Universitat Autònoma de Barcelona

2022/2023

Multidisciplinary Applications I

Code: 102729
ECTS Credits: 6

Degree	Type	Year	Semester
2500895 Electronic Engineering for Telecommunication	OT	4	2

Contact

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Use of Languages

Principal working language: catalan (cat)

Some groups entirely in English: No

Some groups entirely in Catalan: Yes

Some groups entirely in Spanish: No

Teachers

Gabriel Abadal Berini

Núria Barniol Beumala

Prerequisites

It is recommended to have obtained the competences of the subjects of the previous courses

Objectives and Contextualisation

The general objective of the course is to apply electronics as a support technology in other fields and activities, and not just in the field of Information Technology and Communications.

It is intended that the student knows and deepens in the design, manufacture and characterization of micro and nanosystems as sensors and actuators for applications in different areas (sensors / actuators, physical, chemical and biological field).

The specific objectives will be:

1) To know and analyze the different types of microelectromechanical and nanoelectromechanical elements (materials, principles of transduction, basic structures, techniques of actuation and detection)

2) Know the techniques of simulation-modeling, design-manufacturing and characterization for micro-nanosystems.

3) Know the different fields of application of MEMS / NEMS and study specific examples

4) Apply the concepts of electronics to design new devices and systems based on micro and nanosystems.

Competences

- Analyse and evaluate the social and environmental impact of technical solutions
- Apply electronics as a support technology in other fields and activities, and not only in the field of Information and Communication Technologies
- Apply the necessary legislation in the exercise of the telecommunications engineer's profession and use the compulsory specifications, regulations and standards
- Communication
- Develop ethics and professionalism.
- Develop personal attitude.
- Develop personal work habits.
- Develop thinking habits.
- Systematically focus the design of electronic applications and products.
- Work in a multidisciplinary group and in a multilingual environment, and communicate, both in writing and orally, knowledge, procedures, results and ideas related with telecommunications and electronics
- Work in a team.

Learning Outcomes

1. Adapt to multidisciplinary and international surroundings.
2. Adapt to unforeseen situations.
3. Apply electronic energy transformation control systems, especially to the field of renewable energy.
4. Assume and respect the role of the different members of a team, as well as the different levels of dependency in the team.
5. Assume social, ethical, professional and legal responsibility, if applicable, derived from professional exercise.
6. Communicate efficiently, orally and in writing, knowledge, results and skills, both professionally and to non-expert audiences.
7. Conceive and design bioelectronic systems in an environment of multidisciplinary cooperation.
8. Conceive and design micro-nano // electromechanical systems
9. Concisely present in Spanish, Catalan and English the design process of an electronic system, from the design phase to the results and implementation.
10. Develop systemic thinking.
11. Estimate the potential economic and social impact of an electronic system.
12. Generate innovative and competitive proposals in professional activity.
13. Identify the applicable legislation in the development of a specifically applied electronic system
14. Identify the causes of environmental impact of a specifically applied electronic system.
15. Identify, manage and resolve conflicts.
16. Make one's own decisions.
17. Manage information by critically incorporating the innovations of one's professional field, and analysing future trends.
18. On a systematic level, deal with the design process of a specific electronic application.
19. Respect diversity in ideas, people and situations.
20. Use English as a language of communication and as the reference in professional relations.
21. Work cooperatively.
22. Work in complex or uncertain surroundings and with limited resources.

Content

PART I. Technologies of energy harvesting (2/3 course)

1. Introduction to energy harvesting technologies and the concepts of "ultralow power consumption" (ULP), "Zeropower", "wireless sensor network" (WSN).

2. Introduction to the different types of collectors according to the different sources of energy.

3. Introduction to mechanical energy collectors. Mechanical block: resonant cantilever. Transducer block: piezoelectric element. SPICE model.

4. Design and simulation of a mechanical energy collector (LABORATORY)

5. Implementation and characterization of a mechanical energy collector (LABORATORY)

Part II: Microelectromechanical systems in portable devices (1/3 subject)

1. Introduction to microelectromechanical systems (MEMS): classification and description.

2. MEMS in mobile devices: typologies and market trends.

3. Specific cases: inertial sensors (accelerometers), biometric sensors (fingerprints) and RF MEMS.

Methodology

In this subject of the degree, sensors and actuators will be developed, emphasizing especially those for multidisciplinary applications, giving a different vision to the students. The methodology will be based on learning from projects, so students will be offered a certain problem (specific case) that will have to be resolved throughout the course.

To achieve the objectives the training activities include:

Theoretical classes Explanation by the teacher of the basic concepts depending on the specific case to be resolved

Seminars: discussion and analysis of aspects to be solved and raised according to the specific case.

Laboratory classes. practical works in the specific laboratory according to the case to be resolved. Part of these work will include the use of simulation tools

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Seminars	15	0.6	1, 2, 4, 6, 10, 9, 12, 17, 13, 15, 18, 16, 19, 21, 22, 20
Theoretical classes	20	0.8	3, 6, 7, 8, 10, 9, 12, 17, 14, 18, 20
laboratory work	12	0.48	2, 3, 4, 7, 8, 10, 15, 18, 16, 21, 22, 20
Type: Autonomous			
Preparation and edition of the written reports	44	1.76	2, 4, 6, 8, 10, 11, 9, 17, 13, 14, 15, 18, 16, 21, 20
Study for the assimilation of concepts	44	1.76	3, 7, 8, 10, 11, 17, 13, 14, 18, 16, 20

Assessment

The evaluation of the subject will have 4 differentiated sections:

a) 1 partial written tests of the subject (25%), and with a rating above 4 to average with the remaining qualifications. These tests can be retrieved with the final recovery exam (at the end of the semester), requiring a 4 to do average.

b) Oral presentation or written report of one of the cases worked. Obligatory and non-recoverable activity (30%).

c) Attendance, active participation in the laboratory sessions and test answer at the end of each lab session. Obligatory and non-recoverable activity (15%)

d) Written report of the work carried out in the laboratory, paying special attention to the interpretation and discussion of the results compared to those awaited theoretically and / or simulated (30%). This work is mandatory and recoverable. A second term (announced in the Moodle classroom of the subject) will be set to recover / improve a note from the written laboratory report to review and respond to the corrections that the teacher has made about the first version of the original works.

The "Not evaluable" qualification will only be awarded if the student does not participate in any evaluation activities (attendance to the laboratory sessions, oral presentation, exams).

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Laboratory	15%	1	0.04	1, 3, 4, 5, 8, 10, 12, 17, 15, 18, 16, 19, 21, 22
Laboratory written report	30%	6	0.24	3, 6, 8, 11, 9, 12, 13, 14, 18, 16
Oral Presentation or written report of one of the cases	30%	4	0.16	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 9, 12, 17, 13, 14, 15, 18, 16, 19, 21, 20
Partial written exams	25%	4	0.16	3, 6, 8, 11, 9, 17, 13, 14, 18, 16

Bibliography

Fundamentals of Microfabrication. The Science of Miniaturization (2nd edition). M.J. Madou. CRC Press, (2002).

Microsystems Design, . S.D. Senturia. Kluwer Academic Publishers (2001).

Sensors. Vol.7. . W. Göpel, J. Hesse, J.N. Zemel. Wiley-VCH.

Mechanical Sensors- Sensors (Update). Vol.4. H. Baltes, W. Göpel, J. Hesse. Wiley-VCH

Practical MEMS. Ville Kaajakari. Small Gear Publishing. ISBN: 978-0-9822991-0-4 (2009)

Resonant MEMS, O.Brand, I.Dufour, S,M.Heinrich, F.Josse, Wiley-VCH, AMN collection, (2015)

Software

Pspice student version