COURSE MODULE – ADVANCED OPTOELECTRONICS

COURSE CODE	
COURSE LEVEL	Master
ECTS CREDITS	5
COURSE INSTRUCTOR/S	Luca Donetti
DURATION PERIOD	SEMESTER 2
EXPECTED PRIOR-KNOWLEDGE	Semiconductor fundamentals, Principles of light-matter interaction, generation-recombination processes in semiconductors
LANGUAGE OF INSTRUCTION	English

AIM

This course provides the basics and fundamental principles of semiconductor-based light emitting devices: LEDs and lasers. The electrical and optical properties of these devices will be addressed with special focus on the optimization of their efficiency and luminosity. To do that, the course will include the analysis of nanostructures such as quantum wells, quantum wires, and quantum dots, with their fundamental properties, up to applications.

TEACHING ACTIVITIES

This course is based on lectures and practical session activities, exchanges and discussions between students and instructors, as well as homework.

COURSE OUTLINE

(topic 1) Introduction to light emitting devices and the physical principles on which they are based
(topic 2) LED electrical and optical properties; efficiency, luminosity and optimization of device structure
(*topic 3*) Materials employed for LEDs emitting at different wavelengths; LEDs for white light illumination
(*topic 4*) Confined structures and their application in LEDs: quantum wells, quantum wires, quantum dots
(*topic 5* Basic principles of laser: optical gain, resonant cavities, laser oscillation
(*topic 6*) Semiconductor lasers
(*topic 7*) Advanced laser structures: VECSEL, quantum dot laser, quantum cascade laser

PRACTICAL ACTIVITIES

Practical works (laboratory sessions and case studies) in order to implement concepts introduced in the lectures, to practice on real applications and to train students.
(Lab session 1) Simulation of states in quantum wells. Simulation of quantum dots states and interaction with light.

LEARNING OUTCOMES[1]

• *Knowledge* and *Comprehension* of the fundamentals, principles, applications, limits, relationships, of all concepts and topics covered by this course;
• *Application, Analysis, Synthesis* and *Evaluation* skills of the main concepts and topics covered by this course;
• Ability to apply/implement concepts and principles introduced in the lectures on practical tasks and on industrial study cases;
• Ability to self-learn, to understand some problems and to suggest/find solutions to solve these problems.
On completion of this course the students will be able to:
• Understand how light emitting semiconductor devices work.
• Compare the characteristics and features of LEDs and lasers based on different semiconductor materials and different architectures.

[1] The meaning of *keywords* in italic used to define Learning Outcomes are detailed in Annex.

• Know the state of the art light emitting devices and the ongoing research for improved properties or specific applications.

FORM/S OF ASSESSMENT

Written exam (25%), Practical works (50%), Acquired skills (25%)

ASSESSMENT CRITERION

Written exam and Practical works

Excellent - outstanding performance	A
Very Good - above the average standard but with some errors	B
Good - generally sound work with a number of notable errors	C
Satisfactory - fair but with significant shortcomings	D
Sufficient - performance meets the minimum criteria	E
Fail - some more work required before the credit can be awarded	FX
Fail - considerable further work is required	F

Detail of criteria used to assess acquired skills :
• Activities and questionnaires giving evidence of knowing (5%)
• Activities and questionnaires giving evidence of comprehension/understanding (5%)
• Activities and questionnaires giving evidence of analysis (5%)
• Activities and questionnaires giving evidence of synthesis (5%)
• Activities and questionnaires giving evidence of evaluation (5%)

Excellent	A
Very Good - above the average standard	B
Good - generally sound well	C
Satisfactory - but with significant shortcomings	D
Sufficient - performance meets the minimum criteria	E
Fail - some more work required	FX
Fail - considerable further work is required	F

The evaluation of informal learning outcomes will be based on questionnaires and laboratory notebook (self-evaluation, learning diary).

LITERATURE AND STUDY MATERIALS

- F. Schubert: “Light –Emitting Diodes”, 2nd Edition. Cambridge University Press, 2008.
- Takahiro Numai, Fundamentals of Semiconductor Laser (2 ed.), Springer, 2015.
- Manijeh Razeghi, Technology of Quantum Devices, Springer, 2010.
- Papers from international scientific journals

CONTACT DETAILS

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