School of Physics & Astronomy

Important Degree Information:

Students who are aiming for a degree in Physics or Astrophysics and who enter with good Advanced Highers or A-levels or equivalent in Physics and Mathematics may apply to take an accelerated entry route to the programme, which can reduce the length of the BSc honours programme to three years and the MPhys programme to four years.

B.Sc./M.A. Honours
The general requirements are 480 credits over a period of normally 4 years (and not more than 5 years) or part-time equivalent; the final two years being an approved Honours programme of 240 credits, of which 90 credits are at 4000 level and at least a further 120 credits at 3000 and/or 4000 levels. Refer to the appropriate Faculty regulations for lists of subjects recognised as qualifying towards either a B.Sc. or M.A. degree.

B.Sc./M.A. Honours with Integrated Year Abroad
The general requirements are 540 credits over a period of normally 5 years (and not more than 6 years) or part-time equivalent; the final three years being an approved Honours programme of 300 credits, of which 60 credits are gained during the integrated year abroad, 90 credits are at 4000 level and at least a further 120 credits at 3000 and/or 4000 levels. Refer to the appropriate Faculty regulations for lists of subjects recognised as qualifying towards either a B.Sc. or M.A. degree.

M.Phys. Honours
The general requirements are 600 credits over a period of normally 5 years (and not more than 6 years) or part-time equivalent; the final three years being an approved Honours programme of 360 credits, of which 120 credits are at 5000 level and a further 210 credits (minimum) at 3000 and 4000 levels.

M.Sci. Honours
The general requirements are 600 credits over a period of normally 5 years (and not more than 6 years) or part-time equivalent; the final three years being an approved Honours programme of 360 credits, of which 120 credits are at 5000 level and a further 210 credits (minimum) at 3000 and 4000 levels.

B.Eng. Honours
The general requirements are 480 credits over a period of normally 4 years (and not more than 5 years) or part-time equivalent; the final two years being an approved Honours programme of 240 credits, of which 90 credits are at 4000 level and a further 150 credits at 3000 and 4000 levels.

M.Eng. Honours
The general requirements are 600 credits over a period of normally 5 years (and not more than 6 years) or part-time equivalent; the final three years being an approved Honours programme of 360 credits, of which 120 credits are at 5000 level and a further 240 credits at 3000 and 4000 levels.

Other Information: In the case of students who spend part of the Honours programme abroad on a recognised Exchange Scheme, the Programme Requirements will be amended to take into account courses taken while abroad.

Degree Programmes	Programme Requirements at:
(B.Sc. Honours): **Astrophysics**	**Single Honours Astrophysics (B.Sc.) Degree:** **Level 1:** 80 credits comprising**:** PH1011, PH1012, MT1002 and AS1001. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 120 credits comprising: 11 or better in AS2001, PH2011, PH2012, and in MT2001. Those on the accelerated-entry route have the same PH and MT requirements for entry to Honours Astrophysics, but normally take AS1001 in their year of entry. AS2101 is then taken in the first semester of JH. **Level 3:** 105 credits comprising: AS3011, AS3013, PH3007, PH3012, PH3014, PH3061, PH3062 PH3066 and PH3075 (except for students who have taken MT2003). **Level 4:** At least 60 credits comprising: AS4103, PH4022 and at least two of AS3015, AS4021 - AS4025, and PH4031.
(M.Phys. Honours): **Astrophysics** **(for students entering Honours before 2010)**	**Single Honours Astrophysics (M.Phys) Degree:** **Level 1:** 80 credits comprising: PH1011, PH1012, MT1002 and AS1001. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 120 credits comprising: grade 15 or better in AS2001, PH2011 and PH2012, and grade 11 or better in MT2001. Those on the accelerated-entry route have the same PH and MT requirements for entry to Honours Astrophysics, but normally take AS1001 in their year of entry. AS2101 is then taken in the first semester of JH. **Level 3:** 110 credits comprising: AS3011, AS3013, AS3015, PH3007, PH3012, PH3014, PH3061, PH3062, PH3066 and PH3075 (except for students who have taken MT2003). **Level 4:** At least 55 credits comprising: AS4022, AS4023, PH4022 and at least two of AS4021, AS4024, AS4025 and PH4031. **Level 5:** At least 90 credits comprising: AS5101 and at least two of AS5001, AS5002, AS5003.
(M.Phys. Honours): **Astrophysics** **(for students entering Honours in 2010 or later)**	**Single Honours Astrophysics (M.Phys) Degree:** **Level 1:** 80 credits comprising: PH1011, PH1012, MT1002 and AS1001. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 120 credits comprising: grade 15 or better in AS2001, PH2011, PH2012, and in MT2001. Those on the accelerated-entry route have the same PH and MT requirements for entry to Honours Astrophysics, but normally take AS1001 in their year of entry. AS2101 is then taken in the first semester of JH. **Level 3:** 110 credits comprising: AS3011, AS3013, AS3015, PH3007, PH3012, PH3014, PH3061, PH3062, PH3066 and PH3075 (except for students who have taken MT2003). **Level 4:** At least 55 credits comprising: AS4022, AS4023, PH4022 and at least two of AS4021, AS4024, AS4025 and PH4031. **Level 5:** At least 90 credits comprising: AS5101 and at least two of AS5001, AS5002, AS5003.

Degree Programmes	**Programme Requirements at:**
(B.Sc. Honours): **Physics**	**Single Honours Physics (B.Sc.) Degree:** **Level 1:** 60 credits comprising: PH1011, PH1012, and MT1002. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 90 credits comprising: grade 11 or better in PH2011, PH2012, and in MT2001. **Level 3:** 105 credits comprising: PH3002, PH3007, PH3012, PH3014, PH3061, PH3062, PH3066, PH3075 (except for students who have taken MT2003) and PH3101. **Level 4:** 70 credits comprising: PH4021, PH4022, PH4105 and PH4111.
(B.Sc. Honours): **Physics and** **Computer Science,** **Internet Computer Science,** **Logic & Philosophy of Science,** **Mathematics.**	**Physics element of Joint Degree:** **Level 1:** 60 credits comprising: PH1011, PH1012, and MT1002. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 90 credits comprising: grade 11 or better in PH2011, PH2012, and in MT2001 **Level 3:** 60 credits comprising: PH3007, PH3012, PH3061, PH3062, PH3066 and PH3075 (except for students who have taken MT2003). **Level 4:** 10 credits comprising PH4022.
(B.Sc. Honours): **Physics with French^** ^ available also as 'With Integrated Year Abroad Degrees' **Not available to entrants from 2008/9**	**Physics element of Major Degree Programmes:** **Level 1:** 60 credits comprising: PH1011, PH1012, and MT1002. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 90 credits comprising: grade 11 or better in PH2011, PH2012, and in MT2001. **Level 3:** 90 credits comprising: PH3002, PH3007, PH3012, PH3061, PH3062, PH3066, PH3075 (except for students who have taken MT2003) and at least one of PH3101, PH4105. **Level 4:** 55 credits comprising: PH4021, PH4022 and PH4111.
(M.Phys. Honours): **Physics** **(for students entering Honours before 2010)**	**Single Honours Physics (M.Phys.) Degree:** **Level 1:** 60 credits comprising PH1011, PH1012, and MT1002. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 90 credits comprising: grade 15 or better in PH2011 and PH2012, and 11 or better in MT2001 **Level 3:** 135 credits comprising: PH3002, PH3004 or PH3074, PH3007, PH3012, PH3014, PH3061, PH3062, PH3066, PH3073, PH3075 (except for students who have taken MT2003) and PH3101. **Level 4:** 60 credits comprising: PH4021, PH4022, PH4028, PH4030 and PH4105. **Level 5:** 60 credits comprising: PH5101.

Degree Programmes	Programme Requirements at:
(M.Phys. Honours): **Physics** **(for students entering Honours in 2010 or later)**	**Single Honours Physics (M.Phys.) Degree:** **Level 1:** 60 credits comprising PH1011, PH1012, and MT1002. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 90 credits comprising: grade 15 or better in PH2011, PH2012 and in MT2001 **Level 3:** 135 credits comprising: PH3002, PH3004 or PH3074, PH3007, PH3012, PH3014, PH3061, PH3062, PH3066, PH3073, PH3075 (except for students who have taken MT2003) and PH3101. **Level 4:** 60 credits comprising: PH4021, PH4022, PH4028, PH4030 and PH4105. **Level 5:** 60 credits comprising: PH5101.
(M.Phys. Honours): **Physics with Photonics** **(for students entering Honours before 2010)**	**Physics with Photonics (M.Phys.) Degree:** **Level 1:** 60 credits comprising: PH1011, PH1012, and MT1002. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 90 credits comprising: grade 15 or better in PH2011 and PH2012, and 11 or better in MT2001 **Level 3:** 165 credits comprising: PH3002, PH3007, PH3010 or PH4035, PH3012, PH3014, PH3061, PH3062, PH3066, PH3073, PH3074, PH3075 (except for students who have taken MT2003) and PH3101. **Level 4:** 60 credits comprising: PH4021, PH4022, PH4027, PH4028, PH4030, PH4034, and PH4105. **Level 5:** 90 credits comprising: PH5005, PH5008 and PH5101.
(M.Phys. Honours): **Physics with Photonics** **(for students entering Honours in 2010 or later)**	**Physics with Photonics (M.Phys.) Degree:** **Level 1:** 60 credits comprising: PH1011, PH1012, and MT1002. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 90 credits comprising: grade 15 or better in PH2011, PH2012, and in MT2001 **Level 3:** 165 credits comprising: PH3002, PH3007, PH3010 or PH4035, PH3012, PH3014, PH3061, PH3062, PH3066, PH3073, PH3074, PH3075 (except for students who have taken MT2003) and PH3101. **Level 4:** 60 credits comprising: PH4021, PH4022, PH4027, PH4028, PH4030, PH4034, and PH4105. **Level 5:** 90 credits comprising: PH5005, PH5101, and at least 15 credits from PH5008, PH5012, PH5015, PH5016, PH5020, PH5183.
(M.Sci. Honours): **Physics and Chemistry** **(M.Sci. Honours) 5 year Degree** **(for students entering Honours before 2010)**	**Physics element of Physics-Chemistry M.Sci. Degree:** **Level 1:** 60 credits comprising: PH1011, PH1012, MT1002 **Level 2:** At least 90 credits comprising: grade 15 or better in PH2011 and PH2012, and 11 or better in MT2001 **Level 3:** At least 90 credits comprising: PH3002, PH3007, PH3012, PH3061, PH3062, PH3066, PH3075 (except for students who have taken MT2003) and at least one of PH3101, PH4105 **Level 4:** 25 credits comprising: PH4021 and PH4022 **Level 5:** 60 credits from PH5101 plus at least one 15-credit 5000-level module in Physics plus at least 30 credits at 5000 level in Chemistry OR 40 credits from CH5441 plus at least 30 credits at 5000 level in Chemistry plus at least 30 credits in 5000-level modules in Physics.

Degree Programmes	**Programme Requirements at:**
(M.Sci. Honours): **Physics and Chemistry** **(M.Sci. Honours) 5 year Degree** **(for students entering Honours in 2010 or later)**	**Physics element of Physics-Chemistry M.Sci. Degree:** **Level 1:** 60 credits comprising: PH1011, PH1012, MT1002 **Level 2:** At least 90 credits comprising: grade 15 or better in PH201, PH2012, and in MT2001 **Level 3:** At least 90 credits comprising: PH3002, PH3007, PH3012, PH3061, PH3062, PH3066, PH3075 (except for students who have taken MT2003) and at least one of PH3101, PH4105 **Level 4:** 25 credits comprising: PH4021 and PH4022 **Level 5:** 60 credits from PH5101 plus at least one 15-credit 5000-level module in Physics plus at least 30 credits at 5000 level in Chemistry OR 40 credits from CH5441 plus at least 30 credits at 5000 level in Chemistry plus at least 30 credits in 5000-level modules in Physics.
(M.Phys. Honours): **Theoretical Physics**	**Single Honours Theoretical Physics (M.Phys.) Degree:** **Level 1:** 60 credits comprising: PH1011, PH1012, and MT1002. For those who enter at Second level, the PH modules are not required. **Level 2:** At least 90 credits comprising: grade 15 or better in PH2011 and PH2012, and in MT2001 **Level 3:** 120 credits comprising: MT3501, PH3002, PH3007, PH3012, PH3014, PH3061, PH3062, PH3066, PH3073 and PH3075 (except for students who have taken MT2003). **Level 4:** 60 credits comprising: PH4021, PH4022, PH4028, PH4030, PH4032. **Level 5:** At least 90 credits comprising: PH5002, PH5004, PH5102 and at least one of PH5003, PH5011 and PH5012.
(M.Phys. Honours): **Theoretical Physics and Mathematics**	**Theoretical Physics element of Joint M.Phys. Degree:** **Level 1:** 40 credits comprising: PH1011, PH1012. For those who enter at Second level, these PH modules are not required. **Level 2:** 60 credits comprising: grade 15 or better in PH2011 and PH2012. **Level 3:** At least 65 credits comprising: PH3007, PH3012, PH3061, PH3062, PH3075 (except for students who have taken MT2003). and (PH3073 or MT4507) **Level 4:** 35 credits comprising: PH4022, PH4028 and PH4032. **Level 5:** At least 85 credits comprising: PH5002, PH5004, PH5102 or MT5999, and at least one of PH5003, PH5011 and PH5012.
(B.Eng. Honours): **Microelectronics and Photonics** **Not available to entrants from 2007-08**	**Single Honours Microelectronics and Photonics (B.Eng.) Degree:** **Level 1:** 60 credits comprising: PH1011, PH1012 and MT1002. **Level 2:** Modules taught by University of Dundee: 120 credits comprising: EG21001, EG21002, EG21005, EG22001, EG22002, EG22004. **Level 3:** 120 credits comprising: PH3007, PH3014, PH3066, PH3075, PH3110, and modules taught by the University of Dundee: EE31001, EE32002. **Level 4:** 115 credits comprising: PH4025, PH4027, PH4034, PH4035, and modules taught by the University of Dundee EG40001, EG40003, EG40005.

Degree Programmes	Programme Requirements at:
(M.Eng. Honours): **Microelectronics and Photonics** **Not available to entrants from 2007-08**	**Single Honours Microelectronics and Photonics (M.Eng.) Degree:** **Level 1:** 60 credits comprising: PH1011, PH1012 and MT1002. **Level 2:** Modules taught by University of Dundee: 120 credits comprising: EG21001, EG21002, EG21005, EG22001, EG22002, EG22004. **Level 3:** 120 credits comprising: PH3007, PH3014, PH3066, PH3075, PH3110 and modules taught by the University of Dundee: EE31001, EE32002. **Level 4:** 105 credits comprising: PH4025, PH4027, PH4034, PH4035, and modules taught by the University of Dundee: EG40001, EG40003. **Level 5:** 120 credits comprising: PH5018, PH5020 and modules taught by the University of Dundee: CE52001, EE50002 and EE50003.

Modules

Normally the prerequisite for each of the following 3000-level or 4000-level Honours modules is entry to the Honours Programme(s) for which they are specified, as well as any additional specific prerequisite(s) given.

General degree students wishing to enter 3000-level modules, non-graduating students wishing to enter 3000-level or 4000-level modules, and Honours students from other Schools must consult with the relevant Honours Adviser within this School before making their selection.

The Prerequisite for each of the following 5000-level modules is entry to the M.Sci. or M.Phys. Programme(s) for which they are specified, save where an additional prerequisite is given.

InterDisciplinary (ID) Modules

There is a module to which this School contributes – **ID4001 Communications and Teaching in Science** which also appears in the InterDisciplinary Section of the Catalogue (Section 23)

Astronomy (AS) Modules

AS3011 Galaxies

Credits: 10 Semester: 2

Prerequisite: AS2001 or AS2101

Description: This module introduces the basic elements of extragalactic astronomy. This includes the morphological, structural and spectral properties of galaxies, the fundamental plane for elliptical galaxies and the Tully-Fischer relation for spirals. We discuss rotation curves and the need for dark matter. These relationships are used to derive the local value of the Hubble constant along with complementary methods such as the globular cluster luminosity function and surface brightness fluctuations. We assess the space density of galaxies and derive the mean matter density of our local universe. The module also contains material covering our local group and the nearby Virgo and Coma clusters.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

AS3012 Exoplanetary Science

Credits: 10 Semester: 2

Availability: Not available 2010-11

Description: This module introduces the rapidly-developing field of the study of planetary systems beyond our own. It builds on ideas of star formation and stellar structure introduced in AS2001, extending them to the formation of planets in circumstellar accretion discs, and the internal structures of gas-giant planets. New ideas of inward planetary migration due to tidal drag, and dynamical interactions between planets, are introduced. Observational techniques for detecting and studying exoplanets are discussed. The theory of radiative transfer in planetary atmospheres is introduced, in the context of the absorption and scattering mechanisms that may be operating. Cloud formation physics and methods for predicting and identifying the most likely condensates in planetary atmospheres at different temperatures are also covered.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

AS3013 Computational Astrophysics

Credits: 10 Semester: 2

Prerequisite: AS2001 or AS2101

Description: The aim of this module is to introduce students to the concepts involved in computational astrophysics. From a general introduction to a current programming language (Fortran90), students are shown how to explore the basics of problem solving using numerical techniques and their application to astrophysical phenomena. The second part of the module involves the development of a numerical integrator to solve orbits in various gravitational potentials. Students then gain experience with the basics of numerical accuracy, and explore the dynamics of orbits in generalised gravitational potentials from planetary to Galactic systems.

Class Hour: To be arranged.

Teaching: 2 lectures/workshops and some computer sessions.

Assessment: Continuous Assessment = 100%

AS3015 Nebulae

Credits: 15 Semester: 1

Prerequisite: AS2001 or AS2101

Description: 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-ionize nebulae, interstellar shocks, nova and supernova shells, accretion discs, quasar-absorption-line clouds, radio synchrotron jets, radio pulsars, and x-ray plasmas.

Class Hour: To be arranged.

Teaching: 3 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

AS4021 Gravitational Dynamics

Credits: 10 Semester: 2

Prerequisite: AS2001 or AS2101

Description: This module aims to explore the basics of gravitational dynamics and its application to systems ranging from planetary and stellar systems to clusters of galaxies. 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.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

AS4022 Cosmology

Credits: 10 Semester: 2

Prerequisite: AS2001 or AS2101

Description: The module starts with Olber's paradox, (why is the sky dark at night?) and its resolution (that the universe had a beginning) and then reviews the evidence that the universe is currently expanding at 68±10 km/s/Mpc. We then develop a mathematical framework capable of dealing with expanding curved space-time and derive the basic equations which govern the expansion and curvature of the universe as a function of time. We test the predictions, strengths and weaknesses of this standard model including the cosmic microwave background, big bang nucleosynthesis and the need for the theory of inflation. We find that the fate of the universe is entirely dependent on the current density of matter, radiation and vacuum energy, and review the latest observations which measure these key parameters. Finally the ultimate fate of the Universe is revealed.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

AS4023 Stars

Credits: 15 Semester: 2

Prerequisite: AS2001 or AS2101

Description: This module develops the physics of stellar interiors and atmospheres from the basic equations of stellar structure introduced in AS2001. 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 20^{th}-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.

Class Hour: To be arranged.

Teaching: 3 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

AS4025 Observational Astrophysics

Credits: 15 Semester: 1

Prerequisite: AS2001 or AS2101

Description: 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. Observations are secured at the University Observatory using various telescopes for CCD photometry of star clusters and galaxies, and for CCD spectroscopy of stars. Further sources of data may be made available from international observatories. Students gain experience in observation, data analysis, the UNIX operating system, standard astronomical software packages and modelling, and report writing.

Class Hour: To be arranged.

Teaching: Two 3 hour laboratories.

Assessment: Continuous Assessment = 100%

AS4103 Project in Astrophysics 1

Credits: 30 Semester: Whole Year

Anti-requisites: AS5101, PH4111, PH5101, PH5102

Description: 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 review essay. There is no specific syllabus for this module. Students taking the BSc 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 around 29 of the 30 credits' worth of work is normally undertaken in semester two.

Assessment: Project and Oral Examination = 100%

AS5001 Advanced Data Analysis

Credits: 15 Semester: 1

Prerequisite: Highly recommended: AS3013 (Computational Astrophysics) or PH4030 (Computational Physics). Familiarity with a programming language and concepts of computational physics or astrophysics are assumed.

Description: 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.

Class hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: Continuous Assessment = 100%

AS5002 Magnetofluids and Space Plasmas

Credits: 15 Semester: 1

Prerequisite: PH4031 is strongly recommended

Description: 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.

Class hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

AS5003 Contemporary Astrophysics

Credits: 15 Semester: 1

Description: 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.

Class Hour: To be arranged.

Teaching: 3 lectures and some tutorials

Assessment: 2 Hour Examination = 100%

AS5101 Project in Astrophysics 2

Credits: 60 Semester: Whole Year

Anti-requisites: AS4103, PH4111, PH5101, PH5102

Description: 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 review essay. There is no specific syllabus for this module. Students taking the M. Phys. 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 around 59 of the 60 credits' worth of work is normally undertaken in semester two.

Assessment: Continuous Assessment = 100%

InterDisciplinary (ID) Modules

ID4001 Communication and Teaching in Science

Credits: 15 Semester: 1

Availability: Available only to students in their senior Honours or M.Phys. year, and who have been accepted following interview.

Description: This module is based on the Undergraduate Ambassador Scheme launched in 2002. It provides final year students within the Faculty of Science with the opportunity to gain first hand experience of science education through a mentoring scheme with science teachers in local schools. Students will act initially as observers in the classroom and later as classroom assistants. With permission of the teacher-in-charge, students may also be given the opportunity to lead at least one lesson, or activity within a lesson, during their placement. This module will enable students to gain substantial experience of working in a challenging and unpredictable working environment, and of communicating scientific ideas at various different levels; and to gain a broad understanding of many of the key aspects of teaching science in schools. While of particular value to students aiming for a career in education, these core skills are equally important for any career that requires good communication. Entry to this module is by selection following application and interview during the preceding semester.

Class Hour: Flexible

Teaching: Occasional tutorials and a half-day training session.

Assessment: Continuous Assessment = 100%

Physics (PH) Modules

PH3002 Solid State Physics

Credits: 15 Semester: 2

Description: This introductory module is intended to show how the various optical, thermal and electrical properties of solids are related to the nature and arrangement of the constituent atoms in a solid. For simplicity, emphasis is given to crystalline solids. The module examines: symmetry properties of crystals; common crystalline structures; the behaviour of waves in crystals; waves of atomic motion, leading to thermal properties; electronic energy states: conductors, insulators, semiconductors; electrical properties arising from the wave nature of electrons; examples of the fundamental theory to typical solids such as simple metals, silicon and other semiconductors, and magnetic materials.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: Continuous Assessment = 20%, 2 Hour Examination = 80%

PH3007 Electromagnetism

Credits: 15 Semester: 2

Prerequisites: (PH3075 or MT2003) and PH2012 and MT2001.

Description: The properties of electric and magnetic fields will be discussed, starting with static fields and moving on to time-dependent properties. Maxwell's equations are derived, and result in the wave equation and the conclusion that light is an electromagnetic wave. The theory is applied to the transmission of waves in free space, ionised gases (plasmas), metals and dielectrics. The relation between electromagnetic theory and quantum theory will be discussed briefly.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: Continuous Assessment = 20%, 2 Hour Examination = 80%

PH3012 Thermal and Statistical Physics

Credits: 15 Semester: 1

Description: 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: derivation of the three laws of thermodynamics, and the equation of state; Maxwell's relations; correction of solid state results from constant pressure to constant volume, liquifaction of gases; concept of independent quantum state; energy levels and degeneracy; the microcanonical ensemble; quantum gases and the classical limit; the canonical ensemble; fluctuations; the connection with thermodynamics; the classical perfect gas; equipartition of energy; the grand canonical ensemble; black body radiation; matter at high density and pressure; fluctuations and noise; phase transitions; negative temperatures.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: Continuous Assessment = 20%, 2 Hour Examination = 80%

PH3014 Transferable Skills for Physicists

Credits: 15 Semester: Whole Year

Prerequisite: Entry to the School's Honours programme, or shadowing same.

Description: 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.

Class Hour: To be arranged.

Teaching: Occasional lectures or tutorials or workshops.

Assessment: Continuous Assessment on basis of exercises = 100%

PH3061 Quantum Mechanics 1

Credits: 10 Semester: 1

Description: 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 barriers; the linear harmonic oscillator. Solution of the Schrödinger equation for central forces, the radial Schrödinger equation, and the hydrogen atom.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: Continuous Assessment = 20%, 2 Hour Examination = 80%

PH3062 Quantum Mechanics 2

Credits: 10 Semester 2

Prerequisite: PH3061

Description: This module explores more of the main features of quantum mechanics, taking for granted a knowledge of the material in PH3061. The syllabus includes a treatment of perturbation theory, and time dependence of the wave function including transitions between stationary states. Students are introduced to the quantum mechanics of a system of particles, which leads on to the distinction between fermions and bosons and applications to atoms, metals and neutron stars.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: Continuous Assessment = 20%, 2 Hour Examination = 80%

PH3066 Mathematics for Physicists

Credits: 10 Semester: 1

Description: 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. 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 gamma function, 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.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: Continuous Assessment = 20%, 2 Hour Examination = 80%

PH3073 Lagrangian and Hamiltonian Dynamics

Credits: 10 Semester: 2

Prerequisite: PH2011, MT2001 and a knowledge of vector calculus.

Anti-requisite: MT4507

Description: 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 planetary motion, particle scattering, oscillators, and chaos.

Class Hour: To be arranged.

Teaching: Two lectures and some tutorials.

Assessment: Continuous Assessment = 25%, 2 Hour Examination = 75%

PH3074 Electronics

Credits: 15 Semester: 1

Description: This module gives a basic grounding in practical electronics. It introduces and develops the basic principles underlying the synthesis and analysis of digital and analogue circuits. The module is divided into three parts: an introductory section which reviews those parts of electromagnetism most related to electronics, including d.c. and a.c. circuit theory; a section on transistors and amplifiers including simple transistor circuits and noise considerations; and a section on digital electronics including logic gates, flip-flops and the design of circuits with applications to counters, latches registers etc.

Class Hour: To be arranged.

Teaching: Three lectures and some tutorials and practical work.

Assessment: Continuous Assessment = 25%, 2 Hour Examination = 75%

PH3075 Applied Vector Calculus

Credits: 5 Semester: 1

Anti-requisite: MT2003

Description: This module gives a basic grounding in vector calculus for students who have not taken MT2003 or equivalent. It 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.

Class Hour: To be arranged.

Teaching: One lecture and some tutorials.

Assessment: Continuous Assessment = 100%

PH3101 Physics Laboratory 1

Credits: 15 Semester: 2

Anti-requisite: PH3110

Description: 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.

Class Hour: 2.00 - 5.30 pm Monday and 2.00 - 5.30 pm Thursday

Teaching: Two 3 hour laboratories.

Assessment: Continuous Assessment = 100%

PH4021 Physics of Atoms

Credits: 15 Semester: 1

Prerequisite: PH3061, PH3062.

Description: This module provides a rational basis to the identification of atomic energy states and the various interactions of electrons within atoms. It provides an understanding of aspects of laser physics, solid state and stellar physics. The syllabus includes: electron cloud model of an atom; electron spin; magnetic moments of electron behaviour; spin-orbit interactions and possible states of electron energy; one and two-electron systems; line intensities; Lande g-factors; weak Zeeman and strong Paschen-Back magnetic field effects; Stark electric field effects; hyperfine structure and Lamb shifts; magnetic resonance and esr in atomic beam experiments; molecular structure: electronic, vibrational and rotational effects.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH4022 Nuclear and Particle Physics

Credits: 10 Semester: 2

Prerequisites: PH2012, PH3061 and PH3062

Description: The 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 ß-decay, α-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.

Class Hour: To be arranged.

Teaching: Two lectures or tutorials.

Assessment: Continuous Assessment = 5%, 2 Hour Examination = 95%

PH4025 Physics of Electronic Devices

Credits: 15 Semester: 2

Prerequisites: PH3007, PH3012, PH3061

Description: The module describes the physical phenomena involved in the operation of semiconductor devices, and then shows how the phenomena determine the properties of specific devices such as the transistor. Although only a few devices are described, the student taking the module should acquire a sufficient background to understand a wide variety of modern semiconductor devices. The module covers: semiconductor properties: band gaps, optical and electrical properties; conduction in an electric field and by diffusion; factors determining the concentrations of electrons and holes; the continuity equation; properties of pn junctions and Schottky diodes; typical devices: bipolar transistor, field-effect transistor, MOSFET, light emitting diodes, semiconductor lasers.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH4026 Signals and Coherence

Credits: 15 Semester: 2

Availability: 2010-11

Description: 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 course concludes with a discussion of basic antenna principles, link gain, and applications to radar.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH4027 Optoelectronics and Nonlinear Optics 1

Credits: 15 Semester: 1

Prerequisites: PH3007

Description: 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.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH4028 Quantum Mechanics 3

Credits: 10 Semester 2

Prerequisites: PH3061, PH3062

Description: This module presents the main theoretical basis of quantum mechanics, starting with the representation of dynamical variables by operators. The Fourier transform of the wave function is shown to provide information on the momentum distribution. The importance of commutators is demonstrated, and the general uncertainty relation is derived. Other topics which are treated are the variational principle, matrix mechanics, operator methods for finding eigenvalues and eigenfunctions, spin angular momentum, and the total angular momentum for one electron atoms.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

PH4030 Computational Physics

Credits: 10 Semester: 2

Description: 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 will be the use of Mathematica for problem solving in physics. The module is continually assessed through short tests and assignments, with the bulk of the assessment based on the submission of a Mathematica project.

Class Hour: To be arranged.

Teaching: 2 two hour sessions.

Assessment: Continuous Assessment = 100%

PH4031 Fluids

Credits: 15 Semester: 1

Description: 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.

Class Hour: To be arranged.

Teaching: 3 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

PH4032 Relativity and Fields

Credits: 15 Semester: 1

Prerequisites: PH3073 or MT4507

Description: 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.

Class Hour: To be arranged.

Teaching: Three lectures and some tutorials.

Assessment: Continuous Assessment = 25%, 2 Hour Examination = 75%

PH4034 Laser Physics 1

Credits: 15 Semester: 1

Description: 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.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH4035 Principles of Optics

Credits: 15 Semester: 2

Description: 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.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: Continuous Assessment = 25%, 2 Hour Examination = 75%

PH4036 Physics of Music

Credits: 15 Semester: 1

Prerequisites: Admission to the Honours class in physics and astronomy and prior or concurrent attendance at PH3066

Description: 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. Analogue and digital recording and playback technology are other topics of interest which will be described.

Class Hour: To be arranged.

Teaching: Three lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

PH4105 Physics Laboratory 2

Credits: 15 Semester: 1

Anti-requisite: PH3110

Description: 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 topics such as solid state physics, optics, interfacing, and signal processing.

Class Hour: 2.00 - 5.30 pm Monday and 2.00 - 5.30 pm Thursday

Teaching: Two 3 hour laboratories.

Assessment: Continuous Assessment = 100%

PH4111 Project in Physics 1

Credits: 30 Semester: Whole Year

Prerequisites: At least one of PH3101, PH4105

Anti-requisites: AS4103, AS5101, PH5101, PH5102

Description: 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 review essay 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 around 29 of the 30 credits' worth of work is undertaken in semester two.

Assessment: Project and Oral Examination = 100%

PH4112 Physics Project

Credits: 120 Semester: Whole Year

Availability: Available to non-graduating students only

Description: This module is for non-graduating students who wish to pursue a project in physics lasting the whole session. The project is designed to develop students' skills in searching the literature, in the design of the investigation of the topic, in the evaluation and interpretation of data and in the presentation of results. There is no specific syllabus for this module, and students select their project topic in consultation with their supervisor.

Class Hour: No specific hours.

Teaching: Weekly meetings with supervisor.

Assessment: Continuous Assessment = 100%

PH4113 Physics Project

Credits: 60 Semester: Either

Description: This module is for non-graduating students who wish to pursue a project in physics lasting one semester. The project is designed to develop students' skills in searching the literature, in the design of the investigation of the topic, in the evaluation and interpretation of data and in the presentation of results. There is no specific syllabus for this module, and students select their project topic in consultation with their supervisor.

Class Hour: No specific hours.

Teaching: Weekly meetings with supervisor.

Assessment: Project and Oral Examination = 100%

PH5002 Foundations of Quantum Mechanics

Credits: 15 Semester: 1

Prerequisite: PH3061 and PH3062.

Description: This module consists of five parts: (i) Hilbert spaces and operators including a discussion of spectral decomposition of selfadjoint operators; (ii) postulates of quantum mechanics for observables with discrete spectra with illustrative examples including various pictures (Schrodinger, Heisenberg, interaction) of time evolution; (iii) postulates of quantum mechanics for observables with continuous spectra in terms of probability distribution functions and the spectral functions; (iv) quantum theory of orbital, spin angular momenta and their addition, Pauli-Schrodinger equation; (v) introduction to relativistic quantum mechanics.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH5003 Group Theory

Credits: 15 Semester: 1

Prerequisites: PH3061 and PH3062

Description: This module explores the concept of a group, including groups of coordinate transformations in three-dimensional Euclidean space; the invariance group of the Hamiltonian operator; the structure of groups: subgroups, classes, cosets, factor groups, isomorphisms and homorphisms, direct product groups; introduction to Lie groups, including notions of connectness, compactness, and invariant integration; representation theory of groups, including similarity transformations, unitary representations, irreducible representations, characters, direct product representations, and the Wigner-Eckart theorem; applications to quantum mechanics, including calculation of energy eigenvalues and selection rules.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH5004 Quantum Field Theory

Credits: 15 Semester: 2

Prerequisites: PH3061, PH3062 and PH3073 or MT4507

Co-requisite: PH5002 is recommended but not compulsory.

Description: 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, the failure of single particle interpretation of relativistic quantum mechanics, solving simple models using second quantization, Feynman's 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, and a descriptive introduction to Green's functions and Feynman diagrams.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH5005 Laser Physics 2

Credits: 15 Semester: 1

Prerequisites: PH3007, PH3061, PH3062, PH4034

Anti-requisite: PH5018

Description: Quantitative treatment of laser physics embracing both classical and semiclassical approaches; transient/dynamic behaviour of laser oscillators including relaxation oscillations, amplitude and phase modulation, frequency switching, Q-switching, cavity dumping and mode locking; design analysis of optically-pumped solid state lasers; laser amplifiers including continuous-wave, pulsed and regenerative amplification; dispersion and gain in a laser oscillator - role of the macroscopic polarisation; unstable optical resonators, geometric and diffraction treatments; quantum mechanical description of the gain medium; coherent processes including Rabi oscillations; semiclassical treatment of the laser; tunable lasers.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH5011 General Relativity

Credits: 15 Semester: 1

Description: 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.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH5012 Quantum Optics

Credits: 15 Semester: 2

Prerequisite: PH3061, PH3062

Description: 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.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH5013 Superconductivity

Credits: 15 Semester: 1

Availability: not available 2010-11

Prerequisites: PH3002, PH3061, PH3062

Description: This module will involve a treatment of one of the outstanding on-going problems in modern physics. The basic thermodynamics of the superconducting state will be reviewed, emphasising superconductivity as an archetypal second order phase transition. The next section will cover Ginzburg-Landau theory and the different phenomenological properties of type-I and type-II superconductors. An explanation will be given of the famous Bardeen-Cooper-Schrieffer theory of conventional superconductivity. Finally, a brief overview will be given of the many unsolved problems in modern unconventional superconductivity in materials as diverse as oxides, 'heavy fermion' alloys and allotropes of carbon. A few topics will be the subject of individual study by the student and will be examined continuously.

Class Hour: To be arranged.

Teaching: Two lectures and some tutorials.

Assessment: Continuous Assessment = 25%, 2 Hour Examination = 75%

PH5014 The Interacting Electron Problem in Solids

Credits: 15 Semester: 1

Availability: Not available 2010-11

Prerequisites: PH3002, PH3061, PH3062

Description: The aim of this module is to give an overview of developments in modern condensed matter physics. The difficulties of a full quantum mechanical treatment of electrons with strong interactions will be discussed. Common existing approaches such as the Hubbard and t-J models and Fermi liquid theory will be compared. It will be shown that, although microscopic models can explain aspects of magnetism, they have little chance of capturing many other features of the fascinating low-energy physics of these systems. Instead, we introduce the principle of emergence, and show how it suggests radically new approaches to the problem of complexity in condensed matter physics and beyond. In this module, formal lectures will be combined with reading assignments, and the assessment will be based on marked homework together with an oral presentation followed by questions.

Class Hour: To be arranged.

Teaching: Two lectures and some tutorials.

Assessment: Continuous Assessment = 50%, Presentation plus Oral Examination = 50%

PH5015 Experimental Quantum Physics at the Limit

Credits: 15 Semester: 1

Prerequisites: PH3061, PH3062

Description: 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 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 one workshop and a short presentation on a research paper.

Class Hour: To be arranged.

Teaching: Two lectures and some tutorials.

Assessment: Continuous Assessment = 25%, 2 Hour Examination = 75%

PH5016 Biophotonics

Credits: 15 Semester: 1

Prerequisites: PH4035 or PH4034

Description: 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, 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 specific literature reviews, design exercises and mini-projects. A visit to a biomedical research laboratory, e.g. at Ninewells hospital, will also be arranged.

Class Hour: To be arranged.

Teaching: Two lectures and some tutorials.

Assessment: Continuous Assessment = 25%, 2 Hour Examination = 75%

PH5018 Laser Physics 2 Extended

Credits: 20 Semester: 1

Prerequisites: PH3007, PH4034

Anti-requisite: PH5005

Description: This module consists of the material in PH5005 with the addition of a project involving directed reading on a related advanced topic.

Class Hour: To be arranged.

Teaching: Three lectures and some tutorials.

Assessment: Continuous Assessment = 25%, 2 Hour Examination = 75%

PH5020 Photonics Applications - Extended

Credits: 20 Semester: 1

Prerequisites: Admission to the MEng year of the Microelectronics and Photonics Programme

Antirequisites: PH5183

Description: This module consists of two main sections. The first looks at the role of photonics in medicine and biology. The second section looks at nanostructured materials such as photonic crystals and plasmonic metamaterials. The properties of these nanostructured materials are determined from their dispersion diagram or optical bandstructure. Also covered are the physics of multilayer mirrors, interference effects being used to provide more complex features such as slow light propagation and high Q cavities in photonic crystal waveguides, supercontinuum generation in photonic crystal fibres, super-lensing and optical cloaking in plasmonic metamaterials. Students spend some time researching and preparing material on selected aspects from these topics.

Class Hour: To be arranged.

Teaching: Three lectures and some tutorials.

Assessment: Continuous Assessment = 20%, 2 Hour Examination = 80%

PH5021 Organic Electronics and Applications

Credits: 20 Semester: 1

Prerequisites: PH3007, PH3061, PH3002, and success in the application to join the associated international summer school

Description: Organic semiconductors combine optoelectronic function with the simple processing of plastics. This module provides an introduction to the rapidly advancing science and technology of organic electronics. The topics covered in the module include:

1) The photophysics and electronic properties of organic semiconductors.

2) Manufacturing and processing methods of organic semiconductors.

3) The physics of organic electronic devices (organic transistors, organic lasers, organic light emitting diodes, solar cells, hybrid systems).

4) Applications of Organic Electronics in optoelectronics and sensing.

The module is based on an Erasmus Intensive Programme summer school.

Class Hour: To be arranged.

Teaching: 2 weeks intensive pre session course,, followed by tutorial work in the School

Assessment: Continuous Assessment = 100%

PH5022 Organic Semiconductors and Liquid Crystal Displays

Credits: 10 Semester: 1

Prerequisites: CH3712, PH3002, admission to the MSci year in the Materials Science programme

Anti-requisite: PH4027

Description: This module describes the materials science and device physics that underpins modern display technologies. The module is delivered in a distance learning format. The syllabus includes a basic introduction to vector calculus for materials science and an overview of types of displays and characterisation of display properties. The module then focuses on two contemporary display technologies: liquid crystals and organic semiconductors. Topics covered include: semiconducting polymers; photoluminescence and electroluminescence; organic light-emitting diodes; liquid crystals phases; director, order-parameter and distortions; anisotropy and birefringence; operation of twisted nematic displays.

Class Hour: To be arranged.

Teaching: fortnightly tutorials

Assessment: One-and-a-half Hour Examination = 100%

PH5101 Project in Physics 2

Credits: 60 Semester: Whole Year

Prerequisite: PH3101

Anti-requisites: AS4103, AS5101, PH4111, PH5102

Description: 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 review essay on a topic which is normally related to the theme of the project. There is no specific syllabus for this module. Students taking the M.Phys. 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 around 59 of the 60 credits' worth of work is undertaken in semester two.

Assessment: Continuous Assessment = 100%

PH5102 Project in Theoretical Physics

Credits: 45 Semester: Whole Year

Anti-requisites: AS4103, AS5101, PH4111, PH5101

Description: The project aims to survey the literature associated with the topic of the project and either (i) conduct original research into some problem in this field or (ii) prepare a research review of the field. In each case a written report is submitted in the range 5,000 to 10,000 words. There is no specific syllabus for this module. Students taking the M.Phys. 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 around 44 of the 45 credits' worth of work is undertaken in semester two.

Assessment: Continuous Assessment = 100%

PH5183 Photonics Applications

Credits: 15 Semester: 1

Description: Students on this module choose to do two of the following three sections:

Microphotonics and Plasmonics: This covers the Bragg effect, multilayer mirrors, defects causing confined cavity states, periodicity leading to bandstructure, scaling of bandstructure in reduced frequency, Bloch modes and photonic bandgap. It then considers photonic crystal waveguides, photonic crystal fibres, and supercontinuum generation in photonic crystal fibres. Plasmonics is based on oscillations of the free electronics in a metallic material. Resonances of Plasmons are the basis for a new class of materials called 'Metamaterials'. These are compared with photonic crystals. Applications include super-resolution imaging, optical cloaking, sensing, and surface enhanced Raman scattering.

Biophotonics: This will introduce 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, lab-on-a-chip concepts and bio-MEMS.

Optical Trapping and Atom Optics: Quantum physics is one of the most powerful theories in physics yet is at odds with our understanding of reality. In this course 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 material includes optical cooling and trapping of atoms and ions, Fermi gases, studies of Bose-Einstein condensation, and matter-wave interferometry.

Students must not cover Biophotonics in both this module and PH5016, and must not cover Optical Trapping and Atom Optics in both this module and PH5015.

Class Hour: To be arranged.

Teaching: Three lectures and occasional tutorials.

Assessment: Continuous Assessment = 15%, Two Hour Examination = 85%