

# Course guide

## 230803 - LS - Lasers

**Last modified:** 06/05/2019

**Unit in charge:** Barcelona School of Telecommunications Engineering  
**Teaching unit:** 739 - TSC - Department of Signal Theory and Communications.

**Degree:** **Academic year:** 2019 **ECTS Credits:** 6.0  
**Languages:** English

### LECTURER

**Coordinating lecturer:** Artigas Garcia, David  
**Others:** Ferran Canal, David Artigas

### PRIOR SKILLS

Basic concepts of electromagnetic fields. It is recommendable that students take courses 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

| Type              | Hours | Percentage |
|-------------------|-------|------------|
| Hours large group | 52,0  | 34.67      |
| Self study        | 98,0  | 65.33      |

**Total learning time:** 150 h

### CONTENTS

#### 1. Introduction

**Description:**

The laser today

**Full-or-part-time:** 1h

Theory classes: 1h

## 2. Properties of light

### 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 and thermal equilibrium, Absorption, spontaneous emission and stimulated emission.

**Full-or-part-time:** 15h

Theory classes: 15h

## 4.1. Longitudinal cavities.

### Description:

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

**Full-or-part-time:** 13h

Theory classes: 13h

## 5. Laser structures and applications

### 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.

**Full-or-part-time:** 17h

Theory classes: 17h

## 5. Laser systems and applications.

### 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, CO<sub>2</sub>, Excimer.
- 5.3. Lasers or liquid dye.
- 5.4. Laser diodes.

**Full-or-part-time:** 12h

Theory classes: 12h

## 6. Frequency conversion

### Description:

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

**Full-or-part-time:** 2h

Theory classes: 2h



## GRADING SYSTEM

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- 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.

## EXAMINATION RULES.

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Notes and books are allowed in the exams

## BIBLIOGRAPHY

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### 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.

## RESOURCES

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### Other resources: