Imperial College London

Module Specification (Curriculum Review)

Basic details

UID	
Cohorts covered	Earliest cohort: 2023-24; Latest cohort:
Long title	Laser Technology
New code	PHYS70017
New short title	
Brief description of module *(approx. 600 chars.)*	An introduction to principles and practice of laser devices and nonlinear optical technology. The module will provide an understanding of the key physical concepts underlying laser and nonlinear optics and their contemporary applications. Students will be equipped with sufficient knowledge to be able to use and understand lasers and nonlinear processes in the subsequent research or commercial careers.

404 characters

Available as a standalone module/ short course? N

Statutory details

	ECTS	CATS	Non-credit
Credit value	7.5	15	N

HECOS codes:

FHEQ level: Level 7

Allocation of study hours

	Hours	
Lectures	22	
Group teaching	5	*Incl. seminars, tutorials, problem classes.*
Lab/ practical	0	
Other scheduled	11	*Incl. project supervision, fieldwork, external visits.*
Independent study	149.5	*Incl. wider reading/ practice, follow-up work, completion of assessments, revisions.*
Placement	0	*Incl. work-based learning and study that occurs overseas.*
Total hours	187.5	
ECTS ratio	25.00	

Project/placement activity

Is placement activity allowed? No

Module delivery

Delivery mode	Taught/ Campus	Other	
Delivery term		Other	Term 2, exam in term 3

Ownership

Primary department: Physics

Additional teaching departments: None

Delivery campus	South Kensington

Collaborative delivery

Collaborative delivery?	N

External institution	N/A
External department	N/A
External campus	N/A

Associated staff

Role	CID	Given name	Surname
Module Leader		Roland	Smith
Lecturer		Riccardo	Sapienza

Learning and teaching

Module description

Learning outcomes

On completing the Laser Technology module, students will:
- know key laser applications and commercially important lasers;
- be able to match laser properties and laser systems to best meet an applications' needs;
- know how to control (and in some cases design) key laser parameters;
- be able to quantify some laser applications (e.g. laser cutting speed);
- have a rigorous but not overly mathematical understanding of nonlinear optical phenomena and contemporary applications;
- have an understanding of phase matching, second-order nonlinear processes and the key physical processes underlying nonlinear optics;
- be able to use third-order nonlinearity to illustrate the process of intensity-dependent refractive index and its effects (e.g. self-focusing, self-guiding, self phase modulation).

Module content

- Overview of commercially important lasers, current World laser market and laser applications.
- Characterising lasers for real-world applications, spatial mode and M^2 values.
- Details of key laser technologies (Diode, Fibre, Solid State, Gas).
- Solid-State Laser Design.
- Thermal effects in lasers.LearningandTeachingStrategy
- Laser material processing.
- Guided self study covering laser induced damage and scaling of laser systems to high energy.

- Polarisation, refractive index and dispersion
- Second harmonic generation, phase matching (types I and II and non critical)
- Real sources in NLO, phase matching acceptance angle, pulse walk-off and phase-matching bandwidth
- Three-wave mixing and second-order nonlinearity, sum frequency generation, difference frequency generation, optical parametric amplifier and oscillator
- Third-order nonlinearity, intensity-dependent refractive index, self-focusing, self-guiding, self-phase modulation, chirped pulses and pulse compression

Learning and Teaching Approach	This module comprises two sub-modules from the MSc in Optics and Photonics, "Laser Technology" and "Nonlinear Optics", which both require an understanding of lasers (The "Lasers" course is a prerequisite for UG students, a summary document of that module is provided for MSc students). Students will be taught through a combination of lectures and classwork supported by problem sheets and office hours. The Laser Technology element includes three "guided self-study" sessions in which a short "research seminar" style introduction to an open-ended problem is given along with pointers to relevant sources of additional information from the academic literature and commercial websites. Example material might include optical damage in laser systems (including pulse duration scaling) and the role of saturation fluence in the design of large scale MOPA laser systems. Students may tackle these problems individually or in teams as they prefer, worked examples are provided after the session. There will be opportunities to handle and examine real world examples of laser hardware, e.g. laser rods, pump chambers, diode bars, Pockels cells etc.
Assessment Strategy	A single examination provides 100% of the summative assessment.
Feedback	Three problem sheets are provided for the Laser Technology element, and two for the Nonlinear Optics component, both of which include further work associated with the module material and questions which allow students to apply the material. Model solutions are provided for problem sheets and guided self study sessions one week after they are set. Regular weekly office hours are provided to allow for direct interaction between students and the module lecturers.
Reading list	Introduction to Nonlinear Optics, Geoffrey New (Cambridge Press, 2011) Nonlinear Optics (third edition), Robert W. Boyd (Elsevier Academic press, 2008) Lasers by Anthony Siegman ISBN: 0198557132. Laser Physics by Simon Hooker and Colin Webb ISBN 0198506910.

Quality assurance

Date of first approval	
Date of last revision	
Date of this approval	
Module leader	Roland Smith
Notes/ comments	

Office use only

QA Lead	
Department staff	
Date of collection	
Date exported	
Date imported	

Programme structure
Associated modules

UID	Legacy code	Module title	Requisite type

UID	Legacy code	Module title	Requisite type

Assessment details

		Pass mark
Grading method	Numeric	50%

Assessments

Assessment type	Assessment description	Weighting	Pass mark	Must pass?
			50%	
Examination	2 hour written examination	100%	50%	N
		100%		