms of radiation-pressure support in super-massive stars and in terms of the role of opacity in controlling the flow of energy from the stellar interior to the surface; the equation of radiative transfer and the effects of local temperatures, pressures and velocity fields on the continuum and line absorption profiles in the emergent spectrum. Computer-aided tutorial exercises illustrate the computational schemes that represent one of the triumphs of late twentieth-century physics, in their ability to predict the observable properties of a star from its radius and luminosity, which in turn are determined by its mass, age and chemical composition.				
Pre-requisite(s):	Before taking this module you must pass AS4011			
Anti-requisite(s)	You cannot take this module if you take AS4023 or take AS3015			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures occasionally replaced by whole-group tutorials.			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%			
	As used by St Andrews: 2-hour Written Examination = 75%, Coursework = 25%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

AS4015 Gravitational and Accretion Physics

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			

This theoretical module is open to both physics and astrophysics students. It aims to explore the basics of gravitational dynamics and its application to systems ranging from planetary and stellar systems to clusters of galaxies. The dynamics responsible for the growth of super-massive black holes in galaxies and the accretion discs in stellar systems are also covered. Starting from two-body motion and orbits under a central-force law, the module describes the calculation of extended potentials and their associated orbits. The use of the virial theorem and the statistical treatment of large numbers of self-gravitating bodies is then developed with application to stellar systems. Applications of these methods are made to several different astrophysical objects ranging from collisions in globular clusters to the presence of dark matter in the universe.

Pre-requisite(s):	Before taking this module you must pass PH2011 and pass PH2012 and pass MT2501 and pass MT2503 and (pass PH3081 or pass PH3082 or pass MT2506 and pass MT2507)	
Anti-requisite(s)	You cannot take this module if you take AS4021	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures occasionally replaced by whole-group tutorials.	
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%	
	As used by St Andrews: 2-hour Written Examination = 100%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

AS4025 Observational Astrophysics

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
This is an observational and laboratory-based module that introduces students to the hands-on practical aspects of planning observing programmes, conducting the observations and reducing and analysing the data. The exact topics covered may change annually depending on resource availability; examples include galaxy imaging, exoplanet transits and radio telescope construction. Sources of data may include telescopes at the University Observatory and/or international observatories. Students gain experience in observation, data analysis, the Linux operating system, standard astronomical software packages and modelling, and report writing				
Pre-requisite(s):	Before taking this module you must (pass AS2001 or pass AS2101) and pass PH2011 and pass PH2012 and (pass MT2001 or pass 2 modules from {MT2501, MT2503})			
Learning and teaching methods of delivery:	**Weekly contact**: 2 x 3.5-hour laboratories plus supervised work in the observatory.			
	Scheduled learning: 78 hours		**Guided independent study:** 72 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available - laboratory based			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

AS4103 Astrophysics Project (BSc)

SCOTCAT Credits:	30	SCQF Level 10	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Available only to BSc Astrophysics students, and normally only in their final year.			
Planned timetable:	To be arranged			
The project aims to develop students' skills in searching the physics literature and in experimental design, the evaluation and interpretation of data, and in the presentation of results. The main project is preceded by a pre-project report on a topic which is usually related to the theme of the project. There is no specific syllabus for this module. Students taking the BSc degree select a project from a list offered, and are supervised by a member of staff. Project choice and some preparatory work is undertaken in semester one, but normally most of the 30 credits' worth of work is undertaken in semester two. The aim is that students provide the intellectual drive for the project work, and should take on a role similar to that of a research student in the School. Support will be offered by the academic staff member(s) supervising the project and usually also by other members of a research team. Many projects will be carried out in the School's research labs, but other arrangements are possible. A pre-project report precedes the experimental/computational/theoretical work of the project, and is expected to be directly relevant to the subsequent experimental studies.				
Pre-requisite(s):	Entry to final year of BSc Astrophysics programme.. Some projects will need learning from specific modules - please contact potential supervisors.. Before taking this module you must pass PH3061 and pass PH2012 and (pass MT2001 or pass MT2501 and pass MT2503) and (pass PH3081 or pass PH3082 or pass MT2003 or pass MT2506 and pass MT2507) and pass AS3013 and pass PH3081 and pass PH3012			
Anti-requisite(s)	You cannot take this module if you take AS5101 or take PH4111 or take PH5101 or take PH5103			
Learning and teaching methods of delivery:	**Weekly contact**: Project students work 'half-time' on their project through semester 2. All students must meet weekly with their project supervisor and attend fortnightly meetings with their peer-support group. Most projects are based in computer clusters in the School, where students can benefit from peer support and informal interaction with academic supervisor and other members of research teams. It is expected that the 20 hours a week will be primarily in this environment.			
	Scheduled learning: 18 hours		**Guided independent study:** 282 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework (Review Article, Project Report, Presentation and Oral Examination) = 100%			
Re-assessment pattern:	No Re-assessment available - Final year project			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

AS5001 Advanced Data Analysis

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	This module is intended for students in the final year of an MPhys or MSci programme involving the School, and for those taking the MSc in Astrophysics.			
Planned timetable:	To be arranged			
This module develops an understanding of basic concepts and offers practical experience with the techniques of quantitative data analysis. Beginning with fundamental concepts of probability theory and random variables, practical techniques are developed for using quantitative observational data to answer questions and test hypotheses about models of the physical world. The methods are illustrated by applications to the analysis of time series, imaging, spectroscopy, and tomography datasets. Students develop their computer programming skills, acquire a data analysis toolkit, and gain practical experience by analyzing real datasets.				
Pre-requisite(s):	Familiarity with scientific programming language essential, for example through AS3013 or PH3080. Entry to an MPhys programme in the school or MSc Astrophysics.			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials and some supervised computer lab sessions			
	Scheduled learning: 42 hours		**Guided independent study:** 108 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available - laboratory based			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

AS5002 Magnetofluids and Space Plasmas

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	This module is intended for students in the final year of an MPhys or MSci programme involving the School, and for those on the Astrophysics MSc			
Planned timetable:	To be arranged			
This module is aimed at both physics and astrophysics students with interests in the physics of plasmas. The interaction of a magnetic field with an ionized gas (or plasma) is fundamental to many problems in astrophysics, solar- terrestrial physics and efforts to harness fusion power using tokamaks. The syllabus comprises: Solar-like magnetic activity on other stars. The basic equations of magneto-hydrodynamics. Stellar coronae: X-ray properties and energetics of coronal loops. Energetics of magnetic field configurations. MHD waves and propagation of information. Solar and stellar dynamos: mean field models. Star formation: properties of magnetic cloud cores, magnetic support. Physics of accretion discs: transport of mass and angular momentum. Accretion on to compact objects and protostars. Rotation and magnetic fields in protostellar discs. Rotation distributions of young solar-type stars. Magnetic braking via a hot, magnetically channelled stellar wind.				
Pre-requisite(s):	Before taking this module you must pass 1 module from {PH3007, MT4510, MT4553} and pass 1 module from {AS3013, PH4030, PH3080, MT3802, MT4112}			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 100%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

AS5003 Contemporary Astrophysics

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Available only to MPhys Astrophysics or MSc Astrophysics students.			
Planned timetable:	To be arranged			
This module will provide an annual survey of the latest, most interesting, developments in astronomy and astrophysics at the research level. Emphasis will be placed upon the application of knowledge and expertise gained by students in their other modules to these current research topics.				
Pre-requisite(s):	For MPhys: before taking this module you must pass AS4010, AS4012, PH3061 and PH3081. For MSc: students must have substantial astronomy knowledge and skills.			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures and tutorials			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 100%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

AS5101 Astrophysics Project (MPhys)

SCOTCAT Credits:	60	SCQF Level 11	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Available only to those in the final year of an MPhys Astrophysics programme.			
Planned timetable:	To be arranged			

The project aims to develop students' skills in searching the appropriate literature, in experimental and observational design, the evaluation and interpretation of data, and the presentation of a report. The main project is preceded by a pre-project report. There is no specific syllabus for this module. Students taking the MPhys degree select a project from a list of those which are available, and are supervised by a member of the academic staff. Project choice and some preparatory work is undertaken in semester one, but normally most of the 60 credits' worth of work is undertaken in semester two. The aim is that students provide the intellectual drive for the project work, and should take on a role similar to that of a research student in the School. Support will be offered by the academic staff member(s) supervising the project and sometimes also by other members of a research team. Many projects will be carried out in one of the astronomy computing clusters, but other arrangements are possible. A pre-project report precedes the experimental/computational/theoretical work of the project, and is expected to be directly relevant to the subsequent experimental studies.

Pre-requisite(s):	Some projects will need learning from specific modules - please contact potential supervisors.. Before taking this module you must pass PH3061	
Anti-requisite(s)	You cannot take this module if you take AS4103 or take PH4111 or take PH5101 or take PH5103 or take PH4796	
Learning and teaching methods of delivery:	**Weekly contact**: Project students work 'full-time' on their MPhys project through semester 2. All students must meet weekly with their project supervisor and attend fortnightly meetings with their peer-support group. Most projects are based in astronomy computer clusters in the School, where students can benefit from peer support and informal interaction with academic supervisor and other members of research teams. It is expected that the 40 hours a week will be primarily in this environment.	
	Scheduled learning: 21 hours	**Guided independent study:** 579 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%	
	As used by St Andrews: Coursework = 100%	
Re-assessment pattern:	No Re-assessment available - Final year project	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH3007 Electromagnetism

SCOTCAT Credits:	15	SCQF Level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	To be arranged			

The properties of electromagnetic fields will be explored using a variety of mathematical tools (in particular, vector and differential calculus). Topics will include: charge and current distributions, electro- and magnetostatics, materials, electrodynamics, conservation principles, electromagnetic waves and radiation. This module builds on knowledge and skills acquired in prior coursework by developing techniques for solving more advanced problems in electromagnetism.

Pre-requisite(s):	Before taking this module you must (pass PH3081 or pass PH3082 or pass MT2506) and pass PH2012 and (pass MT2001 or pass MT2501 and pass MT2503)	
Anti-requisite(s)	You cannot take this module if you take MT4553	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures and fortnightly tutorials.	
	Scheduled learning: 36 hours	**Guided independent study:** 114 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 95%, Practical Examinations = 0%, Coursework = 5%	
	As used by St Andrews: Written Examination = 80%, Coursework = 20%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH3012 Thermal and Statistical Physics				
SCOTCAT Credits:	15	SCQF Level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	To be arranged			
The aim of this module is to cover at honours level the principles and most important applications of thermodynamics and statistical mechanics. The syllabus includes: equilibrium; the equation of state; the classical perfect gas; discussion of experimental results that lead to the three laws of thermodynamics; idealised reversible engines; the Clausius inequality; the classical concept of entropy and its connection to equilibrium; thermodynamic potentials; Maxwell's relations; open systems and the chemical potential; phase transitions and the Clausius-Clapeyron equation for first order transitions; higher order phase transitions; the connection between statistical physics and thermodynamics; the Boltzmann form for the entropy; microstates and macrostates; the statistics of distinguishable particles; the Boltzmann distribution; the partition function; statistical definition of the entropy and Helmholtz free energy; statistical mechanics of two-level systems; energy levels and degeneracy; quantum statistics: Bose-Einstein and Fermi-Dirac distributions; density of states; black-body radiation; Bose-Einstein condensation; Fermi energy; quantum gases and the classical limit; Maxwell-Boltzmann distribution; equipartition of energy; negative temperatures.				
Pre-requisite(s):	Before taking this module you must pass 4 modules from {PH2011, PH2012, MT2501, MT2503} and (pass at least 1 module from {PH3081, PH3082} or pass 2 modules from {MT2506, MT2507})			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.			
	Scheduled learning: 36 hours		**Guided independent study:** 114 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%			
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework = 20%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH3014 Transferable Skills for Physicists

SCOTCAT Credits:	15	SCQF Level 9	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students.			
Planned timetable:	To be arranged			

The aim of the module is to develop the key skills of oral and written communication, information technology, team working and problem solving. This will be done in the context of physics and astronomy, thus extending student knowledge and understanding of their chosen subject. Guidance, practice and assessment will be provided in the preparation and delivery of talks, critical reading of the literature, scientific writing, developing and writing a case for resources to be expended to investigate a particular area of science, tackling case studies.

Pre-requisite(s):	Entry to the School's honours programme.	
Anti-requisite(s)	You cannot take this module if you take PH4040	
Learning and teaching methods of delivery:	**Weekly contact**: Through the year there are 8 lectures, 9 tutorials, 1 workshop, and about 14 hours of presenting and/or critically evaluating talks.	
	Scheduled learning: 37 hours	**Guided independent study:** 113 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 35%, Coursework = 65%	
	As used by St Andrews: Coursework on basis of exercises and 2 oral presentations = 100%	
Re-assessment pattern:	No Re-assessment available - Assignment based	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH3061 Quantum Mechanics 1

SCOTCAT Credits:	10	SCQF Level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	To be arranged			

This module introduces the main features of quantum mechanics. The syllabus includes: early ideas on quantisation, the emergence of the Schrödinger equation, the interpretation of the wave function and Heisenberg's uncertainty relation. The concepts of eigenfunctions and eigenvalues. Simple one-dimensional problems including potential wells and the harmonic oscillator. Solution of the Schrödinger equation for central forces, the radial Schrödinger equation, and the hydrogen atom.

Pre-requisite(s):	Before taking this module you must pass PH2012 and (pass MT2501 and pass MT2503)	
Co-requisite(s):	You must also take PH3081 or take PH3082 or (pass MT2506 and pass MT2507)	
Learning and teaching methods of delivery:	**Weekly contact**: 2 lectures and fortnightly tutorials.	
	Scheduled learning: 27 hours	**Guided independent study:** 73 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 94%, Practical Examinations = 0%, Coursework = 6%	
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework (incl Class Test 14%)= 20%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH3062 Quantum Mechanics 2

SCOTCAT Credits:	10	SCQF Level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	To be arranged			

This module explores more of the key concepts of quantum mechanics, assuming a knowledge of the material in PH3061. The syllabus includes time-independent and time-dependent perturbation theory, including the treatment of degenerate states. The course includes a matrix description of spin, the Bloch sphere representation of spin, systems of interacting spins, and the quantum mechanics of a system of identical particles, which leads to the distinction between fermions and bosons.

Pre-requisite(s):	Before taking this module you must pass PH3061 and (pass at least 1 module from {PH3081, PH3082} or pass 2 modules from {MT2506, MT2507})	
Learning and teaching methods of delivery:	**Weekly contact**: 2 lectures and fortnightly tutorials.	
	Scheduled learning: 27 hours	**Guided independent study:** 73 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 95%, Practical Examinations = 0%, Coursework = 5%	
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework (incl Class Test 15%) = 20%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH3074 Electronics

SCOTCAT Credits:	15	SCQF Level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	To be arranged			

This module provides a basic grounding in practical electronics. It introduces and develops the basic principles underlying the synthesis and analysis of analogue circuits. The module is divided into two parts: passive circuits, beginning with a review of dc circuit theory before moving onto complex impedance, passive ac circuits and diode applications; active circuits and amplifiers, including simple bipolar amplifiers, operational amplifiers and applications.

Pre-requisite(s):	Before taking this module you must pass PH2011 and pass PH2012 and (pass MT2001 or pass MT2501 and pass MT2503)	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures, tutorials or short lab sessions	
	Scheduled learning: 30 hours	**Guided independent study:** 120 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%	
	As used by St Andrews: 2-hour Written Examination = 75%, Coursework = 25%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH3080 Computational Physics

SCOTCAT Credits:	10	SCQF Level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	To be arranged			
This module is designed to develop a level of competence in Mathematica, a modern programming language currently used in many physics research labs for mathematical modelling. No prior experience is required. The module starts with a grounding in the use of Mathematica and discusses symbolic solutions and numerical methods. The main focus is then on the ways in which Mathematica can be used for problem solving in physics and astrophysics.				
Pre-requisite(s):	Before taking this module you must pass PH2012 and (pass MT2501 and pass MT2503)			
Anti-requisite(s)	You cannot take this module if you take PH3082			
Learning and teaching methods of delivery:	**Weekly contact**: 4 hours supervised PC Classroom			
	Scheduled learning: 44 hours		**Guided independent study:** 56 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 84%, Coursework = 16%			
	As used by St Andrews: 3-hour Computer-based Examination = 75%, Coursework = 25%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH3081 Mathematics for Physicists

SCOTCAT Credits:	15	SCQF Level 9	**Semester**	1
Academic year:	2020-2021			
Planned timetable:	To be arranged			
The module aims to develop mathematical techniques that are required by a professional physicist or astronomer. There is particular emphasis on the special functions which arise as solutions of differential equations which occur frequently in physics, and on vector calculus. Analytic mathematical skills are complemented by the development of computer-based solutions. The emphasis throughout is on obtaining solutions to problems in physics and its applications. Specific topics to be covered will be Fourier transforms, the Dirac delta function, partial differential equations and their solution by separation of variables technique, series solution of second order ODEs, Hermite polynomials, Legendre polynomials and spherical harmonics. The vector calculus section covers the basic definitions of the grad, div, curl and Laplacian operators, their application to physics, and the form which they take in particular coordinate systems.				
Pre-requisite(s):	Before taking this module you must pass PH2011 and pass PH2012 and (pass MT2501 and pass MT2503)			
Anti-requisite(s)	You cannot take this module if you take PH3082 or take MT3506			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures plus fortnightly tutorials.			
	Scheduled learning: 36 hours		**Guided independent study:** 114 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework = 20% (made up of Class Test = 15% and meaningful engagement with tutorial work = 5%)			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH3082 Mathematics for Chemistry / Physics

SCOTCAT Credits:	20	SCQF Level 9	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Available only to Chemistry and Physics MSci students			
Planned timetable:	To be arranged			

This module consists of the content and assessment of all of PH3081 and the first part of PH3080. The module aims to develop mathematical techniques that are required by a professional physicist or astronomer. There is particular emphasis on the special functions which arise as solutions of differential equations which occur frequently in physics, and on vector calculus. Analytic mathematical skills are complemented by the development of computer-based solutions. The emphasis throughout is on obtaining solutions to problems in physics and its applications. Specific topics to be covered will be Fourier transforms, the Dirac delta function, partial differential equations and their solution by separation of variables technique, series solution of second order ODEs, Hermite polynomials, Legendre polynomials and spherical harmonics. The vector calculus section covers the basic definitions of the grad, div, curl and Laplacian operators, their application to physics, and the form which they take in particular coordinate systems. In the other section of the module students are introduced to the Mathematica package, and shown how this can be used to set up mathematical models of physical systems.

Pre-requisite(s):	Entry to MSci Chemistry and Physics degree programme. Before taking this module you must pass PH2012 and pass MT2501 and pass MT2503	
Anti-requisite(s)	You cannot take this module if you take PH3080 or take PH3081 or take MT3506	
Learning and teaching methods of delivery:	**Weekly contact**: 3 x 1-hour lectures (x 10 weeks), 2 x 2-hour PC Classroom supervised sessions (x 5 weeks), 1-hour tutorial (x 5 weeks)	
	Scheduled learning: 57 hours	**Guided independent study:** 143 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 71%, Practical Examinations = 22%, Coursework = 7%	
	As used by St Andrews: 2-hour Written Examination = 60% Coursework = 40%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH3101 Physics Laboratory 1

SCOTCAT Credits:	15	SCQF Level 9	**Semester**	2
Academic year:	2020-2021			
Planned timetable:	To be arranged			
The aims of the module are (i) to familiarise students with a wide variety of experimental techniques and equipment, and (ii) to instill an appreciation of the significance of experiments and their results. The module consists of sub-modules on subjects such as solid state physics, lasers, interfacing, and signal processing and related topics.				
Pre-requisite(s):	Before taking this module you must pass PH2012 and (pass MT2501 and pass MT2503)			
Learning and teaching methods of delivery:	**Weekly contact**: 2 x 3.5-hour laboratories.			
	Scheduled learning: 72 hours		**Guided independent study:** 78 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available - laboratory based			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH4026 Signals and Information

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
This module gives an introduction to what are signals and information, and how they are measured and processed. It also covers the importance of coherent techniques such as frequency modulation and demodulation and phase sensitive detection. The first part of the module concentrates on information theory and the basics of measurement, with examples. Coherent signal processing is then discussed, including modulation/demodulation, frequency mixing and digital modulation. Data compression and reduction ideas are illustrated with real examples and multiplexing techniques are introduced. The module concludes with a discussion of basic antenna principles, link gain, and applications to radar.				
Pre-requisite(s):	Before taking this module you must pass PH3081 or pass PH3082 or (pass MT2506 and pass MT2507)			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: Coursework = 20%, 2-hour Written Examination = 80%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH4027 Optoelectronics and Nonlinear Optics

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
The module provides an introduction to the basic physics underpinning optoelectronics and nonlinear optics, and a perspective on contemporary developments in the two fields. The syllabus includes: an overview of optoelectronic devices and systems; optical modulators; acousto-optics; Bragg and Raman-Nath; propagation of light in anisotropic media; electro-optics; waveguide and fibre optics; modes of planar guides; nonlinear optics; active and passive processes in second and third order; second harmonic generation; phase matching; coupled wave equations; parametric oscillators; self-focusing and self-phase-modulation; optical bistability; phase conjugation; solitons; Rayleigh; Raman and Brillouin scattering.				
Pre-requisite(s):	Before taking this module you must (pass PH3081 or pass PH3082) or (pass MT2506 and pass MT2507) and pass PH3007			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 100%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH4028 Advanced Quantum Mechanics: Concepts and Methods

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			

This module builds on the material of PH3061 and PH3062 Quantum Mechanics 1 and 2 to present some of the important current and advanced topics in quantum mechanics. The mathematics of complex analysis is introduced to allow this to be used for relevant quantum mechanics problems. Scattering theory is developed using partial waves and Green's functions, leading to a discussion of quantum degenerate gases. Advanced topics in perturbation theory including WKB approximation for exploring differential equations. The density matrix formalism as the general state description in open quantum systems is presented; open system dynamics are described within the formalism of the density matrix master equation. Quantum information processing is covered, including concepts such as qubits, quantum entanglement, quantum teleportation, and measurement based quantum computing.

Pre-requisite(s):	Before taking this module you must pass PH3061 and pass PH3062 and (pass PH3081 or pass PH3082) or (pass MT2003 or pass MT2506 and pass MT2507)	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.	
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%	
	As used by St Andrews: 2-hour Written Examination = 100%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH4031 Fluids

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			

This module provides an introduction to fluid dynamics, and addresses the underlying physics behind many everyday flows that we see around us. It starts from a derivation of the equations of hydrodynamics and introduces the concept of vorticity and the essentials of vorticity dynamics. The influence of viscosity and the formation of boundary layers is described with some straightforward examples. The effect of the compressibility of a fluid is introduced and applied to shock formation and to the conservation relations that describe flows through shocks. A simple treatment of waves and instabilities then allows a comparison between theory and readily-observed structures in clouds, rivers and shorelines.

Pre-requisite(s):	Before taking this module you must pass PH3081 or pass PH3082 or (pass MT2506 and pass MT2507)	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures and some tutorials.	
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%	
	As used by St Andrews: 2-hour Written Examination = 100%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH4032 Special Relativity and Fields				
SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
The module analyses classical fields in physics such as the electromagnetic field. Fields are natural ingredients of relativity, because they serve to communicate forces with a finite velocity (the speed of light). The module covers the tensor formalism of special relativity, relativistic dynamics, the Lorentz force, Maxwell's equations, retarded potentials, symmetries and conservation laws, and concludes with an outlook to general relativity.				
Pre-requisite(s):	Before taking this module you must pass PH3007 and pass PH3081 and pass PH4038			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%			
	As used by St Andrews: 2-hour Written Examination = 75%, Coursework (assessed tutorial questions) = 25%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH4034 Principles of Lasers				
SCOTCAT Credits:	15	SCQF Level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
This module presents a basic description of the main physical concepts upon which an understanding of laser materials, operations and applications can be based. The syllabus includes: basic concepts of energy-level manifolds in gain media, particularly in respect of population inversion and saturation effects; conditions for oscillator stability in laser resonator configurations and transverse and longitudinal cavity mode descriptions; single longitudinal mode operation for spectral purity and phase locking of longitudinal modes for the generation of periodic sequences of intense ultrashort pulses (i.e. laser modelocking); illustrations of line-narrowed and modelocked lasers and the origin and exploitability of intensity-induced nonlinear optical effects.				
Pre-requisite(s):	Before taking this module you must pass PH3081 or pass PH3082 or (pass MT2506 and pass MT2507)			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 90%, Practical Examinations = 0%, Coursework = 10%			
	As used by St Andrews: 2-hour Written Examination = 90%, Coursework = 10%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH4035 Principles of Optics

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
This module formulates the main aspects of physics used in modern optics, lasers and optoelectronic systems. Topics covered include: polarised light and its manipulation, with descriptions in terms of Jones' vectors and matrices; Fresnel's equations for transmittance and reflectance at plane dielectric interfaces; reflection and transmission of multi-layer thin films plus their use in interference filters; interpretation of diffraction patterns in terms of Fourier theory; spatial filters; the theory and use of Fabry-Perot etalons; laser cavities and Gaussian beams.				
Pre-requisite(s):	Before taking this module you must pass PH3081 or pass PH3082 or (pass MT2506 and pass MT2507)			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%			
	As used by St Andrews: 2-hour Written Examination = 75%, Coursework = 25%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH4036 Physics of Music

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
Musical instruments function according to the laws of physics contained in the wave equation. Wind instruments, the human voice and the acoustics of concert halls can be explained largely by considering waves in the air, but understanding drums, percussion, string instruments and even the ear itself involves studying the coupling of waves in various media. The concepts of pitch, loudness and tone are all readily explained in quantitative terms as are the techniques that musicians and instrument makers use to control them. The analysis of musical instruments naturally culminates in a look at how musical sound may be synthesised.				
Pre-requisite(s):	Before taking this module you must pass PH3081 or pass PH3082			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 100%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH4038 Lagrangian and Hamiltonian Dynamics

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
The module covers the foundations of classical mechanics as well as a number of applications in various areas. Starting from the principle of least action, the Lagrangian and Hamiltonian formulations of mechanics are introduced. The module explains the connection between symmetries and conservation laws and shows bridges between classical and quantum mechanics. Applications include the central force problem (orbits and scattering) and coupled oscillators.				
Pre-requisite(s):	In taking this module you will need a knowledge of vector calculus. Before taking this module you must pass PH3081 or pass PH3082 or (pass MT2506 and pass MT2507)			
Anti-requisite(s)	You cannot take this module if you take MT4507			
Learning and teaching methods of delivery:	**Weekly contact**: 2 or 3 lectures and some tutorials			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 75%, Practical Examinations = 0%, Coursework = 25%			
	As used by St Andrews: 2-hour Written Examination = 75%, Coursework = 25%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH4039 Introduction to Condensed Matter Physics

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			

This module explores how the various thermal and electrical properties of solids are related to the nature and arrangement of their constituent atoms. For simplicity, emphasis is given to crystalline solids. The module covers: the quantum-mechanical description of electron motion in crystals; the origin of band gaps and insulating behaviour; the reciprocal lattice and the Brillouin zone, and their relationships to X-ray scattering measurements; the band structures and Fermi surfaces of simple tight-binding models; the Einstein and Debye models of phonons, and their thermodynamic properties; low-temperature transport properties of insulators and metals, including the Drude model; the physics of semiconductors, including doping and gating; the effect of electron-electron interactions, including a qualitative account of Mott insulators; examples of the fundamental theory applied to typical solids.

Pre-requisite(s):	Before taking this module you must pass PH3081 or pass PH3082 or (pass MT2506 and pass MT2507) and (pass PH3061 or pass CH3712)	
Co-requisite(s):	You must also take PH3061 or take PH3082 or take PH3081	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials	
	Scheduled learning: 34 hours	**Guided independent study:** 116 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%	
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework = 20%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH4040 Nuclear and Particle Physics with Advanced Skills

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Available only to students on the Physics and Philosophy, and Physics and Computer Science, Physics and Mathematics, Theoretical Physics and Mathematics programmes.			
Planned timetable:	To be arranged			
The first aim of this module is to describe in terms of appropriate models, the structure and properties of the atomic nucleus, the classification of fundamental particles and the means by which they interact. The syllabus includes: nuclear sizes, binding energy, spin dependence of the strong nuclear force; radioactivity, the semi-empirical mass formula; nuclear stability, the shell model, magic numbers; spin-orbit coupling; energetics of betadecay, alpha-decay and spontaneous fission; nuclear reactions, resonances; fission; electroweak and colour interactions, classification of particles as intermediate bosons, leptons or hadrons. Standard model of leptons and quarks, and ideas that go beyond the standard model. The second aim of this module is to develop research skills, and oral and written communication skills in science. Participants will be given training in the use of bibliographic databases, use of the scientific literature, oral and written communication skills, and will develop these skills through structured assignments.				
Pre-requisite(s):	You must have gained entry to honours in BSc Philosophy and Physics or BSc Computer Science and Physics or BSc Mathematics and Physics or MPhys Mathematics and Theoretical Physics.. Before taking this module you must pass PH3061 and pass PH3062			
Anti-requisite(s)	You cannot take this module if you take PH4022 or take PH3014 or take PH4041			
Learning and teaching methods of delivery:	**Weekly contact**: 3 x lectures (x 7 weeks) plus 6 further lectures, 4 tutorials, 1 workshop and 2 hours of giving and evaluating tasks.			
	Scheduled learning: 34 hours		**Guided independent study:** 116 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 60%, Practical Examinations = 7%, Coursework = 33%			
	As used by St Andrews: 2-hour Written Examination = 60%, Coursework = 40%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH4041 Atomic, Nuclear, and Particle Physics

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			
The aim of this module is to describe in terms of appropriate models, the structure and properties of the atom, including its nucleus, the classification of fundamental particles and the means by which they interact. The syllabus includes: electron cloud model of an atom, electron spin and magnetic moment, spin-orbit interactions, revision of single-electron atom and brief qualitative extension to multi-electron atoms, selection rules and line intensities for electric-dipole transitions; nuclear sizes, binding energy, properties of the strong nuclear force; radioactivity, the semi-empirical mass formula; nuclear stability, the shell model, magic numbers; energetics of beta-decay, alpha-decay and spontaneous fission; nuclear reactions, resonances; fission; electroweak and colour interactions, classification of particles as intermediate bosons, leptons or hadrons. Standard model of leptons and quarks.				
Pre-requisite(s):	Before taking this module you must pass PH2011 and pass PH2012 and pass MT2501 and pass MT2503 and (pass PH3081 or pass PH3082) or (pass MT2506 and pass MT2507) and pass PH3061 and pass PH3062			
Anti-requisite(s)	You cannot take this module if you take PH4022 or take PH4037 or take PH4040			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures per week with total of 3 replaced by a tutorial			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 5%, Coursework = 95%			
	As used by St Andrews: 2-hour Written Examination = 95%, Coursework (quizzes) = 5%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH4042 Concepts in Atomic Physics and Magnetic Resonance

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			

This first half of the module builds on the atomic physics covered in PH4041 to look at the atomic structure of helium and many-electron atoms, magnetic interactions within the atom (leading to fine and hyperfine splitting), the Zeeman effect, and topics in atom-light interaction. The second half of the module provides an introduction to the main concepts of magnetic resonance, one of the most important probes of atomic structure, and a current research topic within the School. It will include an introduction to Magnetic Resonance Imaging (MRI), liquid state and solid-state Nuclear Magnetic Resonance (NMR), Electron Spin Resonance (ESR) and Dynamic Nuclear Polarisation (DNP).

Pre-requisite(s):	The pre-requisite may be waived with special permission from the School.. Before taking this module you must pass PH4041	
Anti-requisite(s)	You cannot take this module if you take PH4037	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures per week with total of 3 replaced by a tutorial	
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%	
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework = 20%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH4043 Studies in Physics and Chemistry

SCOTCAT Credits:	5	SCQF Level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Available only to students in the honours years of the joint Chemistry and Physics degree programme.			
Planned timetable:	To be arranged			

This module, which is for students on the joint degree programme Chemistry and Physics, provides guidance on literature research and communication skills. Students choose area(s) of interest relevant to the joint degree to explore and to write a review article and a provide a short presentation. The module thus addresses important professional skills, develops subject knowledge, and explicitly brings together the two halves of the degree programme.

Pre-requisite(s):	This module is available only to students in the honours years of the joint degree programme in Chemistry and Physics.. Before taking this module you must pass CH3441 and pass PH3082 and pass PH3061	
Anti-requisite(s)	You cannot take this module if you take PH3014	
Learning and teaching methods of delivery:	**Weekly contact**: 1-hour lecture (x 4 weeks), 1-hour tutorial (x 5 weeks)	
	Scheduled learning: 9 hours	**Guided independent study:** 41 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 20%, Coursework = 80%	
	As used by St Andrews: Coursework (including Presentation (20%)= 100%	
Re-assessment pattern:	No Re-assessment available	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH4044 Advanced Condensed Matter Physics

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	2
Academic year:	2020-2021			
Availability restrictions:	Available only to students on a programme in the School of Physics & Astronomy.			
Planned timetable:	To be arranged			

This module builds on concepts taught in Introduction to Condensed Matter Physics (PH4039) to introduce more advanced theoretical concepts and lay the foundations required to understand the challenges in current research in condensed matter physics. Topics covered in this module include advanced techniques for band-structure determination, superconductivity and magnetism as well as the physics of semiconductor electronics. The module will further prepare students for more independent learning. The module will be 100% continuously assessed, including a journal club presentation, problem sheets and computational problems to serve as an introduction to advanced modelling and data analysis in condensed matter physics.

Pre-requisite(s):	Before taking this module you must take PH3061 and (take PH3080 or take PH3082) and take PH4039	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials (x 11 weeks), 1 computing hour	
	Scheduled learning: 41 hours	**Guided independent study:** 109 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 60%, Coursework = 40%	
	As used by St Andrews: Oral Examination = 30%, Coursework (computing project - 40%, Journal Club presentation 30%) = 70%	
Re-assessment pattern:	Oral Examination = 100% -Re-Aassessment grade capped at 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH4105 Physics Laboratory 2

SCOTCAT Credits:	15	SCQF Level 10	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Not automatically available to General Degree students			
Planned timetable:	To be arranged			

The aims of the module are (i) to familiarise students with a wide variety of experimental techniques and equipment, and (ii) to instil an appreciation of the significance of experiments and their results. The module consists of sub-modules on topics such as solid state physics, optics, interfacing, and signal processing.

Pre-requisite(s):	Before taking this module you must pass PH3081 or pass PH3082 or (pass MT2506 and pass MT2507)	
Learning and teaching methods of delivery:	**Weekly contact**: 2 x 3.5-hour laboratories.	
	Scheduled learning: 70 hours	**Guided independent study:** 80 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%	
	As used by St Andrews: Coursework = 100%	
Re-assessment pattern:	No Re-assessment available - laboratory based	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH4111 Physics Project (BSc)

SCOTCAT Credits:	30	SCQF Level 10	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Normally only in the final year of a Physics BSc programme			
Planned timetable:	To be arranged			
The project aims to develop students' skills in searching the physics literature and in experimental design, the evaluation and interpretation of data, and in the presentation of results. There is no specific syllabus for this module. Students taking the BSc degree select a project from a list offered, and are supervised by a member of staff. Project choice and some preparatory work is undertaken in semester one, but normally most of the 30 credits' worth of work is undertaken in semester two. The aim is that students provide the intellectual drive for the project work, and should take on a role similar to that of a research student in the School. Support will be offered by the academic staff member(s) supervising the project and usually also by other members of a research team. Many projects will be carried out in the SchoolÆs research labs, but other arrangements are possible. A pre-project report precedes the experimental/computational/theoretical work of the project, and is expected to be directly relevant to the subsequent experimental studies.				
Pre-requisite(s):	Some projects will need learning from specific modules - please contact potential supervisors.. Before taking this module you must pass PH3061			
Anti-requisite(s)	You cannot take this module if you take AS4103 or take AS5101 or take PH5101 or take PH5103 or take PH4796			
Learning and teaching methods of delivery:	**Weekly contact**: Project students work "half-time" on their project through semester 2. All students must meet weekly with their project supervisor and attend fortnightly meetings with their peer-support group. Most projects are based in research labs in the School, where members of research teams will provide supervision ranging from safety cover to assistance with equipment and discussion of interpretation of results - it is expected that the 20 hours a week will be primarily in this environment.			
	Scheduled learning: 18 hours		**Guided independent study:** 282 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework (Review essay, Report and Oral Examination) = 100%			
Re-assessment pattern:	No Re-assessment available - Final year project			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH5004 Quantum Field Theory

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Normally only taken in the final year of an MPhys or MSci programme involving the School			
Planned timetable:	To be arranged			

This module presents an introductory account of the ideas of quantum field theory and of simple applications thereof, including quantization of classical field theories, second quantization of bosons and fermions, solving simple models using second quantization, path integral approach to quantum mechanics and its relation to classical action principles, field integrals for bosons and fermions, the relationship between path integral methods and second quantization, solving many-body quantum problems with mean-field theory, and applications of field theoretic methods to models of magnetism.

Pre-requisite(s):	Before taking this module you must pass PH3012 and pass PH3061 and pass PH3062 and pass 1 module from {PH4038, MT4507} and pass 1 module from {PH4028, MT3503}	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.	
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 85%, Practical Examinations = 0%, Coursework = 15%	
	As used by St Andrews: 2-hour Written Examination = 85%, Coursework = 15%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH5005 Laser Physics and Design

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Normally only taken in the final year of an MPhys or MSci programme involving the School			
Planned timetable:	To be arranged			

Quantitative treatment of laser physics including rate equations; transient/dynamic behaviour of laser oscillators including relaxation oscillations, Q-switching, cavity dumping and mode locking; single-frequency selection and frequency scanning, design analysis of optically-pumped solid state lasers; laser amplifiers; unstable optical resonators, geometric and diffraction treatments. An emphasis is placed on how understanding of the laser physics can be used to design useful laser systems.

Pre-requisite(s):	Before taking this module you must pass PH3007 and pass PH3061 and pass PH3062	
Anti-requisite(s)	You cannot take this module if you take PH5180 and take PH4034	
Learning and teaching methods of delivery:	**Weekly contact**: 4 lectures or tutorials.	
	Scheduled learning: 40 hours	**Guided independent study:** 110 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%	
	As used by St Andrews: 2.5-hour open-notes Written Examination = 80%, Coursework = 20%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH5011 General Relativity

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Normally only taken in the final year of an MPhys or MSci programme involving the School, or as part of MSc Astrophysics.			
Planned timetable:	To be arranged			

This module covers: inertial frames, gravity, principle of equivalence, curvature of spacetime; basic techniques of tensor analysis; Riemannian spaces, metric tensor, raising and lowering of indices, Christoffel symbols, locally flat coordinates, covariant derivatives, geodesics, curvature tensor, Ricci tensor, Einstein tensor; fundamental postulates of general relativity: spacetime, geodesics, field equations, laws of physics in curved spacetime; distances, time intervals, speeds; reduction of equations of general relativity to Newtonian gravitational equations; Schwarzschild exterior solution, planetary motion, bending of light rays, time delays; observational tests of general relativity; Schwarzschild interior solution, gravitational collapse, black holes.

Pre-requisite(s):	Postgraduates: MSc Astrophysics students must discuss your prior learning with your adviser.. Before taking this module you must pass PH3081 or pass PH3082 or (pass MT2506 and pass MT2507)	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.	
	Scheduled learning: 32 hours	**Guided independent study:** 118 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%	
	As used by St Andrews: 2-hour Written Examination = 100%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH5012 Quantum Optics

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Normally only taken in the final year of an MPhys or MSci programme involving the School			
Planned timetable:	To be arranged			
Quantum optics is the theory of light that unifies wave and particle optics. Quantum optics describes modern high-precision experiments that often probe the very fundamentals of quantum mechanics. The module introduces the quantisation of light, the concept of single light modes, the various quantum states of light and their description in phase space. The module considers the quantum effects of simple optical instruments and analyses two important fundamental experiments: quantum-state tomography and simultaneous measurements of position and momentum.				
Pre-requisite(s):	Before taking this module you must (pass PH3081 or pass PH3082 or pass MT2506 and pass MT2507) and pass PH3061 and pass PH3062 and pass PH4028			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures or tutorials.			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 100%, Practical Examinations = 0%, Coursework = 0%			
	As used by St Andrews: 2-hour Written Examination = 100%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH5015 Applications of Quantum Physics

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Normally only taken in the final year of an MPhys or MSci programme involving the School, or a postgraduate photonics programme.			
Planned timetable:	To be arranged			
Quantum physics is one of the most powerful theories in physics yet is at odds with our understanding of reality. In this module we show how laboratories around the world can prepare single atomic particles, ensembles of atoms, light and solid state systems in appropriate quantum states and observe their behaviour. The module includes studies of laser cooling, Bose-Einstein condensation, quantum dots and quantum computing. An emphasis throughout will be on how such quantum systems may actually turn into practical devices in the future. The module will include assessment based on tutorial work and a short presentation on a research topic.				
Pre-requisite(s):	Undergraduate - Before taking this module you must (pass PH3081 or pass PH3082 or pass MT2506 and pass MT2507) and pass PH3061 and pass PH3062			
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures/tutorials, 1 x 3-hour research lab visit, 3 hours student presentations during the semester.			
	Scheduled learning: 30 hours		**Guided independent study:** 120 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 10%, Coursework = 10%			
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework = 20%			
Re-assessment pattern:	Oral Re-assessment, capped at grade 7			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH5016 Biophotonics

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Normally only taken in the final year of an MPhys or MSci programme involving the School, or a postgraduate photonics programme.			
Planned timetable:	To be arranged			

The module will expose students to the exciting opportunities offered by applying photonics methods and technology to biomedical sensing and detection. A rudimentary biological background will be provided where needed. Topics include fluorescence microscopy and assays including time-resolved applications, optical tweezers for cell sorting and DNA manipulation, photodynamic therapy, optogenetics, lab-on-a-chip concepts and bio-MEMS. Two thirds of the module will be taught as lectures, including guest lectures by specialists, with the remaining third consisting of problem-solving exercises, such as writing a specific news piece on a research paper, assessed tutorial sheets and a presentation. A visit to a biomedical research laboratory using various photonics methods will also be arranged.

Pre-requisite(s):	Pre-requisites are compulsory unless you are on a taught postgraduate programme.. Before taking this module you must (pass 1 module from {PH3081, PH3082} or pass 2 modules from {MT2506, MT2507}) and pass 1 module from {PH4034, PH4035}	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures/tutorials.	
	Scheduled learning: 31 hours	**Guided independent study:** 119 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 10%, Coursework = 10%	
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework (including presentation)= 20%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH5023 Monte Carlo Radiation Transport Techniques

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Normally only taken in the final year of an MPhys or MSci programme involving the School, or as part of MSc Astrophysics.			
Planned timetable:	To be arranged			
This module introduces the theory and practice behind Monte Carlo radiation transport codes for use in physics, astrophysics, atmospheric physics, and medical physics. Included in the module: recap of basic radiation transfer; techniques for sampling from probability distribution functions; a simple isotropic scattering code; computing the radiation field, pressure, temperature, and ionisation structure; programming skills required to write Monte Carlo codes; code speed-up techniques and parallel computing; three-dimensional codes. The module assessment will be 100% continuous assessment comprising homework questions and small projects where students will write their own and modify existing Monte Carlo codes.				
Pre-requisite(s):	Postgraduates: MSc Astrophysics students must discuss their prior learning with their adviser. Undergraduates: Before taking this module you must pass PH2012 and pass at least 1 module from {AS3013, PH3080, PH3081, PH3082}.			
Learning and teaching methods of delivery:	**Weekly contact**: 3 hours of lectures (x 6 weeks), 1-hour tutorials (x 5 weeks), during semester 3 x 3 hour supervised computer lab sessions			
	Scheduled learning: 32 hours		**Guided independent study:** 118 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 25%, Practical Examinations = 25%, Coursework = 50%			
	As used by St Andrews: Coursework (worksheets = 50%, 3-hour computing test = 25%, 1-hour Class Test = 25%) = 100%			
Re-assessment pattern:	No Re-assessment available - laboratory based			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH5024 Modern Topics in Condensed Matter Physics				
SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Available only to those in the final year of an MPhys or MSci programme			
Planned timetable:	To be arranged			
This module links with ongoing research in this area in the School, and includes the rich structural and electronic phases that can be stabilised at surfaces of materials and the physics of strongly correlated electron materials. It also covers some experimental techniques commonly used to characterise these, such as quantum oscillations, angle-resolved photoemission spectroscopy, and scanning tunnelling microscopy and spectroscopy. There is an emphasis on developing skills in critical reading of the scientific literature, presenting relevant works in class discussions, and performing computations. Tutorial sessions will be used to provide constructive feedback on problem sheets. Full-class discussions in a journal club style will aid in developing understanding of complex topics and critical reading of research papers.				
Pre-requisite(s):	Before taking this module you must pass 4 modules from {PH3061, PH3062, PH4039, PH4044} and (pass 1 module from {PH3081, PH3082} or pass 2 modules from {MT2506, MT2507}) and pass 1 module from {PH4037, PH4041} and pass 1 module from {PH3080, PH3082}			
Learning and teaching methods of delivery:	**Weekly contact**: 3 hours of lectures (x 7 weeks), 1-hour tutorials (x 4 weeks), 3-hour presentations (x 2 weeks)			
	Scheduled learning: 31 hours		**Guided independent study:** 119 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 70%, Coursework = 30%			
	As used by St Andrews: Coursework = 100%			
Re-assessment pattern:	No Re-assessment available - assignment based			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH5025 Nanophotonics

SCOTCAT Credits:	15	SCQF Level 11	**Semester**	1
Academic year:	2020-2021			
Availability restrictions:	Available only to students in a photonics taught postgraduate programme or the final year of an MPhys Honours Programme			
Planned timetable:	To be arranged			

Nanophotonics deals with structured materials on the nanoscale for the manipulation of light. Photonic crystals and plasmonic metamaterials are hot topics in contemporary photonics, and form part of the School's research programme. The properties of these materials can be designed to a significant extent via their structure. Many of the properties of these nanostructured materials can be understood from their dispersion diagram or optical band-structure, which is a core tool that will be explored in the module. Familiar concepts such as optical waveguides and cavities, multilayer mirrors and interference effects will be used to explain more complex features such as slow light propagation and high Q cavities in photonic crystal waveguides and supercontinuum generation in photonic crystal fibres. Propagating and localized plasmons will be explained and will include the novel effects of super-lensing and advanced phase control in metamaterials.

Pre-requisite(s):	Postgraduates: students should be familiar with Maxwell's Equations of Electromagnetism in differential form.. Undergraduates: before taking this module you must take PH3061 and (take PH3081 or take PH3082) and (take PH4027 or take PH4034 or take PH4035)	
Anti-requisite(s)	You cannot take this module if you take PH5183	
Learning and teaching methods of delivery:	**Weekly contact**: 3 lectures/tutorials (x 10 weeks)	
	Scheduled learning: 30 hours	**Guided independent study:** 120 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 80%, Practical Examinations = 0%, Coursework = 20%	
	As used by St Andrews: 2-hour Written Examination = 80%, Coursework = 20%	
Re-assessment pattern:	Oral Re-assessment, capped at grade 7	
Module coordinator:	Professor A Di Falco	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH5101 Physics Project (MPhys)

SCOTCAT Credits:	60	SCQF Level 11	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Normally available only to those in the final year of an MPhys Physics or MSci Chemistry and Physics degree programme			
Planned timetable:	To be arranged			
The project aims to develop students' skills in searching the physics literature and in experimental design, the evaluation and interpretation of data, and in the presentation of results. There is no specific syllabus for this module. Students taking the MPhys degree select a project from a list offered, and are supervised by a m ember of staff. Project choice and some preparatory work is undertaken in semester one, but normally most of the 60 credits' worth of work is undertaken in semester two. The aim is that students provide the intellectual drive for the project work, and should take on a role similar to that of a research student in the School. Support will be offered by the academic staff member(s) supervising the project and usually also by other members of a research team. Many projects will be carried out in the School's research labs, but other arrangements are possible. A pre-project report precedes the experimental/computational/theoretical work of the project, and is expected to be directly relevant to the subsequent experimental studies.				
Pre-requisite(s):	Some projects will need learning from specific modules - please contact potential supervisors.. Before taking this module you must pass PH3061			
Anti-requisite(s)	You cannot take this module if you take all modules from AS4103 and take all modules from AS5101 and take all modules from PH4111 and take all modules from PH5103 and take all modules from PH4796			
Learning and teaching methods of delivery:	**Weekly contact**: Project students work "full-time" on their MPhys project through semester 2. All students must meet weekly with their project supervisor and attend fortnightly meetings with their peer-support group. Most projects are based in research labs in the School, where members of research teams will provide supervision ranging from safety cover to assistance with equipment and discussion of interpretation of results - it is expected that the 40 hours a week will be primarily in this environment.			
	Scheduled learning: 21 hours		**Guided independent study:** 579 hours	
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%			
	As used by St Andrews: Coursework (Review essay, Report, and Oral Examination) = 100%			
Re-assessment pattern:	No Re-assessment available - Final year project			
Module teaching staff:	To be arranged			
Additional information from Schools:	To be confirmed			

PH5103 Project in Theoretical Physics (60)

SCOTCAT Credits:	60	SCQF Level 11	**Semester**	Full Year
Academic year:	2020-2021			
Availability restrictions:	Available only to those in the final year of an MPhys programme in Theoretical Physics			
Planned timetable:	To be arranged			

This project in theoretical physics research aims to develop students' skills in searching the physics literature, in the design and implementation of investigations in theoretical/computational physics, in the evaluation and interpretation of data, and in the presentation of results. There is no specific syllabus for this module. Students taking the MPhys theoretical physics degree select a project from a list offered, and are supervised by a member of staff. Project choice and some preparatory work is undertaken in semester one, but normally most of the 60 credits' worth of work is undertaken in semester two. The aim is that students provide the intellectual drive for the project work, and should take on a role similar to that of a research student in the School. Support will be offered by the academic staff member(s) supervising the project. In addition to weekly meetings with the project supervisor, students will meet fortnightly with their peer support group. A pre-project report precedes the computational/theoretical work of the project, and is expected to be directly relevant to the subsequent studies. Please note: Some projects will need learning from specific modules - please contact potential supervisors.

Pre-requisite(s):	Some projects will need learning from specific modules - please contact potential supervisors. Before taking this module you must pass PH3061	
Anti-requisite(s)	You cannot take this module if you take PH5102 or take PH5101 or take PH4111 or take AS4103 or take AS5101 or take PH4796	
Learning and teaching methods of delivery:	**Weekly contact**: Project students should spend all their time in semester 2 working on the project. All students must meet weekly with their project supervisor, and attend fortnightly meetings with their peer-support group. Most of their time will be spent working on theoretical physics in an independent fashion, though with the opportunity to discuss things with their supervisor face to face or electronically. In addition, all theoretical physics project students are encouraged to attend the theoretical physics research seminars.	
	Scheduled learning: 36 hours	**Guided independent study:** 564 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 0%, Coursework = 100%	
	As used by St Andrews: Coursework (review essay, report, oral examination) = 100%	
Re-assessment pattern:	No Re-assessment available - Final year project	
Module teaching staff:	To be arranged	
Additional information from Schools:	To be confirmed	

PH5104 Project in Theoretical Physics (Mathematics and Theoretical Physics Students)

SCOTCAT Credits:	65	SCQF Level 11	**Semester**	Full Year
Academic year:	2020-2021			

This project in theoretical physics research aims to develop joint-degree students' skills in searching the physics literature, in the design and implementation of investigations in theoretical/computational physics, in the evaluation and interpretation of data/calculations, and in the presentation of results. The project work is preceded by a substantial review on a topic which is normally related to the theme of the project. Students select a project from a list offered, and are supervised by a member of staff. Input from the School of Maths and Statistics is welcomed, but not required. Project choice, prep work, and some writing of the review is undertaken in sem 1, but most of the 65 credits' worth of work is done in sem 2. Students should provide the intellectual drive for the project work, taking on a role similar to that of a research student in the School. Note: Some projects will need learning from specific modules - please contact potential supervisors.

Learning and teaching methods of delivery:	**Scheduled learning:** 36 hours	**Guided independent study:** 614 hours
Assessment pattern:	**As defined by QAA:** Written Examinations = 0%, Practical Examinations = 28%, Coursework = 72%	
	As used by St Andrews: TBC	