School of Physics & Astronomy

Head of School

Professor A Miller

Degree Programmes

Single Honours Degrees:	Astrophysics (BSc & MPhys) Physics (BSc & MPhys) Physics with Photonics (MPhys) Theoretical Physics (MPhys)
Joint Honours Degrees (BSc):	Physics and Chemistry, Computer Science, Logic & Philosophy of Science, Mathematics.
Joint Honours Degree (MPhys):	Theoretical Physics and Mathematics
Major Degree Programme (BSc)	Physics with French[W], Physics with Management

Students enrolled in Honours Programmes prior to 2001 should see the 2000-01 Course Catalogue for details of Prerequisites and Programmes.

[W]available also as 'with Integrated Year Abroad Degree'

Programme Prerequisites - BSc and MPhys

BSc Physics (all degrees)

11 or better in PH2011 and PH2012, and in MT2101 or (MT2001 and MT2003)

BSc Astrophysics

11 or better in AS2001*, PH2011, PH2012, and in MT2101 or (MT2001 and MT2003).

MPhys Astrophysics

15 or better in AS2001*, PH2011 and PH2012, and 11 or better in MT2101 or (MT2001 and MT2003)

MPhys Physics, Physics with Photonics,

15 or better in PH2011 and PH2012, and 11 or better in MT2101 or (MT2001 and MT2003)

MPhys Theoretical Physics

15 or better in PH2011 and PH2012, and in MT2101 or (MT2001 and MT2003)

MPhys Theoretical Physics and Mathematics

15 or better in PH2011 and PH2012, and 17 or better in MT2101 or (MT2001 and MT2003)

*not applicable for those who enter at second level

Programme Requirements

The following refer only to students who enter third level in September 2001 or earlier.

Astrophysics (BSc)

AS3001 – AS3004, AS3006, AS3101 – AS3103, PH3001, PH3007, PH3014, and a further 60 credits from PH3001 – PH3103.

Physics (BSc)

Single Honours degree: PH3001, PH3002, PH3007, PH3008, PH3012, PH3014, PH3026, and a further 135 credits from PH3001 - PH3103 and AS3001 - AS3103, subject to the conditions that (a) at least 15 credits must be selected from PH3101, PH3102, AS3101 and AS3102, and (b) one of PH3103 and AS3103 must be included.

Joint Honours degrees: PH3001, PH3007 and a further 90 credits from PH3001 - PH3102 and AS3001 - AS3006.

Physics with Management (BSc)

PH3001, PH3002, PH3007, PH3008, PH3012, PH3026, and between 60 and 90 further credits from PH3001 - PH3103 and AS3001 - AS3103, subject to the conditions that (a) at least 15 credits must be selected from PH3101, PH3102, AS3101 and AS3102, and (b) one of PH3103 and AS3103 must be included.

Astrophysics (MSci)

AS3001 - AS3004, AS3006, AS3101, AS3102, AS4001, AS4002, AS4101, PH3001, PH3007, PH3014, PH4009 and at least a further 60 credits from PH3001 - PH4099.

Physics (MSci)

PH3001, PH3002, PH3007, PH3008, PH3012, PH3014, PH3026, PH3101, PH3102, PH4009, PH4101 and at least a further 105 credits from PH3003 - PH4099 and AS3001 - AS4002 including at least 30 credits at 4000 level.

Physics with Photonics (MSci)

PH3001 - PH3002, PH3005, PH3007, PH3008, PH3010, PH3012, PH3014, PH3026, PH3050, PH3101 - PH3102, PH4005, PH4008, PH4009, PH4101 and at least a further 30 credits from PH3003 - PH4099 and AS3001 - AS4002.

Theoretical Physics (MSci)

PH3001 - PH3002, PH3007 - PH3009, PH3012 - PH3014, PH3026, MT3501, PH4002 - PH4003, PH4102, and a further 90 credits from PH3001 - PH4099 and AS3001 - AS4002 including at least 30 credits at 4000 level and including at least 15 credits from PH4004, PH4010 - PH4012.

Theoretical Physics and Mathematics (MSci)

PH3001, PH3007, PH3009, PH3012, PH4002 - PH4003, PH4102 or MT4998, and a further 45 credits from PH3001 - PH4099 and AS3001 - AS4002 including at least 30 credits from PH3026, PH3033, PH4004 and PH4010.

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

The following apply to all students entering third level from September 2002 onwards:

Astrophysics (BSc)

240 credits including AS3011 – AS3013, AS3103, PH3014, PH3061 – PH3062, PH3064 – PH3067 and at least two modules from (AS3014 – AS3019 and PH3072).

Physics (BSc)

Single Honours degree: 240 credits including PH3002, PH3008, PH3014, PH3061, PH3062, PH3064 – PH3067, PH3101 – PH3103.

Joint Honours degree: 120 credits selected from AS3011 – AS3999 or PH3001 – PH3999 including PH3061, PH3062, PH3064 – PH3067.

Major degree: at least 150 credits selected from AS3011 – AS3999 or PH3001 – PH3999 including PH3002, PH3008, PH3061, PH3062, PH3064 – PH3067, PH3103, and at least one of PH3101, PH3102.

Astrophysics (MPhys)

360 credits including AS3011 – AS3019, AS4001, AS4002, AS4004, AS4101, PH3014, PH3061, PH3062, PH3064 – PH3067, and PH3072.

Physics (MPhys)

360 credits including PH3002, PH3004, PH3008, PH3014, PH3026, PH3061 – PH3067, PH3069, PH3101, PH3102, PH4101 and at least 45 other credits at 4000 level.

Physics with Photonics (MPhys)

360 credits including PH3002, PH3004, PH3005, PH3008, PH3010, PH3014, PH3050, PH3061 – PH3067, PH3069, PH3101, PH3102, PH4005, PH4008, PH4101 and at least 15 other credits at 4000 level.

Theoretical Physics (MPhys)

360 credits including MT3501, PH3002, PH3008, PH3014, PH3026, PH3061 – PH3071, PH4002, PH4003, PH4102 and at least 15 other credits chosen from PH4010 – PH4012, and at least 15 other credits at 4000 level.

Theoretical Physics and Mathematics (MPhys)

360 credits including PH3061 – PH3065, PH3067, PH3068, PH4002, PH4003, PH4102 or MT4998, and at least 30 other credits chosen from PH4010 – PH4012.

Astrophysics (MSci) (only for students entering third level in September 2002)

300 credits including AS3011 – AS3019, AS4001, AS4002, AS4101, PH3014, PH3061, PH3062, PH3064 – PH3067, and PH3072.

Physics (MSci) (only for students entering third level in September 2002)

300 credits including PH3002, PH3004, PH3008, PH3014, PH3026, PH3061 – PH3067, PH3069, PH3101, PH3102, PH4101 and at least 45 other credits at 4000 level.

Physics with Photonics (MSci) (only for students entering third level in September 2002)

300 credits including PH3002, PH3004, PH3005, PH3008, PH3010, PH3014, PH3050, PH3061 – PH3067, PH3069, PH3101, PH3102, PH4005, PH4008, PH4101 and at least 15 other credits at 4000 level.

Theoretical Physics (MSci) (only for students entering third level in September 2002)

300 credits including MT3501, PH3002, PH3008, PH3014, PH3026, PH3061 – PH3071, PH4002, PH4003, PH4102 and at least 15 other credits chosen from PH4010 – PH4012, and at least 15 other credits at 4000 level.

Theoretical Physics and Mathematics (MSci) (only for students entering third level in September 2002)

300 credits including PH3061 – PH3065, PH3067, PH3068, PH4002, PH4003, PH4102 or MT4998, and at least 30 other credits chosen from PH4010 – PH4012.

Modules

AS1001 Astronomy and Astrophysics 1

Credits: 20.0 Semester: 1

Prerequisites: Higher Physics or A-level Physics or Higher Mathematics or A-level Mathematics.

Anti-requisite: AS1002

Description: This module surveys our present state of knowledge of the orbits, surfaces and atmospheres of the planets in our solar system; the structure and evolution of the Sun and other stars, including extra-solar planetary systems; the bizarre menagerie of star-forming regions, violent stellar objects and supermassive black holes found within our own Milky Way Galaxy and in other galaxies; and the large-scale structure and ultimate fate of the expanding Universe. Throughout the module, fundamental observations are interpreted using simple but powerful geometric methods to show how distances and other properties of astronomical objects throughout the Universe have been measured, from the time of Copernicus to the era of the Hubble Telescope and beyond.

Class Hour: 11.00 am

Teaching: Four lectures, one tutorial and one laboratory.

Assessment: Laboratory work = 25%, Continuous Assessment = 15%, 2 Hour Examination = 60%

Re-Assessment: Laboratory work = 25%, 2 Hour Examination = 75%

AS1002 The Physical Universe

Credits: 20.0 Semester: 2

Anti-requisites: AS1001 or PH1011 or PH1012

Description: This module presents a descriptive, non-mathematical account of the physical universe. It is divided into two components: concepts in astronomy, dealing with our understandings of the properties and ages of planets, stars, galaxies, and their distributions in space, cosmology and the origin of the Universe; and concepts in physics, dealing with our understandings of the nature of light and matter, the structure of atoms, fundamental particles and their links to cosmology.

Class Hour: 5.00 pm

Teaching: Three lectures, one tutorial/seminar.

Assessment: Continuous Assessment = 50%, 2 Hour Examination = 50%

Re-Assessment: 2 Hour Examination = 100%

PH1011 Physics 1A

Credits: 20.0 Semester: 1

Prerequisite(s): Higher or A-level Physics and Higher or A-level Mathematics.

Anti-requisite: AS1002

Description: This module covers the core subjects of mechanics, waves and optics, and also provides an introduction to lasers and optoelectronics. It is suitable for those who have studied physics to the level of Higher Physics or equivalent. It includes lectures on the dynamics of particles, gravitation, simple harmonic motion, the different types of wave motion, geometrical and wave optics, the principles of lasers, and some aspects of optical communication.

Class Hour: 12.00 noon

Teaching: Four lectures, one workshop, one tutorial and one laboratory.

Assessment: Continuous Assessment = 40%, 2 Hour Examination = 60%

Re-Assessment: Continuous Assessment = 40%, 2 Hour Examination = 60%

PH1012 Physics 1B

Credits: 20.0 Semester: 2

Prerequisite(s): Higher or A-level Physics and Higher or A-level Mathematics.

Anti-requisite: AS1002

Description: This module covers the core subjects of electricity and magnetism, quantum phenomena, and the properties of matter. It is suitable for those who have studied physics to the level of Higher Physics or equivalent. It includes lectures on electrostatics, the electric field and potential, capacitors, d.c. currents, and magnetostatics; the origins of quantum theory and its application to atoms and other small scale systems; the nature and composition of nuclei, atoms, molecules and solids; and some aspects of thermal physics and kinetic theory.

Class Hour: 12.00 noon

Teaching: Four lectures, one workshop, one tutorial and one laboratory.

Assessment: Continuous Assessment = 40%, 2 Hour Examination = 60%

Re-Assessment: Continuous Assessment = 40%, 2 Hour Examination = 60%

AS2001 Astronomy and Astrophysics 2

Credits: 30.0 Semester: 1

Prerequisites: PH1001, PH1002, MT1001 (or Higher Mathematics grade A together with CSYS Mathematics Paper 1 grade B, or A-level Mathematics grade C), MT1002 and AS1001.

Description: This module comprises four lecture courses which extend knowledge gained in the first level module AS1001, and discuss recent developments in the subject: (i) observational techniques - modern telescopes, instruments and detectors for gamma-, X-, uv, optical, IR and radio radiation; spherical astronomy and essential coordinate systems; (ii) the structure and evolution of stars - nucleosynthesis, stellar properties as a function of age, a complete understanding of the HR diagram; (iii) the chemical evolution of the Universe - abundances from the Big Bang to the present; (iv) galactic astronomy - the distribution and motion of stars, gas, dust, and dark matter in our Milky Way and other galaxies.

Class Hour: 11.00 am

Teaching: Four lectures, one tutorial and one laboratory.

Assessment: Laboratory work = 25%, Continuous Assessment = 15%, 3 Hour Examination = 60%

Re-Assessment: Laboratory work = 25%, 3 Hour Examination = 75%

PH2011 Physics 2A

Credits: 30.0 Semester: 1

Prerequisite(s): PH1011, PH1012 and MT1002; alternatively passes in Advanced Higher Physics and Mathematics or in A-level Physics and Mathematics, both normally at grade B or better.

Description: This module covers the subjects of mechanics and relativity, oscillations and waves, and photonics. It is suitable for those who have taken the specified first year modules in physics and mathematics, or have good Advanced Higher or A-level passes or equivalent in physics and mathematics. It includes lectures on the dynamics of particles and rigid bodies, gravitation, Einstein's special theory of relativity, free, forced and damped harmonic motion, waves on strings, acoustics, polarisation of light, interference, diffraction and holography.

Class Hour: 10.00 am

Teaching: Four or five lectures, one workshop, one tutorial and one laboratory.

Assessment: Continuous Assessment = 40%, 3 Hour Examination = 60%

Re-Assessment: Continuous Assessment = 40%, 3 Hour Examination = 60%

PH2012 Physics 2B

Credits: 30.0 Semester: 2

Prerequisite(s): PH1011, PH1012 and MT1002; alternatively passes in Advanced Higher Physics and Mathematics or in A-level Physics and Mathematics, both normally at grade B or better.

Description: This module covers the subjects of quantum physics, electronics, and atoms, molecules and solids. It is suitable for those who have taken the specified first year modules in physics and mathematics, or have good Advanced Higher or A-level passes or equivalent in physics and mathematics. It includes lectures on the origin of Schrödinger's equation in quantum mechanics and its solution for simple one-dimensional potentials; the application of quantum mechanics to atomic and molecular systems and to condensed matter; and an introduction to circuit analysis, AC theory and analogue electronics.

Class Hour: 10.00 am

Teaching: Four or five lectures, one workshop, one tutorial and one laboratory.

Assessment: Continuous Assessment = 40%, 3 Hour Examination = 60%

Re-Assessment: Continuous Assessment = 40%, 3 Hour Examination = 60%

The prerequisite for each of the following Honours modules is entry to the Honours Programme(s) for which they are specified, save where a specific prerequisite is given.

AS3001 Modern Optical Instrumentation

Credits: 15.0 Semester: 2

Availability: 2001-02 only

Antirequisite: PH3010

Description: The course shows how a basic knowledge of physics, particularly optics, can be applied to our understanding of several important areas of modern optical instrumentation. Topics include: imaging systems at the diffraction limit; the plane diffraction grating: optical properties, manufacture and use in spectrographs; the photomultiplier detector and its use for photon counting; the CCD detector: construction, properties and operation as a low-light level detector; proximity image intensifiers; micro-channel plates and their incorporation into image intensifiers; active and adaptive optics; fibre-optic feeds; the Fabry-Perot interferometer: theory, use for laboratory spectroscopy and its use in astronomy; the determination of mirror optical figures.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

AS3002 Astrophysical Processes

Credits: 15.0 Semester: 2

Availability: 2001-02 only

Prerequisite: AS2001

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 emerging 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-ionized nebulae, interstellar shocks, nova and supernova shells, accretion disks, quasar absorption line clouds, radio synchrotron jets, radio pulsars, and X-ray plasmas.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

AS3003 Stellar Physics

Credits: 15.0 Semester: 1

Prerequisite: AS3002

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 optical spectrum. Computer-aided tutorial exercises illustrate the computational schemes that represent one of the triumphs of late 20th-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: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

AS3004 Stellar Dynamics

Credits: 15.0 Semester: 2

Prerequisite: AS2001

Description: The syllabus for this module includes: brief review of two-body motion; application to binary systems of stars observed with various techniques (velocities, pulsar-timing); extension to n-body systems of point-masses and use of virial theorem; gravitational potentials resulting from non-spherical masses, with application to tidal phenomena on the Earth and on stars, and resulting from distribution of point-masses over large distances, with application to the observed structure of galaxies; numerical methods for calculating orbits. The statistical treatment of large numbers of self-gravitating masses; the collisionless Boltzmann equation and its application to determining the masses of galaxies and clusters of galaxies; the ‘dark matter’ problem.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

AS3006 Galaxies and Observational Cosmology

Credits: 15.0 Semester: 1

Prerequisite: AS2001

Availability: 2001-02 only

Description: This module provides a general overview of the properties of galaxies and shows the empirical evidence that leads to the conclusion that our Universe is expanding. How measurements are made of distances, the local rate of expansion and the local mass density are explained. The standard Big Bang model is then developed starting from Olber's Paradox ("Why is the sky dark at night?") and showing how the rate of expansion is dependent on the amount of matter, radiation and vacuum energy within the Universe. This includes due consideration of expanding curved geometries (or spacetime) and a discussion of the success and problems with the current model. The module culminates in an estimation of the current age of our Universe and its ultimate fate based on the latest observational evidence.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

AS3011 Galaxies

Credits: 10.0 Semester: 2

Availability: 2002-03

Prerequisite: AS2001

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: 10.0 Semester: 2

Availability: 2002-03

Prerequisite: AS2001

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: 10.0 Semester: 2

Availability: 2002-03

Prerequisite: AS2001

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%

AS3014 Observational Astrophysics

Credits: 15.0 Semester: 1

Availability: 2003-04

Prerequisite: AS2001

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, computer programming and modelling, and report writing.

Class Hour: To be arranged.

Teaching: Two 3 hour laboratories.

Assessment: Continuous Assessment = 100%

AS3015 Nebulae

Credits: 15.0 Semester: 1

Availability: 2003-04

Prerequisite: AS2001

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%

AS3016 Gravitational Dynamics

Credits: 10.0 Semester: 2

Availability: 2003-04

Prerequisite: AS2001

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 course 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%

AS3017 Observational Cosmology

Credits: 10.0 Semester: 2

Availability: 2003-04

Prerequisite: AS2001

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 75 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%

AS3018 Stars

Credits: 15.0 Semester: 2

Availability: 2003-04

Prerequisite: AS2001

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%

AS3019 Binary Stars and Accretion Discs

Credits: 10.0 Semester: 2

Availability: 2003-04

Prerequisite: AS2001

Description: Since binary stars are as common or more common than single stars in the universe, it is appropriate that there should be a whole module devoted to their study. This module discusses: two-body orbital motion, methods for determining orbits from velocities, pulse-timing, and spatially-resolved systems, analyses of light curves, and the resultant masses, radii, and luminosities of stars of all types found in binaries – from pre-main-sequence stars to neutron stars and black holes. The module also presents accounts of theoretical models and observations on the processes of mass exchange and mass loss in binaries including accretion discs, streams, and outflows.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

AS3101 Astrophysics Laboratory 1

Credits: 15.0 Semester: 1

Prerequisite: AS2001

Description: The aim of the module is to familiarise students with a wide range of problems and techniques in astronomy and astrophysics, while allowing them to pursue individual interests. Students gain experience in the application of many transferable skills including: observation, measurement; data analysis; computer programming and modelling; and report writing. Students are required to tackle four units of practical work, each lasting about twelve hours, covering principles of astronomical observation, astrometry, photometry, stellar spectroscopy and theoretical astrophysics.

Class Hour: 2.00 - 5.00 pm Monday and 2.00 - 5.00 pm Thursday.

Teaching: Two laboratories.

Assessment: Continuous Assessment = 100%

AS3102 Astrophysics Laboratory 2

Credits: 15.0 Semester: 2

Prerequisite: AS2001

Description: The aim of the module is to familiarise students with a wide range of problems and techniques in astronomy and astrophysics, while allowing them to pursue individual interests. Students gain experience in the application of many transferable skills including: observation, measurement; data analysis; computer programming and modelling; and report writing. Students are required to tackle four units of practical work, each lasting about twelve hours, covering principles of astronomical observation, astrometry, photometry, stellar and theoretical astrophysics.

Class Hour: 2.00 - 5.00 pm Monday and 2.00 pm - 5.00 pm Thursday.

Teaching: Two laboratories.

Assessment: Continuous Assessment = 100%

AS3103 Project in Astrophysics 1

Credits: 30.0 Semester: Whole Year

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.

Assessment: Project and Oral Examination = 100%

PH3001 Quantum Mechanics 1

Credits: 15.0 Semester: 1

Availability: 2001-02 only

Description: This module discusses the main principles of quantum mechanics and some of its most important applications. The syllabus includes: early ideas on quantisation, and the emergence of the Schrodinger equation; the interpretation of the wave function; Heisenberg's uncertainty relations; simple one-dimensional problems including potential barriers and wells; the linear harmonic oscillator; representation of physical variables by operators, and the significance of their eigenvalues; the solution of the Schrodinger equation for central forces, Legendre polynomials and spherical harmonics; the radial Schrodinger equation; the hydrogen atom; approximate methods; the variational principle, and time-independent perturbation theory. Students are introduced to computer simulations of one-dimensional problems, and are required to carry out computer-based exercises and a small project.

Class Hour: 10.00 am, Monday, Tuesday and Thursday.

Teaching: Three lectures or tutorials or computer workshops.

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

PH3002 Solid State Physics 1

Credits: 15.0 Semester: 1

Description: This introductory course 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: 2 Hour Examination = 100%

PH3004 Digital & Analogue Circuits

Credits: 15.0 Semester: 1

Description: This course will introduce and develop the basic principles of the synthesis and analysis of digital and analogue circuits. It will advance students' knowledge of transistor circuits and introduce them to the structure and uses of microprocessors. It will cover: passive circuit elements, solution of circuits by differential equations and Laplace transforms; types of impulses, system functions and frequency responses; circuit synthesis; design of digital circuits - combinational, synchronous, asynchronous and pulse mode; internal structure of microprocessors, and memories and structure of microprocessor systems; unipolar and bipolar transistors, amplifiers and switches, types of amplifiers.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH3005 Laser Physics 1

Credits: 15.0 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. Ths 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%

PH3007 Electromagnetism

Credits: 15.0 Semester: 2

Availability: 2001-02 only

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: 2 Hour Examination = 100%

PH3008 Atomic Physics

Credits: 15.0 Semester: 2

Prerequisite: PH3001

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%

PH3009 Quantum Mechanics 2

Credits: 15.0 Semester: 2

Availability: 2001-02 only

Prerequisite: PH3001

Description: The aim is to extend the theory of quantum mechanics to include many-particle systems and time-dependent states with application to atomic physics. The syllabus includes: wave functions for many-particle systems, the Pauli principle and exchange interactions; the time evolution of a system, and transitions between quantum states; operator methods applied to the harmonic oscillator and angular momentum; application to atomic states, to include spin-orbit interactions, relativistic corrections and selection rules. The main features of the periodic table and the spectra of the alkali atoms will be explained in terms of the Hartree model.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials..

Assessment: 2 Hour Examination = 100%

PH3010 Modern Optics

Credits: 15.0 Semester: 2

Antirequisite: AS3001

Description: This course 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: 2 Hour Examination = 100%

PH3011 Information and Measurement

Credits: 15.0 Semester: 2

Availability: 2002-03

Description: The course explains what information is, how we process it, and how it is collected by making measurements. The first eight lectures concentrate on the basics of measurement, information theory, and processing systems. The rest of the course uses various examples to show how these basics are put into use. The CD system is used to illustrate information collection, processing, and communication in digital form. Data compression/reduction is illustrated with examples which include digital compact cassette. Other illustrations include the methods used by spies to encrypt messages and the applications of chaotic systems and signals.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH3012 Thermal and Statistical Physics

Credits: 15.0 Semester: 1

Availability: 2001-02 only

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: 2 Hour Examination = 100%

PH3013 Introduction to Theoretical Physics

Credits: 15.0 Semester: 1

Availability: 2001-02 only

Description: The first part of this module introduces techniques for solving problems in mechanics that go beyond simple methods employing Newton's laws. Two approaches are developed, both of which involve expressing the energy of the system in terms of its generalised coordinates together with its generalised velocities (the Lagrange method) or generalised momenta (the method of Hamilton). The second part deals with elementary tensor theory and its application to special relativity. The third part covers series solutions to differential equations of second order, with specific application to Hermite polynomials, Legendre polynomials and spherical harmonics. A few lectures on the Dirac delta function are also included.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH3014 Transferable Skills for Physicists

Credits: 15.0 Semester: Whole Year

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. Guidance, practice and assessment will be provided in the preparation and delivery of talks, critical reading of the literature, report and essay writing, programming to solve physical problems, 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: Three lectures or tutorials or workshops.

Assessment: Continous Assessment on basis of exercises = 100%

PH3026 Nuclear and Particle Physics

Credits: 15.0 Semester: 2

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: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH3027 Magnetism and Superconductivity

Credits: 15.0 Semester: 1

Prerequisites: PH3001, PH3002, PH3007

Description: The module presents a range of magnetic phenomena in solids, develops the theoretical models for them and explains how the chemical features and structure of real materials influence the magnetic properties. The syllabus includes: review of magnetic field vectors, magnetisation, shape effects; superconductivity, phase diagrams, thermodynamic and London models; coherence length, surface energies, type I and II materials; quantised flux and fluxoid lattice; bean model, BCS theory, macroscopic quantum effects, Josephson tunnelling; modern superconducting materials, Langevin diamagnetism, local moment paramagnetism; mean field models, exchange, direct and indirect, and RKKY interactions; magnetic order; delocalised model, Landau diamagnetism, Pauli paramagnetism, Stoner model, spin waves; materials - rare earth, transition elements, alloys and compounds; domains; examples of current problems in magnetism.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH3039 Computational Physics

Credits: 15.0 Semester: 2

Description: The aim of this module is to introduce students to the use of the computer as an analytical tool in physics and astronomy. The module comprises: (i) an introduction to programming in a high-level language including editing, structured programming and the essentials of the language required to program for scientific application; (ii) the application of Mathcad to problems involving matrices and tensors, differential equations, Fourier transforms and Monte Carlo methods; (iii) the application of computational methods to scientific problem solving.

Class Hour: To be arranged.

Teaching: Two lectures each week and two 1 hour laboratories.

Assessment: Continuous Assessment on basis of projects = 100%

PH3040 Physics of Electronic Devices

Credits: 15.0 Semester: 2

Description: The course 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 course should acquire a sufficient background to understand a wide variety of modern semiconductor devices. The course 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%

PH3041 Radio and Coherent Techniques

Credits: 15.0 Semester: 2

Availability: 2001-02

Description: The aim of this course is to explain the techniques used by radio, microwave and mm-wave engineers to communicate, and collect, information. It concentrates mainly upon radio techniques to explain how coherent electromagnetic signals can be employed to carry information. Practical examples are given to illustrate the way the basic concepts can be applied. These include an explanation of how FM stereo radio and colour TV work as examples of signal multiplexing. The course looks at microwave and millimetre-wave techniques and shows how electronics and optics can be mixed at higher signal frequencies. Using the examples of spy and other types of satellites, it also explains how radar and passive sensing systems can be used to gather information.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH3050 Optoelectronics and Nonlinear Optics 1

Credits: 15.0 Semester: 1

Prerequisite: PH3007

Description: The course 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; optical detectors-pn, pin, avalanche; 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%

PH3061 Quantum Mechanics 1

Credits: 10.0 Semester: 1

Availability: 2002-03

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. Students are introduced to computer simulations of one-dimensional problems and are required to carry out computer-based exercises.

Class Hour: To be arranged.

Teaching: 2 lectures, 2 PC classroom sessions and some tutorials.

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

PH3062 Quantum Mechanics 2

Credits: 10.0 Semester 2

Availability: 2002-03

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: 2 Hour Examination = 100%

PH3063 Quantum Mechanics 3

Credits: 10.0 Semester 2

Availability: 2003-04

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%

PH3064 Electromagnetism 1

Credits: 10.0 Semester: 1

Availability: 2002-03

Description: This module covers the main branches of electrostatics and magnetostatics, starting from the laws due to Coulomb and Biot-Savart. The electric scalar potential is introduced and its use in calculating fields is illustrated. The effects of dielectric and magnetic media are discussed, as is the origin of the displacement current. Maxwell's equations are derived in terms of the four fields E, D, B and H and the wave equation is deduced.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

PH3065 Electromagnetism 2

Credits: 10.0 Semester: 2

Availability: 2002-03

Prerequisite: PH3064

Description: This module extends the treatment of electromagnetism in PH3064. The magnetic vector potential is introduced and its use in magnetic field calculations illustrated. Poisson's equation and Laplace's equation are derived, and used to obtain solutions for the electrostatic potential. Starting from Maxwell's equations, electromagnetic waves are discussed in some depth, including their propagation in various media, their behaviour at boundaries, their interaction with matter, and their generation.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

PH3066 Mathematics for Physicists

Credits: 10.0 Semester: 1

Availability: 2002-03

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 using Mathcad. 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: 2 Hour Examination = 100%

PH3067 Thermal Physics

Credits: 15.0 Semester: 1

Availability: 2002-03

Description: This module gives a detailed account of thermodynamics and kinetic theory, and an introduction to statistical mechanics. The laws of thermodynamics are discussed including the concepts of work, internal energy, reversible and irreversible processes, entropy, Carnot engines and refrigerators, and a treatment of the thermodynamic potentials. In kinetic theory, the Maxwell velocity distribution is derived, followed by a discussion of mean free path and transport properties – diffusion, thermal conductivity and viscosity. In the final section students are introduced to the concepts of statistical mechanics including the microscopic basis for entropy, the partition function and its uses, and a brief introduction to Fermi and Bose distributions.

Class Hour: To be arranged.

Teaching: 3 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

PH3068 Statistical Mechanics

Credits: 10.0 Semester: 2

Availability: 2003-04

Prerequisite: PH3067

Description: Statistical mechanics provides techniques for determining macroscopic properties of systems of interacting quantum particles. The module covers: Ensembles and basic postulates. Derivation of thermodynamical properties from canonical ensemble; application to crystals and to ideal gases at high temperatures. The microcanonical ensemble. Interchangeability of ensembles. System of two state particles and negative temperatures. The grand canonical ensemble. Applications to ideal gases of fermions and bosons at arbitrary temperatures, to white dwarf and neutron stars, to electrons in metals, to liquid helium, to black body radiation and to crystals.

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: 2 hour Examination = 100%

PH3069 Computational Physics

Credits: 10.0 Semester: 2

Availability: 2003-04

Description: The module starts with five sessions in programming with Pascal (building on level 2 work) followed by eight sessions on numerical analysis using Pascal. This material is likely to include: numerical solution of nonlinear equations including graphical methods and Newton-Raphson method. Interpolation including Lagrange interpolation polynomial and Neville iterative interpolation. Curve fitting. Numerical integration including trapezoidal rule, Simpson's rule and Gauss' integration formula. Numerical solution of ODEs including Runge Kutta methods, with relevant exercises. There will be an emphasis on physical examples throughout. The module finishes with a small computational project. Assessment is done continuously via short tests, assignments and the project.

Class Hour: To be arranged.

Teaching: 2 one-and-a-half hour sessions.

Assessment: Continuous Assessment = 100%

PH3070 Classical Mechanics and Special Relativity

Credits: 10.0 Semester: 1

Availability: 2003-04

Description: This module explores the consequences of Einstein's postulates, starting from the Lorentz transformation equations. It covers the main kinematical topics (length contraction, time dilation, transformation equations for velocity, acceleration, frequency etc.) and then moves on to relativistic dynamics using the concept of four vectors. The second part of the module introduces techniques for solving problems in mechanics which go beyond simple methods employing Newton's laws. Two approaches are developed, which involve expressing the energy of the system in terms of its generalised co-ordinates together with its generalised velocities (the Lagrange method) or generalised momenta (Hamilton's method).

Class Hour: To be arranged.

Teaching: 2 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

PH3071 Complex Analysis

Credits: 15.0 Semester: 2

Availability: 2002-03

Description: This module aims to develop a knowledge of complex analysis for the purposes of students of theoretical physics. There is emphasis throughout on obtaining solutions to mathematical problems which arise in physics. Specific topics to be covered will be functions of a complex variable, complex integration, series expansions, singularities, analytic continuation, residue calculus, Fourier and Laplace transformations, principal value integrals, Hilbert transformations, and asymptotic methods. Applications will include two-dimensional problems in mechanics, the ideal fluid in two dimensions, acoustics of the drum, two-dimensional electrostatics, and the rainbow integral.

Class Hour: To be arranged.

Teaching: 3 lectures and some tutorials.

Assessment: 2 Hour Examination = 100%

PH3072 Fluids

Credits: 15.0 Semester: 1

Availability: 2003-04

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%

PH3101 Physics Laboratory 1

Credits: 15.0 Semester: 1

Description: 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 four sub-modules on solid state physics, lasers, interfacing, and signal processing.

Class Hour: 2.00 - 5.00 pm Monday and 2.00 - 5.00 pm Thursday

Teaching: Two 3 hour laboratories.

Assessment: Continuous Assessment = 100%

PH3102 Physics Laboratory 2

Credits: 15.0 Semester: 2

Description: 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. Students select

four sub-modules from a list comprising solid state physics, optics and spectroscopy, circuits and circuit simulations, microprocessors, lasers and vacuum techniques.

Class Hour: 2.00 - 5.00 pm Monday and 2.00 - 5.00 pm Thursday

Teaching: Two 3 hour laboratories.

Assessment: Continuous Assessment = 100%

PH3103 Project in Physics 1

Credits: 30.0 Semester: Whole Year

Prerequisites: At least one of PH3101, PH3102

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 may be related to the theme of the project or may be unrelated to it. 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.

Assessment: Project and Oral Examination = 100%

The Prerequisite for each of the following 4000 modules is entry to the MSci or MPhys Programme(s) for which they are specified, save where an additional prerequisite is given

AS4001 Astronomical Data Analysis

Credits: 15.0 Semester: 1

Prerequisite: AS2001

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%

AS4002 Star Formation and Plasma Astrophysics

Credits: 15.0 Semester: 2

Prerequisite: AS2001

Description: The aim is to describe the physics of how a magnetic field interacts with a plasma, and to use this knowledge to explore the role of magnetic fields in the formation of solar-like stars and in compact objects with accretion discs. 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%

AS4004 Contemporary Astrophysics

Credits: 15.0 Semester: 2

Availability: 2004-05

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%

AS4101 Project in Astrophysics 2

Credits: 45.0 Semester: Whole Year

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 MSci degree select a project from a list of those which are available, and are supervised by a member of the academic staff.

Assessment: Project and Oral Examinations = 100%

PH4001 Solid State Physics 2

Credits: 15.0 Semester: 1

Prerequisites: PH3001 and PH3002

Description: The aim of this module is to develop an understanding of band-structure in crystalline solids, Fermi surfaces in reciprocal space and the Boltzmann transport equation. It examines: reciprocal space concepts reviewed and extended; tight-binding theory for simple cubic structure; Kronig-Penney model; fermi surfaces in real structures; measurement techniques; Landau levels, Shubnikov-de Haas and de Haas-van Alphen experiments; Boltzmann transport of charge and thermal energy.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH4002 Foundations of Quantum Mechanics

Credits: 15.0 Semester: 1

Prerequisite: PH3009

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%

PH4003 Group Theory

Credits: 15.0 Semester: 1

Prerequisite: PH3001

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%

PH4004 Quantum Field Theory

Credits: 15.0 Semester: 2

Availability: 2002-03

Prerequisite: PH4002

Description: The syllabus for this module includes: second quantization for bosons and fermions; annihilation and creation operators; introduction to classical field theory, including the notion of Lagrangian and Hamiltonian densities; the real and complex Klein-Gordon fields for spin zero particles; the Dirac field for spin 1/2 particles; quantization of the electromagnetic field; perturbation expansion for the S matrix; Wick's theorem; origin and use of Feynman rules; outline of idea of renormalization; application to quantum electrodynamics.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.Assessment: 2 Hour Examination = 100%

PH4005 Laser Physics 2

Credits: 15.0 Semester: 2

Prerequisites: PH3001, PH3005 and PH3007

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%

PH4007 Structures and Dynamics of Solids

Credits: 15.0 Semester: 2

Availability: 2002-03

Prerequisite: PH3002

Description: The aim is to develop an understanding of how and why condensed matter scientists attempt to determine the relative positions and motions of atoms in solids. The course will largely focus on neutron techniques, but the relevance of other scattering methods will also be discussed. The syllabus comprises: Introduction to the properties of the neutron and its interaction with matter. Neutron production and instrumentation. Determination of atomic and magnetic structures using neutron diffraction. Diffuse scattering studies of disordered materials, liquids and amorphous solids. The study of large scale macromolecular and biological structures, and of phase transitions, using small angle scattering. Isotopic techniques and contrast matching. Coherent and incoherent excitations in solids, and quasi-elastic scattering studies of tunnelling phenomena. The characterisation of surfaces using reflectometry. Polarised neutron methods.

Class hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH4008 Optoelectronics and Nonlinear Optics 2

Credits: 15.0 Semester: 2

Prerequisite: PH3050

Description: This module develops concepts introduced in PH3050 to a level at which the student should be able to understand state-of-the-art systems in these fields and to appreciate the research literature. In particular, the ideas of nonlinear optics are developed more quantitatively and in greater depth, and the course shows how such properties can be the basis of important devices. The field of optical communication is covered, include the modes of propagation in waveguides and the use of nonlinear effects in optical waveguides. Optoelectronic devices such as SEED are described, including their roles in optical switching.

Class hour: To be arranged.

Teaching: Three lectures or tutorials.Assessment: 2 Hour examination = 100%

PH4009 Advanced Mathematical Techniques in Physics

Credits: 15.0 Semester: 1

Description: The module aims to develop the more sophisticated mathematical techniques that form an appropriate part of the education of a professional physicist or astronomer. Starting from examples selected from various areas of physics, the module will develop enhanced mathematical tools for the efficient solution of problems in these areas. Analytic mathematical skills will be complemented by the development of computer-based solutions. The emphasis throughout will be on obtaining solutions to problems in physics and its applications. Specific topics to be covered will include tensor analysis, numerical analysis, probability theory and statistics, Fourier and Laplace transforms, operator techniques, selected functions and their properties, constrained optimisation, and nonlinear systems.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH4010 Particle Symmetries

Credits: 15.0 Semester: 2

Prerequisites: PH3026, PH4003

Description: Group theoretical methods have been extremely successful in making predictions and bringing an ordered understanding to fundamental particles. This module in intended to treat two major developments, the su(3)

theory of hadrons, including the development of the concept of quarks, and the concept of spontaneous symmetry breaking in both global and local gauge theories, leading to the unified gauge theory of weak and electromagnetic interactions and to quantum chromodynamics. Topics include: The concept of a Lie algebra, and its connection with the idea of a Lie group. Basic general properties of Lie algebras. The theory and classification of semi-simple Lie algebras. The su(3) theory of hadrons. Appearance of Goldstone bosons in spontaneous symmetry breaking of global models. Abelian and non-Abelian gauge theories. Higgs bosons. Unified gauge theory of weak and electromagnetic interactions. Quantum chromodynamics.

Class Hour: To be arranged.

Teaching: Three lectures or tutorials.

Assessment: 2 Hour Examination = 100%

PH4011 General Relativity

Credits: 15.0 Semester: 2

Description: This module examines: 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%

PH4012 Quantum Optics

Credits: 15.0 Semester: 2

Prerequisite: PH3001

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%

PH4101 Project in Physics 2

Credits: 45.0 Semester: Whole Year

Prerequisite: PH3101

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 may be related to the theme of the project or may be unrelated to it.There is no specific syllabus for this module. Students taking the MSci degree select a project from a list offered, and are supervised by a member of staff.

Assessment: Project and Oral Examination = 100%

PH4102 Project in Theoretical Physics 2

Credits: 30.0 Semester: Whole Year

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 MSci degree select a project from a list of those which are available, and are supervised by a member of the academic staff.

Assessment: Project and Oral Examination = 100%