School of Physics & Astronomy

Head of School

Professor S L Lee

Degree Programmes

Postgraduate Diploma:	Photonics and Optoelectronic Devices Physics
M.Sc.:	Photonics and Optoelectronic Devices Physics
Erasmus Mundus – MSc.:	Photonics and Optoelectronic Devices
Eng.D.:	Photonics

Programme Requirements

Photonics and Optoelectronic Devices M.Sc. and Postgraduate Diploma

www.st-andrews.ac.uk/physics/msc

The primary aim of this one-year, full-time course is to provide specialist postgraduate training in modern optics and semiconductor physics, tailored to the needs of the Photonics industrial sector. The secondary aim is to provide the education required for those wishing to continue in academia on Ph.D. research projects in photonics.

Graduates from the course will have gained an in-depth understanding of the fundamental properties of optoelectronic materials and practical experience of the technology and operation of a wide range of laser and semiconductor devices. They will additionally have had experience of research, usually in an industrial environment, and have received training in the transferable skills required in such an environment.

The course is organised jointly by the School of Physics & Astronomy at the University of St Andrews and the School of Engineering and Physical Sciences at Heriot-Watt University. Each organisation will act in turn as host for the course. In 2007-08 the course will be hosted by Heriot-Watt, and in 2008-09 by St Andrews. Regardless of which institution hosts the course, the first semester is spent at St Andrews, and the second semester at Heriot-Watt. For the M.Sc. degree a project is undertaken during the summer months, usually in industry, and is assessed in September.

The course is approved by the Engineering and Physical Sciences Research Council (E.P.S.R.C.) and a number of studentships (tuition fees and stipend) are available from an E.P.S.R.C. grant held by the course.

Postgraduate Diploma:	PH5171 – PH5176
M.Sc.:	PH5171 – PH5177 (www.st-andrews.ac.uk/physics/msc)

[The above modules are correct for when the students are hosted at St Andrews. When they are hosted at Heriot-Watt then the same material is covered, and the same module names are used, but Heriot-Watt module numbers are used.]

Photonics Eng.D.

www.photonics-engd.hw.ac.uk/

The Eng.D. degree in Photonics is a 4-year course involving a blend of specialist postgraduate training in all aspects of photonics, tailored to the needs of the photonics industrial sector, and a significant, challenging and original research project undertaken as a partnership between industry and academia. Each research project provides experience in project management (including financial management) and teamwork as well as the opportunity to gain greater understanding of photonics and the business context in which the research is conducted. A significant proportion of the student's time (typically around 70%) is spent within the sponsoring company.

Graduates from the course will have gained an in-depth understanding of the fundamental properties of photonic materials and practical experience of the technology and operation of a wide range of photonic devices. They will additionally have had extensive experience of research in an industrial environment and have received training in the transferable skills required in such an environment.

The course is organised jointly by the School of Physics and Astronomy of the University of St Andrews, the School of Engineering and Physical Sciences at Heriot-Watt University, and the Department of Electronics and Electrical Engineering at the University of Strathclyde. St Andrews will normally be the location for the start of the course and will provide full time teaching during the first semester of the first year of the course. When this initial semester is completed students move to their industrial location and begin their research. They also take during the next five semesters the balance of the taught component of the Eng.D. either by distance learning or via short courses offered by Heriot-Watt and St Andrews.

The course is approved by the Engineering and Physical Sciences Research Council (E.P.S.R.C.) and a number of EPSRC-funded studentships are available.

Eng.D. PH5201, PH5202, PH5204-PH5208, PF5262 together with modules taught by Heriot Watt University and the University of Strathclyde

[NOTE PH5206, PH5207, PH5255, and PH5262 are optional for this programme]

Physics Postgraduate Diploma and M.Sc.

Postgraduate Diploma: A total of 120 credits from AS and PH modules at 4000 level and above, including at least 90 credits at 5000 level, the course of study to be approved by the Head of School.

M.Sc.: 120 credits as for Postgraduate Diploma together with a dissertation (PH5301) comprising 3 months full-time study and worth 60 credits.

Erasmus Mundus MSc in Photonics and Optoelectronic Devices

http://www. master-photonics.org

This two year programme extends the existing twelve-month M.Sc. in Photonics and Optoelectronic Devices by incorporating an additional year at one of the Erasmus Mundus partner institutions (University of Ghent, Vrije Universitaet Brussels or KTH Stockholm). This increases student exposure to the latest research and methods in Photonics/Optoelectronic Devices. Students may commence their course either at University of St Andrews/Heriot-Watt University or at one of the partner institutions. EU funding is available for a number of suitably qualified students from outside the EU.

Students who spend their first year of study in Scotland spend first semester in St Andrews and the second semester at Heriot-Watt University, Edinburgh. After a short workshop in the summer time, and a summer vacation, students will spend their next year studying outside Scotland at one of the partner universities listed above. Students who spend their first year of study outside Scotland on this programme may spend the second year in Scotland. The first half of the first semester is spent on mostly advanced courses at Heriot-Watt University, and the second half of the semester at St Andrews on mostly advanced courses. The second semester is spent undertaking a major research project, which is normally with one of the photonics research teams at either St Andrews or Heriot-Watt Universities.

Erasmus Mundus M.Sc., for those studying in St Andrews in the first semester of their programme: PH5251, PH5252, PH5253, PH5255, PH5256, PH5257, PH5259, PH5258, PN5207

Erasmus Mundus M.Sc., for those studying in St Andrews in the second year of their programme: PH5257PH5260, and at least 14 credits chosen from PH5253, PH5255, PH5262, PH5259. For those undertaking their project in St Andrews, also PH5261.

Modules

AS5001 Astronomical Data Analysis

Credits: 15.0 Semester: 1

Availability: 2008-09

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%

AS5002 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%

AS5003 Contemporary Astrophysics

Credits: 15.0 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%

PH5002 Foundations of Quantum Mechanics

Credits: 15.0 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: 15.0 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: 15.0 Semester: 1

Prerequisite: PH3073 or MT4507, and PH5002

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: 15.0 Semester: 1

Prerequisites: PH4034, PH3061, PH3062, PH3007

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%

PH5008 Optoelectronics and Nonlinear Optics 2

Credits: 15.0 Semester: 2

Availability: 2007-08

Prerequisite: PH4027

Anti-requisite: PH5019

Description: This module develops concepts introduced in PH4027 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 module 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%

PH5011 General Relativity

Credits: 15.0 Semester: 2

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: 15.0 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: 15.0 Semester: 2

Availability: 2007-08

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: 15.0 Semester: 2

Availability: 2007-08

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: 15.0 Semester: 1

Availability: 2007-08

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: 15.0 Semester: 1

Availability: 2007-08

Prerequisites: PH4034 or PH4035

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: 20.0 Semester: 1

Availability: 2007-08

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%

PH5019 Optoelectronics and Nonlinear Optics 2 - Extended

Credits: 20.0 Semester: 2

Availability: 2007-08

Prerequisite: PH4027

Anti-requisite: PH5008

Description: This module consists of the material of PH5008 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%

PH5171 Lasers

Credits: 20.0 Semester: Whole Year

Programme(s): Compulsory module for Photonics and Optoelectronic Devices Postgraduate Taught Programme.

Description: This module presents a description of the main physical concepts upon which an understanding of laser materials, operations, and applications can be based. These concepts include a semi-classical treatment of light-matter interaction, gain, absorption and refractive index, rate-equation theory of lasers, gain and its saturation, frequency selection and tuning in lasers, transient phenomena, resonator and beam optics, and the principles and techniques of ultrashort pulse generation and measurement.

Class Hour: To be arranged.

Teaching: Three lectures each week and occasional tutorials.

Assessment: Examinations totalling 3 hours, spread over 2 semesters = 100%

PH5172 Modern Optics

Credits: 20.0 Semester: Whole Year

Programme(s): Compulsory module for Photonics and Optoelectronic Devices Postgraduate Taught Programme.

Description: The nonlinear optics section of this module describes the physical ideas and application of second and third order nonlinear optics, including phenomena such as harmonic generation, parametric gain, saturated absorption, nonlinear refraction, Raman scattering, and optical solitons. The modulator section looks at the electro-optic and acousto-optic effects and their use in optical modulators. The section on Fourier Optics and Optical Design includes diffraction theory, Fourier transforms in optics, spatial filtering, holographic techniques and modern optical design. The Biophotonics section discusses the physical principals and uses of lasers and optics in modern medicine and biology.

Class Hour: To be arranged.

Teaching: Three lectures each week and occasional tutorials.

Assessment: Examinations totalling 3 hours, spread over 2 semesters = 100%

PH5173 Photonic Materials

Credits: 10.0 Semester: Whole Year

Programme(s): Compulsory module for Photonics and Optoelectronic Devices Postgraduate Taught Programme.

Description: The physics of semiconductors is covered, including areas of particular importance in optoelectronics such as band theory, optical and electronic properties, mobility and diffusion, and low dimensional structures. The physics of polymers and liquid crystals is covered, showing the way to the use of semi-conducting polymers as light emitters, and the use of liquid crystals in displays and spatial light modulators. The section on materials growth and fabrication aims to give an overview of the science and technology involved in the growth of materials relevant in the photonics field.

Class Hour: To be arranged.

Teaching: Two lectures each week and occasional tutorials.

Assessment: Examinations totaling 2 hours, spread over 2 semesters = 100%

PH5174 Optoelectronic Devices

Credits: 20.0 Semester: Whole Year

Programme(s): Compulsory module for Photonics and Optoelectronic Devices Postgraduate Taught Programme.

Description: The main core of this module consists of sections on semiconductor devices and on telecommunications and optical fibres. Building on ideas developed in the module on Photonic materials, devices such as LEDs, VCSELs, optical amplifiers, and all-optical switches are examined in detail. The physics underpinning the design of optical fibre links is covered, including the physics of waveguiding, optical sources, amplifiers, detectors, coding schemes, and fibre sensors. The physics of photonic crystals is covered, along with comments on their potential uses in telecommunicatios and other applications. Optical instrumentation and Sensors are also covered.

Class Hour: To be arranged.

Teaching: Three lectures each week and occasional tutorials.

Assessment: Examinations totaling 3 hours, spread over 2 semesters = 100%

PH5175 Technical Communication and Business Awareness

Credits: 20.0 Semester: Whole Year

Programme(s): Compulsory module for Photonics and Optoelectronic Devices Postgraduate Taught Programme.

Description: This module addresses issues of the application of science in the photonics industry; many transferable skills should be developed. A series of lectures will be given by industrial scientists in different topic areas. A section on innovation and team work will look at how ideas are born, nurtured, and engineered into a final product. Business awareness will include material on intellectual property rights, business formation, and leadership skills. This module also includes a literature review related to the topic of the industrial project. Students also practise their communication skills by presenting work on paper and orally to members of the industrial advisory committee, staff and fellow students.

Class Hour: To be arranged.

Teaching: Lectures, workshops and guided study.

Assessment: Continuous Assessment = 100%

PH5176 Laboratory

Credits: 30.0 Semester: Whole Year

Programme(s): Compulsory module for Photonics and Optoelectronic Devices Postgraduate Taught Programme.

Description: The teaching laboratory allows students to explore concepts in photonics in a practical setting. It also develops skills in instrumentation, experimental design, and problem solving. Many of the experiments are "open-ended", which encourages further independent thinking. Experiments include diode pumped lasers, resonator design, optical parametric oscillator, modulators, spectroscopy, mobility measurements, optical communications and optical amplifiers.

Class Hour: To be arranged.

Teaching: Three 3-and-a-half-hour sessions per week.

Assessment: Continuous Assessment = 100%

PH5177 Research project

Credits: 60.0 Semester: Summer

Programme(s): Compulsory module for Photonics and Optoelectronic Devices Postgraduate Taught Programme.

Description: All M.Sc. students carry out a 3-month research project, in most cases carried out at a U.K. company. Part-time students who are industry employees may carry out the project at their own company. Students will have completed a literature survey prior to the project, and write a dissertation on the project which is assessed in September.

Class Hour: Placement

Assessment: Dissertation, Continuous Assessment & Oral Examination= 100%

PH5201 Lasers

Credits: 20.0 Semester: 1

Programme(s): Compulsory module for Engineering Doctorate in Photonics Postgraduate Taught Programme.

Description: This module presents a description of the main physical concepts upon which an understanding of laser materials, operations, and applications can be based. These concepts include a semi-classical treatment of light-matter interaction, gain, absorption and refractive index, rate-equation theory of lasers, gain and its saturation, frequency selection and tuning in lasers, transient phenomena, and resonator and beam optics.

Class Hour: To be arranged.

Teaching: 5 one-hour lectures per week (50 lectures in total) plus some tutorials.

Assessment: Three Hour Examination = 100%

PH5202 Modern Optics

Credits: 15.0 Semester: 1

Programme(s): Compulsory module for Engineering Doctorate in Photonics Postgraduate Taught Programme.

Description: The nonlinear optics section of this module describes the physical ideas and application of second and third order nonlinear optics, including phenomena such as harmonic generation, parametric gain, saturated absorption, nonlinear refraction, Raman scattering, and optical solitons. The Biophotonics section discusses the physical principles and uses of lasers and optics in modern medicine and biology.

Class Hour: To be arranged.

Teaching: 3 one-hour lectures per week (27 lectures in total) plus some tutorials.

Assessment: Two Hour Examination = 100%

PH5204 Technical Communication and Optoelectronics in Industry

Credits: 15.0 Semester: 1

Programme(s): Compulsory module for Engineering Doctorate in Photonics Postgraduate Taught Programme.

Description: This module aims to develop students' skills in technical communication and their understanding of the place of photonics in industry. It does this by a combination of exercises involving literature surveys and report writing, including a dissertation on the topic of the student's research, and by a series of lectures given by speakers drawn from the photonics industrial sector.

Class Hour: To be arranged.

Teaching: Occasional two-hour lectures.

Assessment: Continuous Assessment = 100%

PH5205 Experimental Laboratory

Credits: 20.0 Semester: 1

Programme(s): Compulsory module for Engineering Doctorate in Photonics Postgraduate Taught Programme.

Description: The teaching laboratory allows students to explore concepts in photonics in a practical setting. It also develops skills in instrumentation, experimental design, and problem solving. Many of the experiments are "open-ended", which encourages further independent thinking. Experiments include diode pumped lasers, resonator design, optical parametric oscillator, modulators, spectroscopy, mobility measurements, optical communications and optical amplifiers.

Class Hour: To be arranged.

Teaching: Three 3.5 hour sessions per week.

Assessment: Continuous Assessment = 100%

PH5206 Innovation and Teamwork

Credits: 5.0 Semester: 1

Programme(s): Optional module for Engineering Doctorate in Photonics Postgraduate Taught Programme.

Description: This module provides an introduction to project management and teamwork, and aims to foster a greater understanding of the business context in which photonics research is conducted. It involves lectures, "practical" sessions, and team-work sessions in which a product is taken from inception to sales and servicing.

Class Hour: To be arranged.

Teaching: 2 weeks intensive course comprising 8 lectures and 12 hours of workshops.

Assessment: Continuous Assessment = 100%

PH5207 Polymers and Liquid Crystals for Displays

Credits: 5.0 Semester: 1

Programme(s): Optional module for Engineering Doctorate in Photonics Postgraduate Taught Programme.

Description: This short module introduces concepts of optoelectronic display devices, including semiconducting polymers, and the properties of liquid crystals.

Class Hour: To be arranged.

Teaching: 10 one-hour lectures in total and some tutorials

Assessment: One Hour Examination = 100%

PH5208 Semiconductor Physics and Devices

Credits: 10.0 Semester: 1

Programme(s): Compulsory module for Engineering Doctorate in Photonics Postgraduate Taught Programme.

Graduate level module available on-line

Description: This is a distance learning module covering the basic properties of semiconductor physics including their optical and electronic properties, and the low dimensional structures which may be constructed from them; and semiconductor devices ranging from pn junctions, solar cells, and LEDs to lasers, waveguides, optical amplifiers, optical modulators, and detectors.

Teaching: Material, tutorial support, and continuous assessment delivered at a distance by means of WebCT . Students are responsible for ensuring they have internet access. The course covers material equivalent to that covered in 30 conventional lectures.

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

PH5209 Polymers and Liquid Crystals for Displays – Distance Learning

Credits: 5.0 Semester: 1

Availability: not available 2007-08

Programme(s): Optional module for Engineering Doctorate in Photonics Postgraduate Taught Programme.

Graduate level module available on-line

Description: This is a distance learning module covering the concepts of optoelectronic display devices, including semiconducting polymers, and the properties of liquid crystals.

Teaching: Material, tutorial support, and continuous assessment delivered at a distance by means of WebCT . Students are responsible for ensuring they have internet access. The course covers material equivalent to that covered in 12 conventional lectures.

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

PH5251 Core Laser Physics

Credits: 4 ECTS Semester: 1

Programme(s): Compulsory module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Description: This module provides a broad coverage of the operating principles of lasers, starting from population inversion followed by relevant gain-threshold and gain-saturation dynamics with reference to homogenous and inhomogeneous spectral broadening in the laser media. Examples of distinctive laser types in which particular characteristics of solid-state, liquid and gaseous media are exploited. Physical descriptions of resonator stability and transverse modes, longitudinal resonator modes with spectral narrowing and tuning, and for the temporal domain techniques that include Q-switching, cavity dumping and mode locking. Practical implementations of lasers are mentioned throughout to illustrate the suitability of these coherent light sources to a range of applications.

Teaching: 3 lectures per week.

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

PH5252 Advanced Laser Physics

Credits: 4 ECTS Semester: 1

Prerequisite: PH5251

Programme(s): Compulsory module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Description: This module introduces the student to the classical and semiclassical treatments of laser physics, treating the electromagnetic radiation and the active medium of the lawer classically and quantum mechanically. Alternatively a simple rate equation model may be adopted. A number of these variations are explored with regard to their applicability and limitations.

Teaching: 3 lectures per week.

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

PH5253 Nonlinear Optics and Modulators

Credits: 3 ECTS Semester: 1

Programme(s): Compulsory module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Description: This module examines a range of topics: phenomenological theory of nonlinearities; optics of anisotropic media; harmonic generation, mixing and parametric effects; Two-photon absorption, saturated absorption and nonlinear refraction; Rayleigh, Brillouin and Raman scattering; self-focusing and self-phase-modulation; self-induced transparency; solitons; optical switching; electro-optic effect and acounsto-optic effects; electro-optic and acousto-optic modulators.

Teaching: 3 lectures per week for 5 weeks.

Assessment: One Hour Examination= 100%

PH5255 Photonic Crystals

Credits: 2 ECTS Semester: 1

Programme(s): Compulsory module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Description: This module examines a further range of topics. Interface reflectivity leading to Fresnel reflection and Bragg effect. Multilayer mirrors. Defects causing confined cavity states. Cavities in one or two dimensions. Periodicity leading to bandstructure. Scaling of bandstructure in reduced frequency. Bloch modes and photonic bandgap. Photonic crystal waveguides, their dispersion and group velocity. Guiding mechanism in photonic crystal fibres and their dispersive properties. Supercontinuum generation in photonic crystal fibres.

Teaching: 2 lectures per week for 5 weeks.

Assessment: One Hour Examination = 100%

PH5256 Core Photonics Laboratory

Credits: 3 ECTS Semester: 1

Programme(s): Compulsory module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Description: Handling and aligning of optical elements; laser and pulsed laser operation; interferometry; polarization; optical diffraction and spatial filtering; building simple optoelectronic circuits.

Teaching: 2 three-and-a-half hour practical classes per week for 6 weeks.

Assessment: Continuous Assessment = 100%

PH5257 Advanced Photonics Laboratory

Credits: 4 ECTS Semester: 1

Programme(s): Compulsory module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Description: In this module, students will perform a series of experiments independently, each typically lasting 3 - 5 laboratory afternoons. About 30 experiments are available to study various types of optical materials, lasers and light sources, interferometers, as well as solar cells, optical tweezers and Bragg mirrors.

Teaching: 3 three-and-a-half hour practical classes per week for 5 weeks.

Assessment: Continuous Assessment = 100%

PH5258 Photonics in Biomedicine

Credits: 5 ECTS Semester: 1

Programme(s): Compulsory module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Description: In this module students will get an overview of Microscopy and relevance for biological inspection. Optical scattering and absorption. Basics of Cell Biology, structure and function and cells. Proteins and their use in assays. The nature of antibodies/antigens and their mutual binding mechanism. Flurescent labels, fluorescence microscopy and related techniques used in biomedical detection, including time-resolved methods. DNA, structure, use in assays, DNA microarrays. Operational principle of optical tweezers. Cell and DNA manipulation. Lab on a chip. Photodynamic therapy. Different signatures of cancer and other abnormalities.

Teaching: 2 -3 lectures per week, and occasional seminars and tutorials.

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

PH5259 Business Awareness

Credits: 2 ECTS Semester: 1

Programme(s): Compulsory module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Description: This module involves lectures and workshop sessions to introduce students to the skills of team working within the context of innovating in a photonics business. It is held in a concentrated block immediately before students finish the first semester at St Andrews. Lectures include material on invention in a commercial setting, driving forces, challenging linear thought, the inventive step, engineering and rethinking, intellectual property rights and patents, and following through with the product. There are assignments associated with this course.

Teaching: 15 lectures and 15 practical classes over 2 weeks.

Assessment: Continuous Assessment = 100%

PH5260 Project Preparation

Credits: 4 ECTS Semester: 1

Availability: 2007-08

Programme(s): Compulsory module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Description: This module is conducted in self-study and supported by informal tutorial sessions to guide students through the assignment. It consists of conducting a literature search of the field of study related to the project. Students establish the State-of-the-Art in the field and put their own project into context. They critically assess the relevant literature, write a report and give a presentation outlining their project strategy. Furthermore, they study the requirements for conducting their project and develop a plan of experiments.

Teaching: 3 tutorials over 6 weeks.

Assessment: Continuous Assessment = 100%

PH5261 Research Project

Credits: 30 ECTS Semester: 2

Availability: 2007-08

Programme(s): Compulsory module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Description: This module comprises a 5 month long research project that is conducted in self-study and supported by a project supervisor (to be determined). It comprises the analysis of a problem provided by the supervisor and builds on the preparation conducted in the first semester (PH5260). The student will conduct a series of experiments to develop and test possible solutions to the problem provided. The methods employed and solutions developed during the project will be described in a report and the findings be presented as an oral presentation at the summer school.

Teaching: 5 month long project.

Assessment: Continuous Assessment = 100%

PH5262 Contemporary Photonics

Credits: 4 ECTS Semester: 1

Availability: 2007-08

Programme(s): **Compulsory** module in the Erasmus Mundus Master in Photonics and Optoelectronic Devices.

Optional module for EngD Photonics.

Description: This module covers one or more topics of current research interest in photonics. It is expected that the module will make substantial use of the SUPA training programme for PhD students. It is made available as an optional module primarily for Masters Mundus in Photonics students in their second year of study.

Teaching: One or two lectures and occasional tutorials over 3 weeks

Assessment: Continuous Assessment = 100%

PH5301 Dissertation for M.Sc. Programme

Credits: 60.0 Semester: Summer

Programme(s): Compulsory module for M.Sc. Physics Postgraduate Taught Programme.

Description: This dissertation will be supervised by a member of the teaching staff who will advise on the choice of subject and provide guidance during the work. The completed dissertation of not more than 15,000 words must be submitted by the end of August.

Teaching: Weekly meetings with supervisor

Assessment: Dissertation and Oral Examination = 100%