University of the Balearic Islands

Teaching guide

Academic year	2012-13
Subject	11013 - Nonlinear photonics
Group	Group 1, 2S
Teaching guide	A
Language	English

Subject identification

Subject	11013 - Nonlinear photonics
Credits	1.5 in-class (37.5 hours) 4.5 distance (112.5 hours) 6 totals (150 hours).
Group	Group 1, 2S
Teaching period	2nd semester
Teaching language	English

Lecturers

Lecturers	Timetable for student attention					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Ingo Fischer -- fischer.bert@uib.es	There are no defined sessions					

Degrees where the subject is taught

Degree	Character	Course	Studies
Master's Degree in Physics of Complex Systems	Optional		Postgraduate degree

Contextualisation

The aim of this subject is to train potential researchers in the study of nonlinear photonic systems. This comprises lasers as photonic devices, in particular semiconductor lasers, the physics of their nonlinearities, applications of these lasers, their dynamical properties, and their characteristic instabilities. The course is taught using the methodologies of photonics, optics, semiconductor physics and dynamical systems, including laboratory courses.

Requirements

Recommendable

It is highly recommended that the students have taken courses on optics, optolelectronics and / or solid state physics during their undergraduate studies.

Skills

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Specific

1. E1: Ability to perform laboratory experiments based on theoretical knowledge and adequately describe the results..
2. E8: To know to characterize generic behavior of dynamical systems and their instabilities..
3. E9: To know stability analysis techniques and know how to build bifurcation diagrams..

Generic

1. TG1: To be able to describe, both mathematically and physically, complex systems in different situations.
2. TG2: To acquire the capacity to develop a complete research plan covering from the bibliographic research and strategy to the conclusions..
3. TG3: To write and describe rigorously the research process and present the conclusions to an expert audience..

Content

Theme content

1. Introduction Lasers
   * Absorption.
   * Spontaneous emission.
   * Stimulated emission.
   * Population inversion
2. Laser types
   * Gas lasers. solid state lasers, etc
3. Laser rate equations
   * Isomorophy Lorenz equations - Maxwell Bloch equations
   * Classification of lasers. Types A, B, C
4. Semiconductor lasers.
   * Linewidth.
   * Relaxation oscillations.
   * Nonlinearities
5. Important photonic components
   * Detectors.
   * Modulators.
   * Optical amplifiers.
   * Optical fibers
6. Application of semiconductor lasers
   * Optical communication. Further applications
7. Complexity in laser systems
   * Lasers with added degrees of freedom (Injection, Modulation, Feedback).
   * Multimode lasers.
   * Coupled lasers.

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* Spatio-temporal instabilities.

Teaching methodology

In-class work activities

Modality	Name	Typ. Grp.	Description
Theory classes	Lectures	Large group (G)	Explanation of concepts by the professor and in interaction with the students.
Laboratory classes	Laboratory project	Small group (P)	Measurement of * LI Characteristics * relaxation oscillations * laser parameter determination * feedback instabilities
Assessment	Oral presentation	Large group (G)	Oral presentation to the whole class of an assigned problem

Distance education work activities

Modality	Name	Description
Individual self-study	Preparation of lab project and lab report	Preparing for and understanding the requirements for the lab project and describing the lab work following scientific standards.
Individual self-study	Preparation of oral presentation	Preparation of oral presentation
Individual self-study	Understanding of concepts	Understanding and mastering the concepts explained in the lectures

Specific risks and protective measures

For the lab courses a laser safety instruction and necessary means will be provided.

Workload estimate

Modality	Name	Hours	ECTS	%
In-class work activities		**37.5**	**1.5**	**25**
Theory classes	Lectures	26	1.04	17.33
	Total	**150**	**6**	**100**

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Modality	Name	Hours	ECTS	%
Laboratory classes	Laboratory project	11	0.44	7.33
Assessment	Oral presentation	0.5	0.02	0.33
Distance education work activities		**112.5**	**4.5**	**75**
Individual self-study	Preparation of lab project and lab report	42.5	1.7	28.33
Individual self-study	Preparation of oral presentation	40	1.6	26.67
Individual self-study	Understanding of concepts	30	1.2	20
	Total	**150**	**6**	**100**

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Campus Extens platform.

Student learning assessment

Laboratory project

Modality	Laboratory classes
Technique	Student internship dissertation **(Non-retrievable)**
Description	Measurement of *LI Characteristics*relaxation oscillations*laser parameter determination*feedback instabilities
Assessment criteria	Accuracy and quality of the lab work and of its presentation

Percentage of final qualification: 50% following path A

Oral presentation

Modality	Assessment
Technique	Oral tests **(Non-retrievable)**
Description	Oral presentation to the whole class of an assigned problem
Assessment criteria	Accuracy and quality of the presented work as well as the clarity in the oral presentation

Percentage of final qualification: 50% following path A

Resources, bibliography and additional documentation

Basic bibliography

* B.E.A.Saleh, M.C. Teich: Fundamentals of Photonics, Wiley-Interscience (2007)
* D. Meschede: Optics, Light and Lasers, Wiley-VCH (2004)
* Jia-Ming Liu: Photonic Devices, Cambridge University Press (2009)
* T. Erneux, P. Glorieux: Laser DynamicsCambridge University Press (2010)
* J. Ohtsubo:Semiconductor Lasers: Stability, Instability and Chaos, Springer (2013)

Complementary bibliography

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* Atsushi Uchida: Optical Communication with Chaotic Lasers, Wiley-VCH (2012)

Other resources

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