820030 - SCSB - Sensors and Signal Conditioners

Coordinating unit: 295 - EEBE - Barcelona East School of Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2017
Degree: BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
BACHELOR'S DEGREE IN BIOMEDICAL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6
Teaching languages: Catalan, Spanish

Teaching staff
Coordinator: Nescolarde Selva, Lexa Digna
Others: Rosell Ferrer, Francisco Javier
Casellas Beneyto, Francisco José

Opening hours
Timetable: Office A8.34. According to timetable consensuated in the presentation class.

Prior skills
Having passed the "Electronic Systems" subject

Requirements
Simultaneously pursue the subject "Biomedical Signal Processing"

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>Total learning time: 150h</th>
<th>Hours large group: 45h</th>
<th>30.00%</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Hours medium group: 0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Hours small group: 15h</td>
<td>10.00%</td>
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<tr>
<td></td>
<td>Guided activities: 0h</td>
<td>0.00%</td>
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<tr>
<td></td>
<td>Self study: 90h</td>
<td>60.00%</td>
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</table>
## Content

### T1. Introduction to the signals acquisition systems

<table>
<thead>
<tr>
<th>Learning time: 8h</th>
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</thead>
<tbody>
<tr>
<td>Theory classes: 4h</td>
</tr>
<tr>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td>Self study: 2h</td>
</tr>
</tbody>
</table>

**Description:**
Structure of measurement systems and biomedical signal acquisition. Characteristics of systems and sensors used. Safety considerations. Classification of sensors.

**Related activities:**
1. Resolution of problem related to characteristics of sensors.
2. Laboratory of static characterization of sensors.

**Specific objectives:**
1. The student will be able to explain and identify concepts related to all 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 used and their generic characteristics.

### T2. Sensor and signal conditioning

<table>
<thead>
<tr>
<th>Learning time: 88h 20m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory classes: 28h</td>
</tr>
<tr>
<td>Laboratory classes: 7h</td>
</tr>
<tr>
<td>Self study: 53h 20m</td>
</tr>
</tbody>
</table>

**Description:**
2.3 Reagents and electromagnetic sensors. AC conditioning circuitry. Bandpass structures. Amplitude detection circuitry. Determination of the errors associated with the frequency limitations of the devices.

**Related activities:**
1. Resolution of problems related to different types of conditioning circuits.
2. Laboratory related to measures of resistance bridge circuit and differential amplifier.
3. Laboratory related to conditioning circuit for a piezoelectric sensor.
4. Design and implementation of conditioning circuits for the project of non-invasive blood pressure measurement.

**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.
### T3. Analog/digital conversion and data acquisition

**Learning time:** 30h  
- Theory classes: 9h  
- Laboratory classes: 2h  
- Self study: 19h

**Description:**  

**Related activities:**  
1. Resolution of problems related to acquisition systems.  
2. Set up a system for the project, which objective is a acquisition noninvasive blood pressure measurement.

**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.

### Project: Design of a measurement system for biomedical signals with Biopac system.

**Learning time:** 23h 40m  
- Theory classes: 4h  
- Laboratory classes: 4h  
- Self study: 15h 40m

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

**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.

**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.
### Planning of activities

<table>
<thead>
<tr>
<th>Proyect.S1- CONFIGURATION OF A SYSTEM ACQUISITION</th>
<th>Hours: 4h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Laboratory classes: 2h</td>
</tr>
<tr>
<td></td>
<td>Self study: 2h</td>
</tr>
<tr>
<td>Support materials:</td>
<td>Biopac system in the lab.</td>
</tr>
<tr>
<td>Descriptions of the assignments due and their relation to the assessment:</td>
<td>Report with the results and analysis of the measures.</td>
</tr>
<tr>
<td>Specific objectives:</td>
<td>1. The students will be able to explain the characteristics of an acquisition system and set their parameters for a given application.</td>
</tr>
</tbody>
</table>

| Proyect.S2- MEASUREMENT SYSTEM FOR BLOOD PRESSURE | Hours: 19h 40m |
|--------------------------------------------------| Theory classes: 0h |
|                                                  | Self study: 15h 40m |
|                                                  | Laboratory classes: 4h |
| Description:                                    | Project of design and implementation of a measurement system noninvasive blood pressure 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. |
| Support materials:                              | Circuits and acquisition system available in the laboratory. |
| Descriptions of the assignments due and their relation to the assessment: | Work plan and final report. |
| 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. |

<table>
<thead>
<tr>
<th>Practice 1- PRESSURE SENSOR: CHARACTERIZATION, AMPLIFICATION AND ADJUSTMENT OF THE ANSWER</th>
<th>Hours: 7h</th>
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</thead>
<tbody>
<tr>
<td>Description:</td>
<td>Laboratory classes: 4h</td>
</tr>
<tr>
<td></td>
<td>Self study: 3h</td>
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<tr>
<td>Laboratory which objective is a design and characterization of a conditioning circuit for a pressure sensor with resistive bridge configuration.</td>
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</tbody>
</table>
Support materials:
Kit available in the laboratory.

Descriptions of the assignments due and their relation to the assessment:
Previous calculations, report on the measures and analysis.

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.

Practice 2 - PIEZOELECTRIC SENSOR: CONDITIONING OF A PIEZOELECTRIC SENSOR AND CHARGE MODE AMPLIFIER

Hours: 6h
Laboratory classes: 4h
Self study: 2h

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

Support materials:
Kit available in the laboratory.

Descriptions of the assignments due and their relation to the assessment:
Previous calculations, measurements and report analysis.

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

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

Regulations for carrying out activities
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:

