Last update: 06-05-2019

230803 - LS - Lasers

Coordinating unit: 230 - ETSETB - Barcelona School of Telecommunications Engineering

Teaching unit: 739 - TSC - Department of Signal Theory and Communications

Academic year: 2019

Degree: BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN ELECTRONIC SYSTEMS ENGINEERING (Syllabus 2009). (Teaching unit Optional)
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SCIENCE AND TECHNOLOGY (Syllabus 2010). (Teaching unit Optional)
BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Teaching unit Optional)

ECTS credits: 6 Teaching languages: English

Teaching staff

Coordinator: Artigas Garcia, David

Others: Ferran Canal, David Artigas

Prior skills

Basic concepts of electromagnetic fields. It is recommendable that students take curses on Microwaves beforehand, although it is not indispensable.

Teaching methodology

Lessons in the blackboard and with slides. Problem solved in class.

Learning objectives of the subject

The first objective is to explain the principles of laser operation. The concepts will be applied to various materials in order to attain an overall view of the topic. Students will be able to understand, study and design any laser system. Special emphasis will be placed on studying commercial systems. . Basic contents of the course are the following. The properties of light and its interaction with matter: Classical and quantum points of view. Conditions for amplifying lasers. Characteristics of laser cavities. Oscillation. The present state of laser systems: types and applications. Nonlinear effects applied to changes in frequency.

Study load

Total learning time: 150h	Hours large group:	52h	34.67%
	Self study:	98h	65.33%

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Content

1. Introduction

Learning time: 1h
Theory classes: 1h

Description:
The laser today

2. Properties of light

Learning time: 15h
Theory classes: 15h

Description:
2.1. Interaction of light with matter.
2.2. Spatial and temporal coherence.
2.3. Quantum concepts: Quantum model of the atom, Energy levels, Radiative transitions, Radiation andthermal equilibrium, Absorption, spontaneous emission and stimulated emission.

4.1. Longitudinal cavities.

Learning time: 13h
Theory classes: 13h

Description:
3.1. Population inversion.
3.2. Threshold condition and sufficient condition.
3.3. Laser oscillation.

5. Laser structures and applications

Learning time: 17h
Theory classes: 17h

Description:
4.1. Longitudinal modes in resonant cavities
4.2. Transverse modes in cavities with spherical mirrors: stable and unstable cavities.
4.3. Stable laser cavity.
4.4. Unstable laser cavities.

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5. Laser systems and applications.	Learning time: 12h Theory classes: 12h

Description:
5.1. Solid-state lasers.
Neodymium, Ruby laser, Erbium laser, fiber laser, Tunable Laser (titanium-sapphire, alexandrite).
5.2. Gas lasers.
Helium-Neon, Argon, CO2, Excimer.
5.3. Lasers or liquid dye.
5.4. Laser diodes.

6. Frquency conversión	Learning time: 2h Theory classes: 2h

Description:
6.1. Nonlinear Processes for harmonic generation.
6.2. Optical parametric oscillator (OPO).

Qualification system

- Continuous assessment: two exams, 50% each. If approved by the average between exams, It is not needed to go to the final exam.

- Final exam if not approved by continuous assessment only.

Regulations for carrying out activities

Notes and books are allowed in the exams

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Bibliography

Basic:

Silfvast, W.T. Laser fundamentals. 2nd ed. Cambridge: Cambridge University Press, 2004. ISBN 0521833450.

Verdeyen, J.T. Laser electronics. 3rd ed. Englewood Cliffs: Prentice Hall, 1995. ISBN 0131016687.

Milonni, P.W.; Eberly, J.H. Lasers. New York [etc.]: Wiley, 1988. ISBN 0471627313.

Cabrera, J.M.; López, F.J.; Agulló-López, F. Óptica electromagnética: vol I: fundamentos. 2a ed. Madrid: Addison-Wesley : Universidad Autónoma de Madrid, 1998. ISBN 8478290214 (V.1).

Complementary:

Feynman, R.P.; Leighton, R.B.; Sands, M. The Feynman lectures on physics. New millennium ed. New York: Basic Books, 2010. ISBN 9780465023820.

Boyd, R.W. Nonlinear optics. 3rd ed. San Diego (California): Academic Press, 2008. ISBN 9780123694706.

Others resources: