Course guide
230694 - IBES - Introduction to Biomedical Electronic Systems

Last modified: 25/05/2023

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

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

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura

Others: Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Basic analog circuits analysis.Signal Processing fundamentals: Fourier Transform, Sampling Theorems, Digital Filter design. Programming with Matlab and/or Python

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEE9. Ability to design, implement and operate high performance laboratory electronic instrumentation, with emphasis on error analysis, calibration and virtual control.
CEE21. Ability to process continuous variable signals using digital techniques.
CEE11. Ability to evaluate the quality and safety of electronic products including reliability, physical testing, electrical safety and electromagnetic compatibility.

Transversal:
CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

CT4. 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.

TEACHING METHODOLOGY

- Lectures
- Application classes
- Laboratory practical work
- Exercises
-Project Based Learning

LEARNING OBJECTIVES OF THE SUBJECT

The aim of the subject is to make students aware of the different kinds of signals that can be acquired from a human body and enable them to be able to select instruments, use them and acquire signals and process the signals to obtain estimators relevant for the clinical practice.

Learning results of the subject:
Ability to understand the function of electrodes as electrical interfaces, especially for wearable applications
Ability to understand the physical functions of sensors used to build biomedical equipment.
Ability to understand the technical specifications of measurement equipment and electronic components used to design biomedical instrumentation.
Ability to acquire biological signals and process them to obtain clinically relevant parameters.
Ability to understand the regulations concerning biomedical systems, including safety and EMC.

STUDY LOAD

Type	Hours	Percentage
Hours small group	20,0	16.00
Hours large group	19,0	15.20
Self study	86,0	68.80

Total learning time: 125 h

CONTENTS

Introduction to Biomedical Systems

Description:
Introduction to the objectives of the subject . Basic definitions. Concept of biomedical Engineering. Historical review

Related activities:
understand the complexity of signals that can be acquired from a live being, the restriction on system design and the necessary regulations associated.

Related competencies :
CT4. 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.

Full-or-part-time: 5h
Theory classes: 1h
Self study : 4h

Endogenous electrical signals

Description:
Electrobiological Phenomena. Biomedical Electrodes. Dry electrodes and non-contact electrodes for for wearable systems. Requirements for biopotential measurement systems

Specific objectives:
understand the origin of endogenous electrical signals in living beings. Understantd the function of electrodes and their impact on system design and quality of recorded signals. Ability to record and process biopotential signals from human body.

Related activities:
Laboratory. Acquisition of Bioelectric Signals

Related competencies :
CEE21. Ability to process continuous variable signals using digital techniques.
CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Full-or-part-time: 22h
Theory classes: 4h
Laboratory classes: 2h
Self study : 16h

Electrical and thermal properties of Biological materials

Description:
Thermal properties (Bioheat Thermal Equation). Dielectric properties. Physical Models. Descriptive models.

Specific objectives:
understand the passive properties of biological materials. Understand the sensors and excitation needed to obtain information from passive properties. Be able to make estimators of body composition and fluid shifts out of impedance measurements. Be able to obtain the cardiac rhythm from optical properties of muscle.

Full-or-part-time: 14h
Theory classes: 4h
Self study : 10h

Diagnostic devices and systems

Description:
Monitors for electric signals (ECG, EEG, EMG, ...). Blood pressure measurements. Blood flow and cardiac output measurements. Impedance plethysmography and impedance cardiography. Respiratory flow and volume. Imaging Systems (MRI, CT, PET, EIT...)

Specific objectives:
Ability to understand the physical principle of sensors being used in measurements on the human body. Ability to design and customize electronic circuits for the measurement of biological signals. Ability to process signals to obtain clinically relevant information.

Related activities:
LABORATORY
- Ventilation Monitoring with Thermistor
- Blood perfussion monitoring with photoplethismograph
- ECG acquisition and processing
-Open project combining two or more signals

Full-or-part-time: 72h
Theory classes: 6h
Laboratory classes: 18h
Self study : 48h

Therapeutic Devices and Systems

Description:
Electrical Stimulation. Magnetic Stimulation. Heating (including ESU)

Specific objectives:
Ability to understand the physical principles of electrical and magnetic stimulation. Ability to understand thermal processes in the human body.

Full-or-part-time: 12h
Theory classes: 4h
Self study : 8h

GRADING SYSTEM

Final exam 45%
Exercises 5%
Laboratory Assessment /Project (including reports) 50%

EXAMINATION RULES.

No devices with wireless communication capabilities or textual information storage capabilities, including programmable calculator,s will be allowed during exams.

BIBLIOGRAPHY

Basic:
- Kramme, R.; Hoffmann, KP; Pozos, RS. Springer handbook of medical technology [on line]. Springer, 2011 [Consultation: 21/09/2016]. Available on: http://dx.doi.org/10.1007/978-3-540-74658-4. ISBN 9783540746584.

Complementary:
- Leitgeb, N. Safety of electromedical devices [on line]. Springer, 2010 [Consultation: 21/09/2016]. Available on:

http://dx.doi.org/10.1007/978-3-211-99683-6. ISBN 9783211996836.
- Pavlovic, M. Bioengineering, a conceptual approach [on line]. Springer, 2015 [Consultation: 08/06/2022]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/978-3-319-10798-1. ISBN 9783319107981.
- Plonsey, R.; Barr, R.C. Bioelectricity: a quantitative approach [on line]. 3rd ed. New York: Kluwer Academic/Plenum, 2007 [Consultation: 21/10/2016]. Available on: http://dx.doi.org/10.1007/978-0-387-48865-3. ISBN 9780387488646.