Course guide
230570 - LASERS - Laser Systems and Applications

Last modified: 19/06/2024

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: MASTER'S DEGREE IN PHOTONICS (Syllabus 2013). (Optional subject).

Academic year: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here:

Others: Consultar aquí / See here:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE3. Know the fundamentals of laser physics, the types of lasers and their main applications.
CE4. Demonstrate knowledge of the fundamentals of image formation, propagation of light through different media and Fourier Optics.
CE7. Ability to understand optical engineering as an economic and business activity considering, among others, social, ethical and sustainability aspects
CE9. Ability to synthesize and present photonics research results according to the procedures and conventions of scientific presentations in English.

Generical:
CG1. Ability to project, design and implement products, processes, services and facilities in some areas of photonics, such as photonic engineering, nanophotonics, quantum optics, telecommunications and biophotonics.
CG2. Ability to modeling, calculate, simulate, develop and implement in research and technological centers and companies, particularly in research, development and innovation tasks in all areas related to Photonics.
CG4. Ability to understand the generalist and multidisciplinary nature of photonics, seeing its application, for example, to medicine, biology, energy, communications or industry

Transversal:
1. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

2. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.

3. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

5. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Basic:
CB6. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context
CB7. Students should know how to apply the knowledge acquired and their problem-solving ability in new or little-known environments within broader (or multidisciplinary) contexts related to their area of ¿¿study.
CB8. Students should be able to integrate knowledge and face the complexity of formulating judgments based on information that, being incomplete or limited, includes reflections on the social and ethical responsibilities linked to the application of their knowledge and judgment.
CB10. Students should possess the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

TEACHING METHODOLOGY

- Lectures
- Activities

LEARNING OBJECTIVES OF THE SUBJECT

The aim of this course is to provide the students a broad overview of the various laser systems currently being used in both scientific, industrial and biomedical fields. Specific attention is paid to cutting-edge applications.

STUDY LOAD

Type	Hours	Percentage
Self study	51,0	68.00
Hours large group	24,0	32.00

Total learning time: 75 h

CONTENTS

1.Introduction to Laser Materials Processing: Macroprecessing and Microprocessing

Description:
1.1 Description of laser systems. Light-matter interaction. Laser light properties and brightness improvement systems.
1.2 Macroprocessing of materials with lasers. Requirements for different processes: cut, welding, drilling, marking, surface treatment, rapid prototyping (3D printing and additive manufacturing).
1.3 Microprocessing of materials with lasers. Laser systems with minimal thermal charge (excimers and femtosecond lasers). Nonthermal ablation and micromanufacturing.

Full-or-part-time: 6h 40m
Theory classes: 6h 40m

2. Semiconductor light sources: Lasers, LEDS and amplifiers

Description:
2.1 Physics of semiconductor lasers
2.2 LEDs and optical amplifiers
2.3 Laser diodes

Full-or-part-time: 6h
Theory classes: 6h

3. General laser models

Description:
3.1. Laser turn-on and modulation response
3.2. Optical injection, optical feedback, polarization.

Full-or-part-time: 5h 20m
Theory classes: 5h 20m

4. Micro- and nano-lasers and biomedical applications

Description:
4.1 Micro- nano-lasers and novel laser sources
4.2 Biomedical applications: from optogenetics to lab-on-a-chip devices

Full-or-part-time: 4h
Theory classes: 4h

ACTIVITIES

Hands-on training sessions on laser model simulations

Full-or-part-time: 2h
Theory classes: 2h

Visit to a company

Full-or-part-time: 3h
Theory classes: 3h

Students' presentations on cutting edge applications

Full-or-part-time: 2h
Theory classes: 2h

GRADING SYSTEM

- Oral presentation. The student will be able to choose a topic from a list proposed by the professors (40%).
- Exam (40%).
- Attending classes and activities (20%)

BIBLIOGRAPHY

Basic:

- Saleh, B.E.A.; Teich, M.C. Fundamentals of photonics. 2n. Hoboken: John Wiley & Sons, 2019. ISBN 9781119506874.
- Liu, J.M. Photonics devices. Cambridge: Cambridge University Press, 2005. ISBN 9780521551953.
- Ohtsubo, J. Semiconductor Lasers: stability, instability and chaos [on line]. 3rd ed. Berlin ; New York: Springer, 2013 [Consultation: 21/05/2020]. Available on: http://dx.doi.org/10.1007/978-3-642-30147-6. ISBN 9783642301469.
- Schaaf, P. Laser processing of materials. Dordrecht: Springer, 2010. ISBN 9783642132803.
- W. M. Steen, J. Mazumder . Laser Material Processing [on line]. 4. Dordrecht: Springer, 2010Available on: https://discovery.upc.edu/iii/encore/record/C__Rb1452867 https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007%2F978-1-84996-062-5 . ISBN 9781849960625.
- Rulliere, C. Femtosecond laser pulses : principles and experiments. 2nd ed. New York: Springer, 1998. ISBN 0387017690.