Course guides
230643 - IS - Instrumentation and Sensors

<table>
<thead>
<tr>
<th>Unit in charge:</th>
<th>Barcelona School of Telecommunications Engineering</th>
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<tbody>
<tr>
<td>Teaching unit:</td>
<td>710 - EEL - Department of Electronic Engineering.</td>
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<tr>
<td>Degree:</td>
<td>MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Compulsory subject).</td>
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<tr>
<td></td>
<td>MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).</td>
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<tr>
<td></td>
<td>MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).</td>
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<tr>
<td>Academic year:</td>
<td>2021</td>
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<tr>
<td>ECTS Credits:</td>
<td>5.0</td>
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<td>Languages:</td>
<td>English</td>
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**LECTURER**

<table>
<thead>
<tr>
<th>Coordinating lecturer:</th>
<th>PERE JOAN RIU I COSTA</th>
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<td>Others:</td>
<td>RAMON BRAGÓS BARDIA</td>
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**DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES**

**Specific:**
1. Ability to integrate instrumentation systems on mobile devices.
2. Ability to evaluate the quality and safety of electronic products including reliability, physical testing, electrical safety and electromagnetic compatibility.
3. Ability to deploy distributed instrumentation systems and advanced sensor networks including self-powered systems based on energy harvesting from the environment.
4. Ability to design, implement and operate high performance laboratory electronic instrumentation, with emphasis on error analysis, calibration and virtual control.

**Transversal:**
5. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.
6. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

**TEACHING METHODOLOGY**

- Lectures
- Application classes
- Laboratory practical work
- Exercises
- Short answer test (Control)
- Extended answer test (Final Exam)
LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

The aim of this course is to train students in methods of design, implementation and operation of advanced instrumentation and sensor systems. This includes instrumentation and sensor networks, advanced sensor conditioning methods, smart sensor systems and error analysis. Also reliability, electrical safety and electromagnetic compatibility issues are covered.

Learning results of the subject:

- Ability to understand the physical principles and manufacturing technologies of advanced sensors.
- Know how to design and manage instrument and sensor networks and associated synchronization problems.
- Knowledge of various techniques of collecting energy from the environment.
- Ability to understand the technical specifications of high-sensitivity and high frequency measurement equipment.
- Knowledge of the basic principles of the calibration of instruments and the techniques used to carry it out.
- Ability to design virtual instrumentation and automatic test systems.
- Knowledge for integrating instrumentation systems on mobile devices.
- Ability to interpret the regulations affecting electronic products.
- Knowledge of the various tests required to verify electronic products.

STUDY LOAD

<table>
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<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tr>
<td>Hours large group</td>
<td>26,0</td>
<td>20.80</td>
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<tr>
<td>Self study</td>
<td>86,0</td>
<td>68.80</td>
</tr>
<tr>
<td>Hours small group</td>
<td>13,0</td>
<td>10.40</td>
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Total learning time: 125 h

CONTENTS

1. Introduction

Description:
- Instrumentation systems architecture
- Sensor networks architecture
- Data transfer and power supply needs of instrumentation and sensor systems
- General considerations about instrumentation and sensor system specification and verification

Full-or-part-time: 7h
- Theory classes: 2h
- Guided activities: 1h
- Self study: 4h
2. Instrumentation systems

**Description:**
- Advanced instrumentation systems architectures
- Virtual instrumentation
- Error analysis and specification
- Estimation theory
- Instrumentation systems calibration techniques

**Full-or-part-time:** 51h
- Theory classes: 10h
- Laboratory classes: 6h
- Guided activities: 10h
- Self study: 25h

3. Sensor systems

**Description:**
- Sensor principles, implementation and characteristics review
- Advanced sensor conditioning techniques
- Coherent detection methods for AC sensors
- Self-correction and self-calibration techniques
- Smart-sensor structure and standards
- Sensor networks
- Energy harvesting techniques for sensor systems

**Full-or-part-time:** 53h
- Theory classes: 9h
- Laboratory classes: 8h
- Guided activities: 10h
- Self study: 26h

4. Reliability, electrical safety and electromagnetic compatibility in measurement systems

**Description:**
- Electromagnetic compatibility issues in measurement systems
- Interference identification and reduction techniques
- Electrical safety
- Reliability

**Full-or-part-time:** 14h
- Theory classes: 4h
- Guided activities: 4h
- Self study: 6h
ACTIVITIES

LABORATORY
Description:
- Synchronization techniques on LXI
- Instrument calibration
- Guarding and shielding
- Coherent and synchronous detection of AC sensors
- Self-calibration of a sensor
- IEEE 1451 Smart sensor standard implementation

EXERCISES
Description:
- Exercises to strengthen the theoretical knowledge
- Guided study of sensors, instruments and methods related materials

SHORT ANSWER TEST (CONTROL)
Description:
Mid term control.

EXTENDED ANSWER TEST (FINAL EXAMINATION)
Description:
Final examination.

GRADING SYSTEM
Final examination: 50%
Exercises: 20%
Laboratory assessments: 30%

BIBLIOGRAPHY
Basic:

Complementary: