Course guides
820030 - SCSB - Sensors and Signal Conditioners

Unit in charge: Barcelona East School of Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.
Degree: BACHELOR’S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
Academic year: 2021 ECTS Credits: 6.0 Languages: Catalan, Spanish

LECTURER
Coordinating lecturer: LEXA DIGNA NESCOLARDE SELVA
Others: Primer quadrimestre:
LEXA DIGNA NESCOLARDE SELVA - M11, M12, M13, M14, M15

PRIOR SKILLS
Having passed the "Electronic Systems" subject.

REQUIREMENTS
PROCESSAMENT DE SENYALS BIOMÈDICS - Irequisit
SISTEMES ELECTRÒNICS - Prerequisite

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Identify, Understand and apply the principles of sensors, conditioners and biomedical signal acquisition systems.

Transversal:
2. TEAMWORK - Level 2. Contributing to the consolidation of a team by planning targets and working efficiently to favor communication, task assignment and cohesion.

TEACHING METHODOLOGY
Lectures, cooperative work, autonomous learning, project based learning.

LEARNING OBJECTIVES OF THE SUBJECT
Understanding the principles of the sensors used in biomedical applications. Acquiring the ability to understand and use conditioning circuits and signal acquisition systems suitable for the usual biomedical signals.
STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Hours small group</td>
<td>15.0</td>
<td>10.00</td>
</tr>
<tr>
<td>Self study</td>
<td>90.0</td>
<td>60.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>45.0</td>
<td>30.00</td>
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</tbody>
</table>

**Total learning time:** 150 h

CONTENTS

**T1. Introduction to biomedical signal acquisition systems**

**Description:**
1.1 Structure of the measurement and acquisition systems for biomedical signals. Types of Sensors. Sensor classification. Security considerations.
1.2 General input-output configuration. Interferences and internal disturbances. Compensation techniques.
1.4 Dynamic characteristics of measurement systems: Zero order measurement systems. First-order measurement systems. Second order measurement systems.
1.5 Input characteristic: impedance

**Specific objectives:**
1. The student, will be able to explain and identify the concepts related to all the static and dynamic characteristics of sensors, in general.
2. The student, will be able to explain the structure of a biomedical signal acquisition system and to identify and classify the different sensors that are used and their generic characteristics.

**Related activities:**
1. Resolution of exercises on sensor characteristics.
2. Laboratory practice on static characterization of sensors.

**Full-or-part-time:** 8h
Theory classes: 4h
Laboratory classes: 2h
Self study : 2h
### T2. Sensor and signal conditioning

**Description:**


2.4 Other detection methods: Sensors based on semiconductor junctions. Sensors based on ultrasound. Sensors based on optical fibers. Biosensors

**Specific objectives:**

1. The student will be able to describe the principles of operation of the sensors used in equipment acquisition of biomedical signals, the electric model and its advantages and limitations.

2. The student will be able to analyze the conditioning circuitry associated with sensors, select the most appropriate and perform basic designs.

**Related activities:**

1. Resolution of problems related to different types of conditioning circuits.

2. Resolution of problems related to acquisition systems.

3. Laboratory related to measures of resistance bridge circuit and differential amplifier.

4. Laboratory related to conditioning circuit for a piezoelectric sensor.

**Full-or-part-time:** 30h

Theory classes: 9h
Laboratory classes: 2h
Self study : 19h

### T3. Biomedical sensors

**Description:**


3.2 Pressure measurements. Pressure units and requirements for pressure measurements. Direct and indirect pressure measurements.


3.4 Measures of movement and force. Objective and units of measurement. Measurement methods.


**Specific objectives:**

1. The student will be able to identify the components of a data acquisition system for biomedical applications and their functions. In addition, set up, analyze and perform basic designs.

**Related activities:**

1. Resolution of problems related to different types of conditioning circuits.

2. Resolution of problems related to acquisition systems.

3. Practice of conditioning circuit for piezoelectric sensor.

4. Configuration of an acquisition system for the non-invasive measurement of blood pressure project.

5. Design and implementation of conditioning circuits for the non-invasive blood pressure measurement project.

**Full-or-part-time:** 88h 20m

Theory classes: 28h
Laboratory classes: 7h
Self study : 53h 20m
### Project: Design of a measurement system for biomedical signals with Biopac system.

**Description:**
Design of system to measurement biomedical non-invasive signals, by means of sensors, conditioning circuits and system acquisition with Biopac system.

**Specific objectives:**
1. Develop skills for teamwork.
2. The student will be able to carry out the design and implementation of biomedical signal measurement and acquisition systems.

**Related activities:**
In combination with the subject "Biomedical Signal Processing", carrying out a project in which the students designed a system of non-invasive measurement of biomedical signals with Biopac:
1. Selection of sensors and design of the conditioning circuits.
2. Configuration and programming of the acquisition system.
3. Processing of signals and obtain of the biomedical parameters.

**Full-or-part-time:** 23h 40m
- Theory classes: 4h
- Laboratory classes: 4h
- Self study: 15h 40m

### ACTIVITIES

#### Proyect.S1- CONFIGURATION OF A SYSTEM ACQUISITION

**Description:**
Laboratory of configuring a system with biomedical signal acquisition Biopac.

**Specific objectives:**
1. The students will be able to explain the characteristics of an acquisition system and set their parameters for a given application.

**Material:**
Biopac system in the lab.

**Delivery:**
Report with the results and analysis of the measures.

**Full-or-part-time:** 4h
- Laboratory classes: 2h
- Self study: 2h
**Proyect S2 - MEASUREMENT SYSTEM FOR BLOOD PRESSURE AND ECG**

**Description:**
Project of design of a measurement system noninvasive blood pressure and ECG based on the use of sensors, conditioning circuits and a procurement system, by the integrating of circuits obtained in previous practices and complementing it with the signal processing necessary to obtain estimators blood pressure.

**Specific objectives:**
1. Develop skills for teamwork.
2. The student must be able to integrate circuits into the design and add to the project the signal processing necessary to obtain the blood pressure estimators.

**Material:**
Circuits and acquisition system available in the laboratory.

**Delivery:**
Work plan and final report.

**Full-or-part-time:** 19h 40m
Laboratory classes: 4h
Self study: 15h 40m

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**Practice 1 - PRESSURE SENSOR: CHARACTERIZATION, AMPLIFICATION AND ADJUSTMENT OF THE ANSWER**

**Description:**
Laboratory which objective is a design and characterization of a conditioning circuit for a pressure sensor with resistive bridge configuration.

**Specific objectives:**
1. Be able to explain the coupling between sensors with differential output and differential amplifiers.
2. To design basic structures of differential amplifiers and to obtain their characteristics.

**Material:**
Kit available in the laboratory.

**Delivery:**
Previous calculations, report on the measures and analysis.

**Full-or-part-time:** 7h
Laboratory classes: 4h
Self study: 3h
Practice 2- PIEZOELECTRIC SENSOR: CONDITIONING OF A PIEZOELECTRIC SENSOR AND CHARGE MODE AMPLIFIER

**Description:**
Laboratory which objective is the design of the conditioning circuit for a piezoelectric sensor. In addition the characteristics of sensor will be determined.

**Specific objectives:**
1. To be able to explain the load amplifier used (SLOA033A), to design its parameters and to determine its characteristics.

**Material:**
Kit available in the laboratory.

**Delivery:**
Previous calculations, measurements and report analysis.

**Full-or-part-time:** 6h
Laboratory classes: 4h
Self study: 2h

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**GRADING SYSTEM**

Midcourse Control: 20%
Laboratory activities: 20%
Project: 25%
Final exam: 35%
* This subject has not re-evaluation.

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**EXAMINATION RULES.**

Late delivery or non delivery of individual tasks (cooperative work and in the Project) will penalize the final grade. The completion of the laboratory practices and the project is a necessary condition to pass the course.

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**BIBLIOGRAPHY**

**Basic:**

**Complementary:**