# COURSE MODULE – OPTICAL SENSORS

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| COURSE CODE | OS |
| COURSE LEVEL | Master |
| ECTS CREDITS | 5 |
| COURSE INSTRUCTOR/S | Carlos Sampedro Matarín |
| DURATION PERIOD | SEMESTER 2 |
| EXPECTED PRIOR-KNOWLEDGE | Semiconductor fundamentals, principles of light-matter interaction, LED technology, laser principles, |
| LANGUAGE OF INSTRUCTION | English |

**AIM**

This course provides the basics and fundamental principles of optical sensors, with especial focus on technology and cutting edge multidisciplinary applications. The contents include transduction and sensor theory, physical fundaments of optical sensors, semiconductor-based optical sensors, and application of optical sensors from traditional to nano- and bio-technologies. The course will include case studies, using different simulation tools and practical exercises.

**TEACHING ACTIVITIES**

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

**COURSE OUTLINE**

*(topic 1)* Transduction and sensing systems.

*(topic 2)* Basic photodetectors based on semiconductor devices. Photodiodes, phototransistors and solar cells.

(*topic 3*) Image sensors based on matrix arrangements. CCD, CMOS sensors.

(*topic 4*) Photomultiplier systems

(*topic 5* Optical waveguides in sensing systems

(*topic 6*) Semiconductor-Based Nanostructures for Photoelectrochemical Sensors and Biosensors

(*topic 7*) Optical sensors in scientific instrumentation and transportation systems.

(*topic 8*) Future applications

**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, 2) Simulation of semiconductor optical sensors. Technology and geometry optimization.
(Lab session 3) Characterization lab of optical sensors

**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:
• Demonstrate an understanding of basic semiconductor optical sensors and nanostructures for optical detection.
• Analyze, and compare different optical sensors and determine the suitable option for a given application.
• Know the state of the art of optical sensors and the roadmap for future applications.

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

FORM/S OF ASSESSMENT

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

ASSESSMENT CRITERION

Written exam and Practical works

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|---|---|
| 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 (20%)
• Activities and questionnaires giving evidence of comprehension/understanding (20%)
• Activities and questionnaires giving evidence of analysis (20%)
• Activities and questionnaires giving evidence of synthesis (20%)
• Activities and questionnaires giving evidence of evaluation (20%)

| | |
|---|---|
| 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

- Jörg Haus “Optical Sensors: Basics and Applications“. Wiley-VCH 2010
- K. Kalantar-zadeh, “Sensors. An introductory course”. Springer 2013
- S. Li et all “Nanoscale sensors”, Springer 2013
- G. Rao “Optical sensor systems in Biotechnology“, Springer 2009
- Papers from international scientific journals

CONTACT DETAILS

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