Course guide
300269 - BODYSEN - Body Sensor Nodes

Last modified: 19/05/2025

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

Degree: MASTER'S DEGREE IN APPLIED TELECOMMUNICATIONS AND ENGINEERING MANAGEMENT (MASTEAM) (Syllabus 2015). (Optional subject).
MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).
ERASMUS MUNDUS MASTER IN COMMUNICATIONS ENGINEERING AND DATA SCIENCE (CODAS 1) (Syllabus 2024). (Optional subject).
ERASMUS MUNDUS MASTER IN COMMUNICATIONS ENGINEERING AND DATA SCIENCE (CODAS 2) (Syllabus 2024). (Optional subject).

Academic year: 2025 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Serrano Finetti, Ernesto

Others: Serrano Finetti, Ernesto
Casanella Alonso, Ramon

PRIOR SKILLS

DC and AC circuit analysis, linear system theory, analysis and design of basic analog, digital and mixed-signal electronic circuits, random signal analysis, electric and magnetic fields

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
08 MTM. (ENG) Diseñar e implementar redes de sensores inalámbricas para cualquier aplicación de cualquier ámbito social.

Generical:
03 DIS. (ENG) Diseñar aplicaciones de alto valor añadido basadas en las Tecnologías de la Información y las Comunicaciones (TIC), aplicadas a cualquier ámbito de la sociedad.
06 RES. (ENG) Resolver problemas y mejorar procesos en cualquier ámbito social a partir de la aplicación de las TIC, integrando conocimientos de diversos ámbitos y aplicando ingeniería de alto nivel tecnológico.

Transversal:
05 TEQ. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

Basic:
CB7. Students will be able to apply the acquired knowledge and their ability to solve problems in new or little explored environments in broader (or multidisciplinary) contexts related to their study area.
CB9. Students will be able to communicate their conclusions and the knowledge and ultimate reasons that support them to specialized and non-specialized audiences in a clear and unambiguous manner.
CB6. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.

TEACHING METHODOLOGY

Lectures in the classroom, project design and implementation work in the laboratory, autonomous work outside the classroom and the laboratory.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course, the student should be able to:
1) Describe the principles of operation of sensors intended for the non-invasive measurement of physiological parameters.
2) Design electronic interfaces for those sensors and evaluate their performance.
3) Understand the origin, description and analysis of interference in systems based on those sensors.
4) Understand and apply common methods to reduce that interference and evaluate the results.
5) Conceive, implement and experimentally verify sensor nodes for common physiological parameters.

STUDY LOAD

Type	Hours	Percentage
Self study	48,0	64.00
Hours large group	27,0	36.00

Total learning time: 75 h

CONTENTS

1. Physiological sensors.

Description:
Biopotentials. Electrodes for biopotentials (ECG, EEG, EMG). Brain-Computer interfaces. Arterial pressure waves. Photoplethysmography. Pulse oximetry. Bioimpedance measurement and applications. Other physiological signals from mechanical origin.

Related activities:
All activities

Full-or-part-time: 18h
Theory classes: 6h
Self study : 12h

2. Signal conditioning and data acquisition

Description:
Biopotential amplifiers. Interference modelling. Signal and safety ground. Guarding and shielding. Front-ends for photoplethysmography. Front-ends for bioimpedance measurements. Front-ends for mechanical signals. Microcontrollers for wearable applications

Related activities:
All activities

Full-or-part-time: 18h
Theory classes: 6h
Self study : 12h

3. Design and implementation of body sensor nodes

Description:
Performance assessment of some commercial sensors for ECG and PPG. Design specifications and work plan for an own-built biopotential amplifier. Concept design. Physical design, implementation and experimental assessment. Interference assessment. Front-ends for mechanical signals using accelerometers ang gyroscopes. Interface sensors to microcontrollers for wearable applications.
All these activities will be carried out at the laboratory.

Related activities:
Activities 2 and 4

Full-or-part-time: 36h
Laboratory classes: 24h
Self study : 12h

ACTIVITIES

Activity 1: Lectures.

Specific objectives:
Exposition of the course contents and discussion of the weekly homeworks

Material:
Class slides

Full-or-part-time: 12h
Self study: 12h

Activity 2: Individual assessment (written exams).

Description:
There will be a short mid-term written exam and a final written exam. Besides, there will be a laboratory results group presentation.

Specific objectives:
Assessment of the learning objectives

Full-or-part-time: 3h
Guided activities: 3h

Activity 3: Homework (Questionnaires and exercises)

Description:
Brief numercial exercises and short theoretical questions

Specific objectives:
Consolidation of the learning objectives

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

Activity 4: Laboratory work

Description:
The students will work with a set of commercially available solutions for photoplethysmography, IMU and gyroscopic sensors and ECG/EMG amplifiers. Besides, the students will have to complete the design of the passive components of a biopotential (ECG) amplifier. Besides, there will be a specific session to demonstrate the effects and solutions to power-line intereference

Specific objectives:
Assessment of different commercial sensors. Design of a biopotential amplifier. Hands-on work on capacitively coupled power-line interferences in amplifiers.

Material:
Sensor boards, lab instrumentation

Delivery:
The lab results will be summarized and presented face-to-face on a specific 1 hour session

Full-or-part-time: 48h
Self study: 24h
Laboratory classes: 24h

GRADING SYSTEM

Mid-term written exam test (30 %), lab work and results (35 %) and a final written exam (35 %).

BIBLIOGRAPHY

Basic:
- Webster, John G; Clark, John W. Medical instrumentation : application and design. 2nd. ed. New York [etc.]: John Wiley, cop. 1995. ISBN 0471124931.

Complementary:
- Ott, Henry W. Electromagnetic compatibility engineering. Hoboken, N.J.: John Wiley & Sons, cop. 2009. ISBN 9780470189306.
- Pallás Areny, Ramón; Webster, John G. Analog signal processing. New York [etc.]: John Wiley & Sons, cop. 1999. ISBN 0471125288.