

School of Physics & Astronomy

Head of School Professor S Lee

Degree Programmes

Graduate Diploma: Photonics and Optoelectronic Devices

M.Sc.: Photonics and Optoelectronic Devices

Eng.D.: Photonics

Programme Requirements

Photonics and Optoelectronic Devices

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 and 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 and provide the first half of the teaching. In 2003-04 the course will be hosted by Heriot-Watt, and in 2004-05 by St Andrews. At the start of February each year students transfer to the other university to complete the taught part of the course. 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 E.P.S.R.C. Advanced Course Studentships are available.

Graduate Diploma: PH5171 – PH5176

M.Sc.: PH5171 – PH5177

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

Photonics

<http://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 students' 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.

Physics and Astronomy – 5000 Level Modules

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 and Heriot Watt will act in turn as the location for the start of the course and provide full time teaching during the first semester of the first year of the course. In 2003-04 the course will be hosted by Heriot-Watt, and in 2004-05 by St Andrews. 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 (EPSRC) and a number of EPSRC Advanced Course Studentships are available.

Eng.D. PH5201- PH5208 together with modules taught by Heriot Watt University and the University of Strathclyde (for students starting in 2004, 2006 ...)
[NOTE PH5203, PH5206 and PH5207 are optional for this course]

PH5208 together with modules taught by Heriot Watt University and the University of Strathclyde (for students starting in 2003, 2005)

Modules

PH5171 Lasers

Credits: 24.0 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: 24.0 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 Holography includes diffraction theory, Fourier transforms in optics, spatial filtering, and holographic techniques. The section on photonic guiding explains how micro-structuring of materials can lead to designer light guides and emitters.

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:	12.0	Semester:	Whole Year
Programme(s): Programme.	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 totalling 2 hours, spread over 2 semesters = 100%		

PH5174 Optoelectronic Devices

Credits:	24.0	Semester:	Whole Year
Programme(s): Programme.	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 optical sources, amplifiers, detectors, coding schemes, and fibre sensors. The final sections of the course may change from year to year, and may include lectures on two of: optical informatics, lasers in medicine, terahertz technology, optical instrumentation and sensors, and optical packaging.		
Class Hour:	To be arranged.		
Teaching:	Three lectures each week and occasional tutorials.		
Assessment:	Examinations totalling 3 hours, spread over 2 semesters = 100%		

PH5175 Technical Communication and Business Awareness

Credits:	24.0	Semester:	Whole Year
Programme(s): Programme.	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%		

Physics and Astronomy – 5000 Level Modules

PH5176 Laboratory

Credits:	36.0	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:	36.0	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 submitted in early September.		
Class Hour:	To be arranged.		
Assessment:	Dissertation, Continuous Assessment & Oral Examination= 100%		

PH5201 Lasers

Credits:	20.0	Semester:	1
Availability:	2004-05		
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
Availability:	2004-05		
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 modulator section looks at the electro-optic and acousto-optic effects and their use in optical modulators. The section on photonic guiding explains how micro-structuring of materials can lead to designer light guides and emitters.		
Class Hour:	To be arranged.		
Teaching:	3 one-hour lectures per week (27 lectures in total) plus some tutorials.		
Assessment:	Two Hour Examination = 100%		

Physics and Astronomy – 5000 Level Modules

PH5203 Terahertz Technology

Credits:	5.0	Semester:	1
Availability:	2004-05		
Programme(s):	Optional module for Engineering Doctorate in Photonics Postgraduate Taught Programme.		
Description:	This short course covers the principle of superheterodyne detection, terahertz heterodyne systems, antennas, and amplitude modulation and demodulation.		
Class Hour:	To be arranged.		
Teaching:	2 one-hour lectures per week (10 lectures in total) plus some tutorials.		
Assessment:	One Hour Examination = 100%		

PH5204 Technical Communication and Optoelectronics in Industry

Credits:	15.0	Semester:	1
Availability:	2004-05		
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
Availability:	2004-05		
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
Availability:	2004-05		
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%		

Physics and Astronomy – 5000 Level Modules

PH5207 Polymers and Liquid Crystals for Displays

Credits: 5.0 Semester: 1
Availability: 2004-05
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%