

School of Physics & Astronomy

Head of School

Professor A Miller

Degree Programmes

Graduate Diploma: Optoelectronic and Laser Devices (2000-2001 St Andrews)
(alternate years St Andrews and Heriot-Watt)

M.Sc.: Optoelectronic and Laser Devices (2000-2001 St Andrews)
(alternate years St Andrews and Heriot-Watt)

Programme Requirements

Optoelectronic and Laser Devices

This is a one-year, full-time M.Sc. course organised jointly by the School of Physics and Astronomy of the University of St Andrews and the Department of Physics at Heriot-Watt University. The course provides postgraduate vocational training in optical electronics, laser and semiconductor physics tailored to the needs of the optoelectronic industry. Graduates gain an understanding of the fundamental properties of optoelectronic materials and experience the technology and operation of a wide range of laser and semiconductor devices.

The joint involvement of the two universities makes available to students the combined expertise and diversity of research equipment of two large research groups. In addition, students spend three months undertaking an industrially related research project with an optoelectronics company or, in a minority of cases, in the university.

Each department in turn acts as host for the course: in 2000-2001 the course will be hosted at St Andrews. The course will once again be hosted by Heriot-Watt in 2001-02. Approximately three quarters of the course is given by the host department. The remaining quarter is given by the other department after Easter and students transfer to the other university.

When hosted by St Andrews in 2000-01, teaching will comprise six lecture modules plus another module representing laboratory work. The modules for 2000-01 are listed below. Each lecture module is assessed through a two-hour examination whereas the laboratory work is assessed in a continuous manner. An additional examination is taken at Heriot-Watt University. A dissertation on the industrial project is assessed in September at which time an oral examination is also usually required.

In 2001-02, the students will spend only the second half of the second semester at St Andrews, when the modules PH4953 and PH4954 will be taken, along with formal laboratory work.

The course is approved by the Engineering and Physical Sciences Research Council (EPSRC) and a number of EPSRC Advanced Course Studentships are available.

Extensive refurbishment of the laboratories took place in 1996-98, funded by a SHEFC Initiative. Many new experiments involving modern laser systems were added at both St Andrews and Heriot-Watt.

Graduate Diploma (2000-01): PH3005, PH3050, PH4005, PH4008, PH4900, PH4951 and PH4953. In addition, when Heriot-Watt is the host institution, PH4953 and PH4954 are taken at St Andrews in the second half of the second semester. When St Andrews is the host, PH4960, PH4961 are taken at Heriot-Watt in the second half of the second semester.

M.Sc. (2000-01): As for Graduate Diploma plus a dissertation of not more than 15,000 words

Physics & Astronomy - 4000 Level modules

Modules

PH3005 Laser Physics 1

Credits: 15.0 Semester: 1

Availability: 2000-01

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

Description: This module presents a basic description of the main physical concepts upon which an understanding of laser materials, operations and applications can be based. The syllabus includes: basic concepts of energy-level manifolds in gain media, particularly in respect of population inversion and saturation effects; conditions for oscillator stability in laser resonator configurations and transverse and longitudinal cavity mode descriptions; single longitudinal mode operation for spectral purity and phase locking of longitudinal modes for the generation of periodic sequences of intense ultrashort pulses (i.e. laser modelocking); illustrations of line-narrowed and modelocked lasers and the origin and exploitability of intensity-induced optical effects.

Class Hour: To be arranged.

Teaching: 27 lectures and 6 tutorials in total.

Assessment: 2 Hour Examination = 100%

PH3050 Optoelectronics & Nonlinear Optics 1

Credits: 15.0 Semester: 1

Availability: 2000-01

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

Description: The module provides an introduction to the basic physics underpinning optoelectronics and nonlinear optics, and a perspective on contemporary developments in the two fields. The syllabus includes: an overview of optoelectronic devices and systems; optical modulators; acousto-optics, Bragg and Raman-Nath; propagation of light in anisotropic media; electro-optics; waveguide and fibre optics; modes of planar guides; 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: 27 lectures and 6 tutorials in total.

Assessment: 2 Hour Examination = 100%

PH4005 Laser Physics 2

Credits: 15.0 Semester: 2

Availability: 2000-01

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

Description: The syllabus includes: 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: 27 lectures and 6 tutorials in total.

Assessment: 2 Hour Examination = 100%

PH4008 Optoelectronics and Nonlinear Optics 2

Physics & Astronomy - 4000 Level modules

Credits: 15.0 Semester: 2
Prerequisite: PH3050
Availability: 2000-01
Programme(s): Compulsory module for Optoelectronic and Laser Devices Postgraduate Taught Programme.
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: 27 lectures and 6 tutorials in total.
Assessment: 2 Hour Examination = 100%

PH4900 Optoelectronic and Laser Laboratory

Credits: 30.0 Semester: 1 + half of 2
Availability: 2000-01
Programme(s): Compulsory module for Optoelectronic and Laser Devices Postgraduate Taught Programme.
Description: A range of introductory and advanced experiments are available for students to work on their own, with assistance and guidance from demonstrators. Introductory experiments include work on investigating laser modes, laser alignment, diffraction, interference, fibre optics and photoelectric cells. Advanced experiments include holography, laser stabilisation, optical pumping, holosteric lasers, semiconductor lasers, investigations of semiconductor materials, laser velocimetry and second order nonlinear optics. One oral presentation gives the opportunity to develop formal speaking skills.
Class Hour: 2.00 - 5.30 pm Monday, Wednesday, Thursday.
Teaching: Three Laboratories each week.
Assessment: Continuous Assessment = 100%

PH4951 Semiconductor Physics and Devices

Credits: 15.0 Semester: 1
Availability: 2000-01
Programme(s): Compulsory module for Optoelectronic and Laser Devices Postgraduate Taught Programme.
Description: This module is designed to give students an advanced knowledge of state-of-the-art semiconductor materials and devices. The first half of this course will cover the fundamental properties of semiconductors and apply this knowledge to optoelectronic devices in the second half. Electronic band structures, electronic transport, optical properties and the conditions for lasing will be covered in bulk and low dimensional semiconductors. The electronic properties of junctions, interfaces and heterostructures will be studied. Devices covered will be light emitting diodes, lasers, photodetectors, modulators and optical logic elements.
Class Hour: To be arranged.
Teaching: 27 lectures and 6 tutorials in total.
Assessment: 2 Hour Examination = 100%

PH4953 Coherent and Pico/Femtosecond Techniques

Physics & Astronomy - 4000 Level modules

Credits: 15.0 Semester: 1
Availability: 2000-01
Programme(s): Compulsory module for Optoelectronic and Laser Devices Postgraduate Taught Programme.
Description: Coherent Techniques includes superheterodyne detection, conversion gain, noise temperature, tetrahertz heterodyne systems, feedback oscillators, negative resistance oscillators, coherent antennas, antennas, link gain, thermal sources, amplitude modulation and demodulation, quasi-optical circuits, beams and modes.
Pico/Femtosecond Techniques reviews longitudinal modes of standing wave and travelling wave resonators. Basic concepts of phase-locking are discussed and active and passive modelocking schemes described. Also covered are saturable gain and loss, and the exploitation of nonlinear optical effects for enhanced modelocking. Application examples and measurement techniques associated with ultrashort laser pulses are given.
Class Hour: To be arranged.
Teaching: 27 lectures and 6 tutorials in total.
Assessment: 2 Hour Examination = 100%

PH4954 Photonics and Applications

Credits: 15.0 Semester: half of 2
Availability: 2001-02
Programme(s): Compulsory module for Optoelectronic and Laser Devices Postgraduate Taught Programme.
Description: The content of this course varies in keeping with changes in research but typical topics are tunable solid state lasers, optical parametric oscillators, holosteric lasers, advanced semiconductor optoelectronic devices and optical communications.
Class Hour: To be arranged.
Teaching: 27 lectures and 6 tutorials in total.
Assessment: 2 Hour Examination = 100%

PH4960 Optical Communication and Information Processing

Credits: 30.0 Semester: half of 2
Availability: 2000-01
Programme(s): Compulsory module for Optoelectronic and Laser Devices Postgraduate Taught Programme, when St Andrews is the host institution.
Description: This module is taught at Heriot-Watt University. It includes a series of lectures on topics such as Fourier Optics, Optical Computing, Optical Engineering and Fibre Communications.
Class Hour: To be arranged.
Teaching: Around 60 lectures.
Assessment: 3 Hour Examination = 100%

PH4961 Optoelectronics and Lasers Laboratory 2

Credits: 15.0 Semester: half of 2
Availability: 2000-01
Programme(s): Compulsory module for Optoelectronic and Laser Devices Postgraduate Taught Programme, when St Andrews is the host institution.
Description: This module is taught at Heriot-Watt University. A range of introductory and advanced experiments are available for students to work on their own, with assistance and guidance from demonstrators. Experiments include laser optics, mode control and spatial filtering, TEA CO₂ laser, optical time-domain reflectometry, liquid crystal and hybrid optical bistable devices, optical communications, holographic interferometry, optical coating and preparation of thin-film devices, microprocessor control of experiments.
Class Hour: To be arranged.
Teaching: Three Laboratories each week.
Assessment: Continuous Assessment = 100%