Course guide
230733 - EMST - Electronic Measurement Science and Technology

Last modified: 11/04/2025

Unit in charge: Barcelona School of Telecommunications Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).
MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2022). (Compulsory subject).

Academic year: 2025 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: PERE JOAN RIU COSTA

Others: Primer quadrimestre:
RAMON BRAGOS BARDIA - 21, 23
PERE JOAN RIU COSTA - 21, 23

PRIOR SKILLS

Analog functions design, basic analog and digital filter design, basic electronic instruments knowledge: use of instruments and block diagrams. Statistics: random variables and stochastic processes. Basic uncertainty assessment according to GUM, basic signal processing: Fourier transform, sampling theorems

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CMEE8. Implement distributed instrumentation systems and advanced sensor networks including self-sufficient systems based on the harvesting of energy from the environment.
CMEE9. Design, implement and operate high-performance electronic laboratory instrumentation, with emphasis on error analysis, calibration and virtual control.
CMEE10. Evaluate the suitability of the measurement methods and estimate the associated uncertainty.
CMEE11. Design and implement sensor-based and application-oriented systems

Transversal:
CTMEE4. Solvent use of information resources. Manage the acquisition, structuring, analysis and visualization of data and information in the field of specialty and critically assess the results of said management.

TEACHING METHODOLOGY

- Lectures
- Application classes
- Project Based Learning
- Laboratory practical work
- Exercises
- Short answer test
- Extended answer test

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, recovering of signals in noisy environments, advanced sensor conditioning methods, smart sensor systems, information codification in non-analog domains and advanced uncertainty analysis
Learning results of the subject:
- Know the physical principles and manufacturing technology of advanced sensors.
- Know how to design and manage network measurement systems.
- Understand the technical specifications of high-performance measurement equipment.
- Know the basic principles of the calibration of instruments and systems based on sensors and the techniques used to carry it out.
- Know how to design virtual instrumentation and automatic test systems.
- Know how to design the measurement and processing blocks of IoT devices.
- Know and know how to interpret the regulations that affect electronic products.

STUDY LOAD

Type	Hours	Percentage
Hours small group	13,0	10.40
Hours large group	26,0	20.80
Self study	86,0	68.80

Total learning time: 125 h

CONTENTS

Introduction

Description:
Introducción and description of course objectives, contents and activities

Full-or-part-time: 1h
Theory classes: 1h

Advanced Uncertainty Analysis

Description:
Limits of GUM
Non Gaussian variables. Numerical estimation methods
Combining different classes of errors

Full-or-part-time: 14h
Theory classes: 3h
Laboratory classes: 1h
Self study : 10h

Signal Recovery from Noise

Description:
Optimal estimators for DC signals
Optimal estimators for vector (AC) signals
Noise analysis
Interference analysis

Full-or-part-time: 16h
Theory classes: 4h
Laboratory classes: 2h
Self study : 10h

Standards and Calibration. Time standards

Description:
Codification of information in time-domains
Universal counters
Standard oscillators
Uncertainty analysis in time measurements

Full-or-part-time: 15h
Theory classes: 4h
Laboratory classes: 1h
Self study : 10h

Application-based sensor systems design

Description:
Case study of a specific sensor application *
Requirements and specifications extraction
Emphasis in the Market Context and potential Social Impact

*(The case study will be an Electrical Impedance Spectroscopy based sensor for biotechnological applications)

Full-or-part-time: 23h
Theory classes: 5h
Laboratory classes: 3h
Guided activities: 15h

Circuit architecture for sensor system acquisition

Description:
System architecture alternatives
Analog front-end
System-on-chip approaches

Full-or-part-time: 28h
Theory classes: 5h
Laboratory classes: 3h
Guided activities: 20h

Sensor data analysis and processing

Description:
Sensor signal processing
Model fitting
Physical variables extraction

Full-or-part-time: 28h
Theory classes: 4h
Laboratory classes: 3h
Guided activities: 21h

ACTIVITIES

LABORATORY

Description:
Development of a sensor based on impedance spectroscopy for biotechnological application.
- Assessment of the effective resolution of the oscilloscope and methods to improve it
-Codification of a software-defined broadband vector voltmeter.
-Construction and characterization of the sensor
-System-level design approaches for Frugal Design. Emphasis in the mediating role of measurement systems and their applications in sustainability.

Full-or-part-time: 12h
Laboratory classes: 12h

GRADING SYSTEM

-Final / half-term written exam: 40%
-Individual works, written: 10%
-Group Project presentation, oral and written: 20%
-Group Project development, including lab: 30%

EXAMINATION RULES.

In written exams, no devices with wireless communication capabilities or the ability to store textual or graphical information, including programmable calculators, will be allowed .

BIBLIOGRAPHY

Basic:

- Pallás-Areny, R.; Webster, J.G. Sensors and signal conditioning [on line]. 2nd ed. New York: John Wiley and Sons, 2001 [Consultation: 03/02/2021]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?docID=4747125. ISBN 0471332321.
- D'Antona, G.; Ferrero, A. Digital Signal Processing for Measurement Systems. Theory and Applications [on line]. New York, NY: Springer, 2006 [Consultation: 20/07/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/0-387-28666-7. ISBN 9781281334732.
- C. Ratcliffe and B Ratcliffe. Doubt-Free Uncertainty In Measurement [on line]. Springer, 2015 [Consultation: 20/07/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-319-12063-8. ISBN 9783319120638.
- Wang, P.; Liu, Q. Biomedical sensors and measurement [on line]. Heidelberg ; New York: Hangzhou : Springer, 2011 [Consultation: 20/07/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-642-19525-9. ISBN 9787308082693.
- Sawan, M. Handbook of Biochips : Integrated Circuits and Systems for Biology and Medicine [on line]. New York, NY: Springer, 2022 [Consultation: 20/07/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/referencework/10.1007/978-1-4614-3447-4. ISBN 9781461434474.

Complementary:

- Putten, A.F.P.V. Electronic measurement systems: theory and practice. 2nd ed. Bristol ; Philadelphia: IOP Publishing, 1996. ISBN 978-0750303408.
- Dargie, W.; Poellabauer, C. Fundamentals of wireless sensor networks: theory and practice [on line]. Chichester: John Wiley & Sons, 2010 [Consultation: 17/07/2017]. Available on: http://onlinelibrary.wiley.com/book/10.1002/9780470666388. ISBN 9780470666388.