Laser physics

Lecturers
Simon-Pierre GORZA (Coordinator) and Pascal KOCKAERT

Course mnemonic
PHYS-H410

ECTS credits
5 credits

Language(s) of instruction
English

Course period
Second term

Campus
Solbosch

Course content

The first part of the course is dedicated to an introduction to laser theory. It starts with a description of the interaction of radiation with atoms and ions which are weakly interacting with any surrounding species. The laser Maxwell-Bloch equations are then derived in a semi-classical approach and serve as a basis for studying the continuous wave laser behaviour. The interaction of radiation with semiconductors will then be considered and applied to the description of semiconductor lasers, either in bulk or quantum well form.

The second part of the course starts with the study of optical pulses, that are viewed as wave packets. The propagation of Gaussian beams is then introduced, followed by its application to the description of light propagation in an optical cavity, the study of the stability of a cavity and its transverse modes. Particular aspects of the fiber lasers are then pointed out.

The course continues with the study of pulse shaping and pulse characterization.

The last part of the course is devoted to the laser dynamics, including their stability regimes, and the possibility to generate pulses through mode-locking and Q-switching.

Objectives (and/or specific learning outcomes)

Understand physical principles at the origin of the laser and use of these principles to select and justify the design of specific lasers to particular engineering applications.

1. Differentiate characteristics of the laser emission that are limited by physical principles from those that are limited by existing technology.
2. Identify if some characteristics of laser emission are needed for a specific application.
3. Determine the parameters of a laser for a specific application.
4. Select the mechanism to generate pulses for a specific application.
5. Assemble the different parts of a laser.
6. Check the proper functionning of a laser by characterizing its output.
7. Justify the design of a laser cavity for a specific application.

Teaching method and learning activities

The theoretical course (36h) is supported by hands-on experiments (24h).

Contribution to the teaching profile

- **modelling** : building of the physical model to describe a laser ;
- **matter physics** : reactions of atoms and molecules to optical pumpin ;
- **photonics** : mainly optical sources, optical detection and propagation.
- **mastering multidisciplinary problems** : link between mathematical modeling and experimental devices ;
- **group working**, at the laboratory.

References, bibliography and recommended reading

Lasers, Fundamentals and Applications (2d edition), K. Thyagarajan & A. Ghatak, Springer, New-York (2010). Access through the university library website by following the link below

http://www.springerlink.com.ezproxy.ulb.ac.be/content/978-1-4419-6441-0/#section=786382&page=2&locus=4

Principles of Lasers (5th edition), O. Svelto, Springer, New-York(2010). Access through the university library website by following the link below

http://www.springerlink.com.ezproxy.ulb.ac.be/content/978-1-4419-1301-2/#section=672865&page=5&locus=5

Course notes

Université virtuelle

Other information

Place(s) of teaching

Solbosch

Contact(s)

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Evaluation method(s)

Oral examination and Practice exam

Evaluation method(s) (additional information)

Oral examination in January/February (first exam session) and Augustus/Septembre (second exam session).

Determination of the mark (including the weighting of partial marks)

If the demonstrations and lab experiments have been performed actively, the practical part is not mandatory.

In case the practical part is performed, the final note is the pounded average of the two parts: 2/3 for the theoretical part, 1/3 for the practical part.

In all cases, during the oral examin, questions can be asked over the practicals and the demonstrations. There will however be no practical part in the lab, and therefore no setup to build during the oral exam.

Main language(s) of evaluation

English

Other language(s) of evaluation, if applicable

French

Programmes

Programmes proposing this course at the Brussels School of Engineering

MA-IRPH | Master of science in Physical Engineering | finalité Professional/unit 1