2SC5592 – Quantum cascade lasers

Instructors: Thomas Antoni
Department: DOMINANTE - PHYSIQUE ET NANOTECHNOLOGIES
Language of instruction: FRANCAIS
Campus: CAMPUS DE PARIS - SACLAY
Workload (HEE): 40
On-site hours (HPE): 27,00

Description

The aim of this course is to learn new concepts in modern maths and physics and to realize how they enable technological breakthroughs that can be industrialized. This course is also a first opportunity to tackle the basic principles of nanotechnologies. In addition to scientific knowledge, it will also develop the soft skills of the engineer job through teamwork, written and oral communications.

Quantum cascade lasers are nanodevices invented twenty years ago. Engineering miracle their operation is possible because of the lattest advances in quantum mechanics, optics and thermics. In a team work, the students will get familiar with these concepts and implement an engineer approach to turn them, numerically, in an object reality-constrained.

Quarter number

ST5

Prerequisites (in terms of CS courses)

Quantum and Statistical Physics , Partial Differentieal Equations

Syllabus

- quantum physics (electronic transport, band structures, semiconductors)
- optics (mode guiding, cavities, emission)
- lasers
- basics of nanotechnologies
- partial differential equations
- numerical simulations through MATLAB or Python

Class components (lecture, labs, etc.)

This course is open to fourty students and will take place over a full week.

The students will be divided into two teams of twenty people, each team having to deliver a numerical quantum laser. The teams will be composed of four groups of five students, each group being more specifically responsible for developing a basic unit of the device.

Grading

Group oral presentation (skills C1.2, C1.3, C4.1, C6.1, C7.2)
Personal report (skills C1.1, C1.4, C4.2, C7.1)
Quiz (skills C2.1, C2.2)
Personal contribution to the group (skills C2.3, C2.4, C2.5, C7.3, C7.4)

Course support, bibliography

A list of books available at the documentation center will be given dureing the first session.

Resources

- Exchanges with engineers who are experts in the various fields covered
- Bibliographic Resources
- Use of MATLAB or Python

Learning outcomes covered on the course

- turn a theoretical concept into an actual object
- pose the problem
- estimate orders of magnitude and iterate
- criticize a result
- know how to tackle multi-physics systems

Description of the skills acquired at the end of the course

- Specify, design, build and validate all or part of a complex system
- Mobilizing a broad scientific and technical base in the framework of a transdisciplinary approach
- Transpose to other disciplinary fields, generalize knowledge

- Identify and rapidly acquire new knowledge and skills needed in relevant technical, economic and other fields
- Evaluate the effectiveness, feasibility and robustness of proposed solutions
- Choose solutions and act pragmatically, with a view to achieving tangible results
- Making complex content intelligible. Structure one's ideas, one's argumentation.
- Synthesize and take a step back
- Building buy-in and ownership
- Master scientific and technical communication. Be precise, relevant.
- Gather relevant and reliable information to support an argument.
- Teamwork/collaboration