

## Masters in Photonics and Optoelectronic Devices

[www.st-andrews.ac.uk/physics/msc](http://www.st-andrews.ac.uk/physics/msc)

The primary aim of this twelve-month, full-time programme 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. There are strong links between our research activities and the teaching of this MSc .

Graduates from the programme 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 lead organisation for the course. In 2016/7 the course will be led by St Andrews, and in 2017/8 by Heriot-Watt. Regardless of which institution leads the course, the first semester is spent at St Andrews, and the second semester at Heriot-Watt. For the MSc degree a project is undertaken during the summer months, usually in industry, and is assessed in September.

Taught Element:

105 credits: PH5180 - PH5182, PH5184 - PH5187

15 credits: chosen from PH5015, PH5016

MSc:

105 credits: PH5180 - PH5182, PH5184 - PH5187

15 credits: chosen from PH5015, PH5016

60 credits: PH5177

([www.st-andrews.ac.uk/physics/msc](http://www.st-andrews.ac.uk/physics/msc))

[Note that PH5184 - PH5187 are carried out at Heriot-Watt University under their own module numbers.]

**Compulsory modules - Semester 1:**

PH5180 Laser Physics				
<b>SCOTCAT Credits:</b>	20	SCQF Level 11	<b>Semester:</b>	1
<b>Planned timetable:</b>	10.00 am Mon, Tue, Wed, Thu (TBC)			
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 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.				
<b>Programme module type:</b>	Compulsory for Photonics and Optoelectronic Devices Postgraduate Programmes. Optional for EngD Programme			
<b>Pre-requisite(s):</b>	Admission to a Taught Postgraduate programme within the School.			
<b>Learning and teaching methods and delivery:</b>	<b>Weekly contact:</b> 4 lectures/tutorials each week.			
<b>Assessment pattern:</b>	2.5-hour open-notes Examination = 80%, Coursework = 20%			
<b>Module Co-ordinator:</b>	Dr B D Sinclair			
<b>Lecturer(s)/Tutor(s):</b>	Dr B D Sinclair, Dr C T A Brown, Dr L O'Faholain (TBC)			

PH5181 Photonics Laboratory 1				
<b>SCOTCAT Credits:</b>	15	SCQF Level 11	<b>Semester:</b>	1
<b>Planned timetable:</b>	2.00 pm - 5.30 pm Mon, Tue and Thu			
The photonics teaching laboratory gives training in the experimental photonics, and allows students the opportunity to explore photonics practically in a series of chosen open-ended investigations. Students use their knowledge and skills from the lecture modules, supplemented by additional reading, to investigate relevant photonic effects. Phase I involves work in small groups in introductory areas, then phase II allows primarily individual investigation of topics such as the second harmonic generation, optical parametric oscillation, erbium amplifiers, Nd lasers, optical tweezers, spectroscopy, remote sensing of speed, Bragg reflectors, and holography. A formal lab report is included.				
<b>Programme module type:</b>	Compulsory for Photonics and Optoelectronic Devices MSc Programme and EngD Photonics Programme.			
<b>Pre-requisite(s):</b>	Admission to a Taught Postgraduate programme within the School.			
<b>Learning and teaching methods and delivery:</b>	<b>Weekly contact:</b> 3 x 2.5-hour practicals.			
<b>Assessment pattern:</b>	Coursework = 100%			
<b>Module Co-ordinator:</b>	Dr B D Sinclair			
<b>Lecturer(s)/Tutor(s):</b>	Dr B D Sinclair and others			

PH5182 Displays and Nonlinear Optics				
<b>SCOTCAT Credits:</b>	10	SCQF Level 11	<b>Semester:</b>	1
<b>Planned timetable:</b>	To be arranged.			
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 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 final section looks at second order nonlinear effects being exploited in optical parametric amplifiers and oscillators in the optical and THz regions.				
<b>Programme module type:</b>	Compulsory for Photonics and Optoelectronic Devices MSc Programme. Optional for EngD Photonics Programme			
<b>Pre-requisite(s):</b>	Admission to a Taught Postgraduate programme within the School.			
<b>Learning and teaching methods and delivery:</b>	<b>Weekly contact:</b> 2 lectures and occasional tutorials.			
<b>Assessment pattern:</b>	2-hour Written Examination = 80%, Coursework = 20%			
<b>Module Co-ordinator:</b>	Prof I D W Samuel (TBC)			
<b>Lecturer(s)/Tutor(s):</b>	Prof I D W Samuel, Prof M H Dunn, Dr M Mazilu, Dr C F Rae (TBC)			

### Compulsory modules - Semester 2:

PH5184 Photonics Experimental Laboratory 2 (B21HL)				
<b>SCOTCAT Credits:</b>	15	SCQF Level 11	<b>Semester:</b>	2
<b>Availability restrictions:</b>	Available only to students on the Photonics and Optoelectronics MSc programme			
<b>Planned timetable:</b>	To be arranged.			
This module is taught at Heriot-Watt University, and forms part of certain taught Master's degrees run collaboratively between St Andrews and Heriot-Watt Universities.				
<b>Programme module type:</b>	Compulsory for Photonics and Optoelectronic Devices MSc Programme.			
<b>Pre-requisite(s):</b>	Admission to the Photonics and Optoelectronics MSc.			
<b>Learning and teaching methods and delivery:</b>	<b>Weekly contact:</b> At Heriot-Watt University			
<b>Assessment pattern:</b>	Coursework = 100%			
<b>Module Co-ordinator:</b>	at Heriot-Watt University			

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PH5185 Semiconductor Optoelectronic Devices (B21OD)				
<b>SCOTCAT Credits:</b>	15	SCQF Level 11	<b>Semester:</b>	2
<b>Availability restrictions:</b>	Available only to students on the Photonics and Optoelectronics MSc programme			
<b>Planned timetable:</b>	To be arranged.			
This module is taught at Heriot-Watt University, and may form part of certain taught Master's degrees run collaboratively between St Andrews and Heriot-Watt Universities.				
<b>Programme module type:</b>	Compulsory for Photonics and Optoelectronic Devices MSc Programme.			
<b>Pre-requisite(s):</b>	Admission to the Photonics and Optoelectronics MSc.			
<b>Learning and teaching methods and delivery:</b>	<b>Weekly contact:</b> At Heriot-Watt University			
<b>Assessment pattern:</b>	3-hour Written Examination = 100%			
<b>Module Co-ordinator:</b>	at Heriot-Watt University			

PH5186 Modern Optics (B21FM)				
<b>SCOTCAT Credits:</b>	15	SCQF Level 11	<b>Semester:</b>	2
<b>Availability restrictions:</b>	Available only to students on the Photonics and Optoelectronics MSc programme			
<b>Planned timetable:</b>	To be arranged.			
This module is taught at Heriot-Watt University, and may form part of certain taught Master's degrees run collaboratively between St Andrews and Heriot-Watt Universities.				
<b>Programme module type:</b>	Compulsory for Photonics and Optoelectronic Devices MSc Programme.			
<b>Pre-requisite(s):</b>	Admission to the Photonics and Optoelectronics MSc.			
<b>Learning and teaching methods and delivery:</b>	<b>Weekly contact:</b> At Heriot-Watt University			
<b>Assessment pattern:</b>	3-hour Written Examination = 100%			
<b>Module Co-ordinator:</b>	at Heriot-Watt University			

PH5187 Fibre Optic Communications (B21FC)				
<b>SCOTCAT Credits:</b>	15	SCQF Level 11	<b>Semester:</b>	2
<b>Availability restrictions:</b>	Available only to students on the Photonics and Optoelectronics MSc programme			
<b>Planned timetable:</b>	To be arranged.			
This module is taught at Heriot-Watt University, and may form part of certain taught Master's degrees run collaboratively between St Andrews and Heriot-Watt Universities.				
<b>Programme module type:</b>	Compulsory for Photonics and Optoelectronic Devices MSc Programme.			
<b>Pre-requisite(s):</b>	Admission to the Photonics and Optoelectronics MSc.			
<b>Learning and teaching methods and delivery:</b>	<b>Weekly contact:</b> At Heriot-Watt University			
<b>Assessment pattern:</b>	3-hour Written Examination = 100%			
<b>Module Co-ordinator:</b>	at Heriot-Watt University			

## Compulsory module for MSc - Summer

PH5177 Research Project (POED MSc)				
<b>SCOTCAT Credits:</b>	60	SCQF Level 11	<b>Semester:</b>	Summer
<b>Availability restrictions:</b>	This project module is organised and assessed with Heriot Watt as the lead institution in 2015/6 and alternate years thereafter, St Andrews in 2016/17 and alternate years after that. It is available only to those in the Photonics and Optoelectronic Devices MSc programme.			
<b>Planned timetable:</b>	Placement, full time.			
All POED MSc 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.				
<b>Programme module type:</b>	Compulsory for Photonics and Optoelectronic Devices MSc Programme.			
<b>Pre-requisite(s):</b>	Satisfactory completion of the taught element of Photonics and Optoelectronic Devices MSc programme .			
<b>Learning and teaching methods and delivery:</b>	<b>Weekly contact:</b> About 40 hours a week working on the project, with appropriate levels of supervision			
<b>Assessment pattern:</b>	Dissertation and Oral Examination = 100%			
<b>Module Co-ordinator:</b>	Dr B D Sinclair			
<b>Lecturer(s)/Tutor(s):</b>	Dr B D Sinclair			

## Optional modules - Semester 1:

PH5015 Applications of Quantum Physics				
<b>SCOTCAT Credits:</b>	15	SCQF Level 11	<b>Semester:</b>	1
<b>Planned timetable:</b>	12.00 noon Mon, Tue, Thu (TBC)			
Quantum physics is one of the most powerful theories in physics yet is at odds with our understanding of reality. In this module we show how laboratories around the world can prepare single atomic particles, ensembles of atoms, light and solid state systems in appropriate quantum states and observe their behaviour. The module includes studies of laser cooling, Bose-Einstein condensation, quantum dots and quantum computing. An emphasis throughout will be on how such quantum systems may actually turn into practical devices in the future. The module will include assessment based on tutorial work and a short presentation on a research topic.				
<b>Programme module type:</b>	Optional for Postgraduate programmes in the School			
<b>Pre-requisite(s):</b>	Relevant physics and mathematics			
<b>Learning and teaching methods and delivery:</b>	<b>Weekly contact:</b> 3 lectures/tutorials, 1 x 3-hour research lab visit, 3 hours student presentations during the semester.			
<b>Assessment pattern:</b>	2-hour Written Examination = 80%, Coursework = 20%			
<b>Module Co-ordinator:</b>	Dr D Cassettari (TBC)			
<b>Lecturer(s)/Tutor(s):</b>	Dr D Cassettari, Dr M Mazilu (TBC)			

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PH5016 Biophotonics				
<b>SCOTCAT Credits:</b>	15	SCQF Level 11	<b>Semester:</b>	1
<b>Planned timetable:</b>	9.00 am Mon, Wed, Fri (TBC)			
<p>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 writing a specific news piece on a research paper, assessed tutorial sheets and a presentation. A visit to a biomedical research laboratory using various photonics methods will also be arranged.</p>				
<b>Programme module type:</b>	Optional for Postgraduate programmes in the School. Optional for EngD Photonics Programm			
<b>Pre-requisite(s):</b>	Relevant physics and mathematics			
<b>Learning and teaching methods and delivery:</b>	<b>Weekly contact:</b> 3 lectures/tutorials.			
<b>Assessment pattern:</b>	2-hour Written Examination = 80%, Coursework = 20%			
<b>Module Co-ordinator:</b>	Dr T Brown (TBC)			
<b>Lecturer(s)/Tutor(s):</b>	Dr T Brown, Prof M C Gather, Dr C Penedo-Esteiro (TBC)			