1. DATOS BÁSICOS

Asignatura	Sensors & Actuators
Titulación	Grado en Ingeniería Biomédica
Escuela/ Facultad	Arquitectura, Ingeniería y Diseño
Curso	Tercero
ECTS	6 ECTS
Carácter	Obligatorio
Idioma/s	English
Modalidad	Presencial
Semestre	Segundo semestre
Curso académico	2019/2020
Docente coordinador	Borja Rodríguez Vila

2. PRESENTACIÓN

Sensors & Actuators is a mandatory subject of the 3rd academic course of bachelor's degree in Biomedical Engineering, which belongs to the automatization module and totally integrated into the electronic module.
Medicine is one of the disciplines which requires a deep monitoring of information, from many different types and with very different characteristics. Thus, on one hand, the study of sensors plays a key role on the academic training in Biomedical Engineering, being understood as the practical implementation of the electronic instrumentation for detecting and registering variables related to health. On the other hand, actuators are used to give a response to these variables registered by sensors, being motors their main fundamentals, and being closely related to the power electronics.
Therefore, Sensors & Actuators is related to the digital signals processing and to the software development in general. This subject will cover in detail the main sensors used in the health sector. Furthermore, students will build up small sensors' projects on a way that they will put into practice the theory learned.

3. COMPETENCIAS Y RESULTADOS DE APRENDIZAJE

Basic competences:

- CB2: That students know how to apply their knowledge to their work or vocation in a professional manner and possess the skills that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.
- CB3: That students can gather and interpret relevant data (usually within their area of study) to make judgments that include a reflection on relevant social, scientific or ethical issues.
- CB4: That students can transmit information, ideas, problems and solutions to a specialized and non-specialized public.
- CB5: That students have developed those learning skills necessary to undertake further studies with a high degree of autonomy.

Transversal competences:

- CT12: Critical reasoning: Ability to analyze an idea, phenomenon or situation from different perspectives and assume before it a personal approach, built from the rigor and argued objectivity, and not from intuition.
- CT13: Problem solving: Ability to find a solution to a confusing question or a complicated situation without a predefined solution, which hinders the achievement of an end.

Specific competences:

- CE7: Knowledge of sensors and actuators and their applications in biomedical engineering.

Learning outcomes:

- RA1: Ability to apply rigorous measurement procedures.
- RA2: Know the role of the electronics on the measurement devices.
- RA3: Ability to analyse the behavior of actuators.
- RA4: Ability to develop digital controllers.
- RA5: Ability to detect failures

The table below shows the relationship between the competences developed in the subject and the learning outcomes that are pursued:

Competences	Learning outcomes
CB3	**RA1:** Ability to apply rigorous measurement procedures.
CB2, CB3, CB4, CoEs7	**RA2:** Know the role of the electronics on the measurement devices.
CB5, CT12, CoEs7	**RA3:** Ability to analyse the behavior of actuators.
CB5, CT12, CT13, CoEs7	**RA4:** Ability to develop digital controllers.
CB2, CB3	**RA5:** Ability to detect failures

4. CONTENIDOS

Unit 1. Introduction

- Context
- Objectives
- Recapitulation of basic concepts of electronics

Unit 2. Sensor characterization

- Static models
- Dynamic models

Unit 3. Sensing the real world

- Strain sensors
- Motion sensors
- Magnetic sensors
- Acoustic sensors
- Temperature sensors
- Light sensors
- Image sensors
- *Lab practices*

Unit 4. Physical principles for sensing

- Resistance, capacitance, inductance
- Piezoelectric and photoelectric effects
- *Lab practices*

Unit 5. Lumped element models and equivalent circuits

- Mechanical and electrical equivalences.
- Problems in the classroom

Unit 6. Sensors for medical signals

- Electrocardiography
- Electromyography

Unit 7. Actuators

- Universal DC motors
- Flat motors
- Step-by-step motors
- Servo motors
- *Lab practice*

Unit 8. Course Project

- Designed and developed in groups

5. METODOLOGÍAS DE ENSEÑANZA-APRENDIZAJE

The following are the types of teaching-learning methodologies that will be applied:

- Survey of objectives and interests. It is used to establish the objectives of the subject, collect the interests of the student on it, and then go making reference throughout the course so that the group of students is assessing the achievement of those objectives and interests.
- Master class and seminars
- Laboratory practices
- a) Research by groups (jigsaw) and / or b) problem solving by groups. It will be used for the development of both declarative and procedural knowledge. In type a) a different topic is assigned to each group, to investigate; then new groups are formed in which each component of the group has investigated one of the topics, and understanding and problem solving activities are proposed to the new group. In type b) a series of short questions or short problems are proposed for group resolution.

6. ACTIVIDADES FORMATIVAS

Next, the distribution of types of training activities and the dedication in hours to each of them is detailed:

Modalidad presencial:

Formative activities	Number of hours
Master class	40 h
Group work	20 h
Autonomous work	50 h
Mentoring, follow-up and evaluation	25 h
Lab practice	15 h
TOTAL	**150**

7. EVALUACIÓN

The table below shows the evaluation activities, the evaluation criteria of each of them, as well as their weight on the total grade of the subject.

Sistema de evaluación	Peso
Knowledge test	45%
Reports	25%
Alternative evaluation techniques:	15%
Basic competences: inter-pairs evaluation rubric based on lab practices	15%

In the Virtual Campus, when you access the subject, you will be able to consult in detail the activities that you must perform, as well as the delivery dates and the evaluation procedures of each of them.

7.1. Convocatoria ordinaria

To pass the course in ordinary call you must obtain a grade greater than or equal to 5.0 out of 10.0 in the final grade (weighted average) of the subject. Furthermore, you must:

- obtain a grade greater than or equal to 5.0 out of 10.0 in the final exam.
- obtain a grade greater than or equal to 5.0 out of 10.0 in the group project demo.

7.2. Convocatoria extraordinaria

The activities not passed in ordinary call, or those that were not delivered, must be delivered after having received the corresponding corrections by the teacher. Furthermore, if you didn't pass intermediate and final exams, you will have a single exam with a weight of 45%.

8. CRONOGRAMA

In this section, a chronogram with evaluable activities deadlines is shown:

Actividades evaluables	Fecha
Activity 1. Recapitulation of basic concepts	Week 1
Activity 3. Lab practice	Week 4
Activity 5. Presentation about a biomedical sensor	Week 5-6
Activity 7. Lab practice	Week 8-9
Activity 8. Midterm exam	Week 9-10
Activity 12. Lab practice	Week 13-14
Activity 13. Lab report	Week 15

Activity 14. Project report	Week 17
Activity 15. Project demo and presentation	Week 17
Activity 16. Final exam	Week 15

This chronogram can have modifications due to logistic reasons related to the activities. Any modification will be notified to the student through the Virtual Campus.

9. BIBLIOGRAFÍA

The book of reference for this course is:

- Handbook of modern sensors: Physics, Designs and Applications. Jacob Fraden. SpringerLink

10. UNIDAD DE ATENCIÓN A LA DIVERSIDAD

Estudiantes con necesidades específicas de apoyo educativo:

Las adaptaciones o ajustes curriculares para estudiantes con necesidades específicas de apoyo educativo, a fin de garantizar la equidad de oportunidades, serán pautadas por la Unidad de Atención a la Diversidad (UAD).

Será requisito imprescindible la emisión de un informe de adaptaciones/ajustes curriculares por parte de dicha Unidad, por lo que los estudiantes con necesidades específicas de apoyo educativo deberán contactar a través de: unidad.diversidad@universidadeuropea.es al comienzo de cada semestre.

INSTITUTIONAL ASSESSMENT OF LEARNING OUTCOMES PLAN
Covid-19
TEMPLATE TO ADAPT TEACHING AND EVALUATION ACTIVITIES

Course/Module: Sensors & Actuators
Degree Program: Biomedical Engineering
Year (1º-6º): 2º
Group (s): M32
Professor: Borja Rodriguez Vila
Coordinating professor: Borja Rodriguez Vila (Degree coordinator)

Teaching Activity described in the syllabus	Adapated activity in distance learning
Master class	Performed online using BB Collaborate
Group work	Performed online using BB Collaborate and other cloud tools
Autonomous work	No change
Mentoring, follow-up and evaluation	Performed online using BB Collaborate and email
Lab practice	Lab exercises are performed online, buying Arduino kits and using BB Collaborate

Laboratory exercises		Laboratory exercises (adapted)	
Description of original fase to face evaluation activity	Laboratory exercises	**Description of new activity**	Laboratory exercises
Content to be assessed	3 laboratory exercises: - Sensor characterization - Wheatstone Bridge and Pulse Width Modulation - Servomotors and stepper motors The second practice is adapted because the students do not have a multimeter at home.		
Learning Outcomes to be assessed ***(Please check Syllabus of the course/module)***	The Learning Outcomes that are addressed are the same: specify: RA1: Ability to apply rigorous measurement procedures. RA3: Ability to analyse the behavior of actuators. RA4: Ability to develop digital controllers. RA5: Ability to detect failures		
Duration	3 hours each	**Approximate duration**	3 hours 22/05/2020
Weight in evaluation	15%		15%
Please note:	The students will perform the laboratory practices at home following written instructions. The selected date, they will present the experimental setups.		

Presentation		Presentation (adapted)	
Description of original fase to face evaluation activity	Presentation about a biomedical sensor	**Description of new activity**	Presentation about a biomedical sensor
Content to be assessed	The student should investigate a biomedical sensor and explain the subjacent problem, the sensor functioning and the physical principle it is based on.		
Learning Outcomes to be assessed ***(Please check Syllabus of the course/module)***	The Learning Outcomes that are addressed are the same: specify: RA1: Ability to apply rigorous measurement procedures. RA3: Ability to analyse the behavior of actuators. RA4: Ability to develop digital controllers. RA5: Ability to detect failures		
Duration	2 hours	**Approximate duration**	2 hours 03/04/2020
Weight in evaluation	5%		5%
Please note:	Presentations in BB Collaborate, already performed, recorded and evaluated.		

Course project		Course project (adapted)	
Description of original fase to face evaluation activity	Presentation and demo of the course project	**Description of new activity**	Presentation and demo of the course project
Content to be assessed	The student should find a problem and propose a solution. Development of a proof-of-concept consisting of sensors, actuators and a control system.		
Learning Outcomes to be assessed ***(Please check Syllabus of the course/module)***	The Learning Outcomes that are addressed are the same: specify: **RA4: Ability to develop digital controllers.** **RA5: Ability to detect failures**		
Duration	2 hours	**Approximate duration**	2 hours 29/05/2020
Weight in evaluation	10%		10%
Please note:	Presentations in BB Collaborate.		

Intermediate exam		Intermediate exam (adapted)	
Description of original fase to face evaluation activity	Intermediate exam	**Description of new activity**	Resolution of problems.
Content to be assessed	The intermediate exam covers the 4 first units of the course.		
Learning Outcomes to be assessed ***(Please check Syllabus of the course/module)***	The Learning Outcomes that are addressed are the same: specify: **RA1: Ability to apply rigorous measurement procedures.** **RA2: Know the role of the electronics on the measurement devices.**		
Duration	1.5 hours	**Approximate duration**	1.5 hours 01/05/2020
Weight in evaluation	10%		10%
Please note:	The students must send the solution in a certain period. Different models of the problems will be created.		

Final exam		Final exam (adapted)	
Description of original fase to face evaluation activity	Final exam	**Description of new activity**	Resolution of problems. Theory test in BB
Content to be assessed	The final exam covers all the course.		
Learning Outcomes to be assessed ***(Please check Syllabus of the course/module)***	The Learning Outcomes that are addressed are the same: specify: **RA1: Ability to apply rigorous measurement procedures.** **RA2: Know the role of the electronics on the measurement devices.**		
Duration	2.5 hours	**Approximate duration**	2.5 hours 05/06/2020
Weight in evaluation	35%		**35%**
Please note:	• Resolution of problems: 20%. The students must send the solution in a certain period. Different models of the problems will be created. • Theory test using Blackboard and Respondus: 15%.		

Report		Report (adapted)	
Description of original fase to face evaluation activity	Report	**Description of new activity**	Reports
Content to be assessed	The lab practices report should cover the 3 lab practices. The course project report should cover all the information about the course project, including code and circuit diagrams.		
Learning Outcomes to be assessed ***(Please check Syllabus of the course/module)***	The Learning Outcomes that are addressed are the same: specify: RA1: Ability to apply rigorous measurement procedures. RA3: Ability to analyse the behavior of actuators. RA4: Ability to develop digital controllers. RA5: Ability to detect failures		
Duration		**Approximate duration**	
Weight in evaluation	25%		**25%**
Please note:	Lab practices report: 10% **Course project report: 15%**		