GENERAL INFORMATION

Course information	
Name	Biomedical Electronics
Code	DEA-OPT-624
Degree	MII, MITL
Year	2º
Semester	2º / Spring
ECTS credits	3 ECTS
Type	Elective
Department	Electronics, Control Engineering and Communications
Area	Analog electronics
Coordinator	Romano Giannetti

Lecturer	
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Lecturer	
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Department	
Area	
Room	
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Tutorial timetable	

DETAILED INFORMATION

Contextualization of the course

Contribution to the professional profile of the degree

The course is aimed to provide to the students the basic knowledge required to undertake the study of electronic systems used in medical field, and the associated instrumentation.

When students have finished out the course, they will understand the basic principles governing the generation and emission of signals in and from the human body, the basics of safety regulations in designing biomedical systems and the techniques and electronic principles on which are based the instruments used in medical field. This will provide the ability to decide on the selection, purchase and installation of these systems in a hospital or clinic environment. Additionally, the student will have a foundation on which they can build up more knowledge in order to be able to participate in the design and implementation of biomedical systems.

Prerequisites

The prerequisites that students must have to fruitfully follow the course are the basic concepts of analog electronics: amplification and operational amplifiers (input and output impedances, basic operational amplifier circuits as inverting and non-inverting amplifiers) , concept of signal and bias in amplifiers, frequency response (Bode plots), filter circuits (first-order low pass, high pass, and second-order resonant filters), basic electromagnetic fields principles. In addition they should have a working knowledge of the mathematical methods used in the design and analysis of the above electronic systems: concepts of signals and their spectra, use of complex impedances, frequency analysis of circuits.

CONTENTS

Competences and Learning Outcomes

Competences

General Competences

CG3. The capability of adapting to new theories, methods and changing engineering situations based on a sound technical training.

CG4. The capability of solving problems with personal initiative, efficient decision making, critical reasoning and transmitting technical information in the engineering world.

CG5. The capability of conducting measurements, calculations, assessments, studies, reports, planning, etc.

CG10. The ability to work in a multilingual and multidisciplinary environment.

Basic Competences

Specific Competences

Learning outcomes

RA1. The student understands how electrical signals are generated in the human body, and how to pick them up.

RA2. The student has a basic knowledge of the sensors used to translate biological quantities in electrical signals.

RA3 The student is able to assess the effect that a current can have on the body given its characteristics (intensity, frequency, duration).

RA4.The student know the risks associated with the electrical stimulation of body tissues.

RA5. The student understands the concept of differential/instrumentation amplifier, and is able to apply that knowledge both in analyzing a given circuit and to find out the characteristics of the amplifier given the specific problem.

RA6. The student understands the concept of Digital to Analog conversion, its feature and limitation, and understands the meaning of the related parameters (bits, dynamic range, linearity, quantization noise, etc.).

RA7. The student understands the concept of noise and interference pick-up, and is able to calculate the effect of noise in an electronic system.

RA8. The student has a basic knowledge of the safety norms in biomedical instrumentation design, and their application.

RA9.The student knows the design solutions oriented toward safety, such as insulation amplifiers, breakers, safety alarms and uninterrupted supply systems.

RA10. The student is able to find information about a biomedical instrument, analyze and understand it, and explain its working principles to the other students.

TEACHING METHODOLOGY

General methodological aspects

The course will be divided in two parts, partly overlapping in time. The teacher will explain the basics of the subject and will go in depth in the more important issues, proposing exercises and quizzes for the student to solve in class in a collaborative way. After the first third of the course is completed, the students will form groups and each one will research a specific application, which will present to the rest of the class in the last third of the course.

In-class activities

1.- **Expository lesson (11h)**: The instructor will explain the fundamental concepts, stressing the most important issues. At all time an active participation will be required to the student, by asking questions, posing problems, and stimulating open discussion.
2.- **Problem-solving sessions (4h):** The professor will propose a problem, and the students, organized in small informal groups, will solve it under the instructor's supervision.
3.- **Supervised group work (6h)**: The students, organized in groups, will research and study a specific biomedical instrument under the lecturer's supervision, and prepare a presentation for the rest of the class.
4.- **Presentations (4h):** the students, organized in groups, will explain to the rest of the class the working of a specific biomedical instrumentation system.
5.- **Tutoring (3h):** review sessions and additional tutoring, which will be organized when needed, on a per-group and/or per-student base.
6.- **Evaluation (2h):** quizzes and one mid-term exam.

Off-class activities

At-home work will be focused on the objective to learn to solve problems oriented to biomedical instrumentation systems design and to learn to understand complex system and prepare to explain them to other people.

So the main at-home activities will be:

1.- Personal, individual study of the course materials and books. (44h)
2.- Research about medical instrumentation using the proposed bibliography and other sources. (12h)
3.- Preparation of the presentations to explain the specific instrument chosen by the group. (4h)

ASSESSMENT AND GRADING CRITERIA

Assessment activities	Grading criteria	Share
tests: • Quizzes • Mid-term exam(s) • Final exam	- Check the full understanding of the theoretical concepts. - Problem-solving, applying the concepts. - Critical evaluation of the results of numerical exercises. - Written communication skills.	60%
The grade on the final exam must be at least 4 (over 10) to pass the course.		
•	-	
Presentations: • Evaluation of the written material developed by the group • Evaluation of the quality of the oral presentation	- Full understanding of the concept. - Skills in selecting the important part of the information - Summarizing and highlighting the main features of the systems. - Group work skills. - Oral presentation skills.	40%
There will be an inter-group evaluation method to differentiate among members of the same group.		

GRADING AND COURSE RULES

Grading

Regular assessment

In the ordinary assessment period, the final grade will be obtained as follow:
 60% will be the exams grade (30% mid-term and quizzes, 30% final). The grade on the final exam must be at least 4 (over 10) to pass the course, independently from the other marks.

 40% from the presentation/group work; in case the student is not presenting any project/group work, the course will be evaluated as failed.

In the retake/extraordinary period, which will be granted only if the student presented a group work, the final grade will be:

 60% from the extraordinary (retake) exam grade, with a minimum mark of 4 (over 10).
 40% from the presentation.

Retakes

In the retake/extraordinary period, which will be granted only if the student presented a group work, the final grade will be:

 60% from the extraordinary (retake) exam grade, with a minimum mark of 4 (over 10).
 40% from the presentation.

Course rules

- Each test will check the totality of the course content to that point
- The lack of assistance throughout the course of over 15% of the teaching hours can cause the loss of the right for the student to take the exam in the ordinary session of the academic year (cf. **Artículo 93º: Escolaridad,** Reglamento General de la Universidad, Normas Académicas ETSI-ICAI)
- The student who commits an irregularity in any evaluable test will be graded Fail (0) on this test and a disciplinary procedure will be opened against him or her (cf. **Artículo 168º. Infracciones y sanciones del alumnado**, Reglamento General de la Universidad).
- During the tests, generally, the use of books and notes is forbidden. In most tests, the use of a calculator and a one-page cheat-sheet will be allowed (check with the instructor).

WORK PLAN AND SCHEDULE[1]

Off-class activities	When?	Date due
• Read and study the day's subject	After each lesson	
• Review the solution of the proposed problems and quizzes	Every three weeks	
• Analysis and selection of the subject for the group presentation	Week 5	Week 6
• Personal study for the mid-term and final exams	Week 7 and 14.	
• Preparation of the presentation material (PDF/PPT presentation, hand-out, summary)	Week 10 to 14	One day before the presentation

STUDENT WORK TIME SUMMARY			
IN_CLASS HOURS			
Expository lesson	**Supervised Group work**	**Presentations / tutoring**	**Evaluation**
11	10	7	2
OFF_CLASS HOURS			
Personal study	**Research about biomedical systems**	**Group work: preparation of the presentations**	
44	12	4	
		CRÉDITOS ECTS:	**3 (90 horas)**

BIBLIOGRAPHY

Bibliografía Básica

- Notes prepared by the lecturer (in the Web page of the course).
- Joseph Bronzino, Susan~M. Blanchard, and John Enderle., *Introduction to Biomedical Engineering.* Academic Press, 1999. ISBN: 0122386604

Bibliografía Complemetaria

- John G. Webster, Medical Instrumentation: applications and design, Wiley; 4 edition (February 3, 2009)
- B.H. Brown, R.H. Smallwood, D. Hose, et al., *Medical Physics and Biomedical Engineering*. The Institute of Physics, 1999, ISBN: 0750303689.
- Leslie Cromwell. *Instrumentación y medidas biomédicas,* Prentice Hall, 1980., ISBN: 0130764485.
- Michael Domach., *Introduction to Biomedical Engineering*. Prentice Hall, 2003. ISBN: 0130619779.
- Sverre Grimmes, Orjan Martinsen., *Bioimpedance and bioelectricity basics.* Academic Press, 2000. ISBN: 0123032601.

[1] En la ficha resumen se encuentra una planificación detallada de la asignatura. Esta planificación tiene un carácter orientativo y las fechas podrán irse adaptando de forma dinámica a medida que avance el curso.

- Leonard Johnson, editor, *Essential Medical Physiology.* Academic Press, 2003. ISBN: 0123875846.
- Robert Northop, *Signal and System Analysis in Biomedical Engineering.* CRC press, 2003. ISBN: 0849315573.
- Reinaldo Perez, *Design of Medical Electronic Devices.* Academic Press, 2002. ISBN: 0125507119.
- Ajit Sadana, *Engineering Biosensors: Kinetics and Design Applications*. Academic Press, 2001. ISBN: 0126137633.
- Daniel J. Schneck,Joseph D. Bronzino, *Biomechanics: Principle and Applications.* CRC Press, 2002. ISBN: 0849314925.

	IN-CLASS ACTIVITIES				OUT-OF-CLASS ACTIVITIES				LEARNING OUTCOMES
Week	h/w	LECTURE & PROBLEM SOLVING	LAB	ASSESMENT	h/w	SELF-STUDY	LAB PREPARATION AND REPORTING	OTHER ACTIVITIES	Learning Outcomes
1	2	Introduction, historical perspective. (2h)			2	Review and self-study (2h)			RA1
2	2	Physiology of the electric signals produced by the human body. (45'), problem solving (1h)			4	Review, self-study and problem-solving (4h)			RA1, RA2
3	2	Body and EM fields interactions. (2h)		Quiz (15')	4	Review, self-study and problem-solving (4h)			RA3, RA4
4	2	Amplification. Instrumentation and differencial amplifier. (45'), problem solving (1h)			4	Review, self-study and problem-solving (4h)			RA5
5	2	Noise and interferences, system design. (2h)			4	Review, self-study and problem-solving (4h)			RA5, RA7
6	2	Conversion to digital signals. Effective bits. Sampling, anti-aliasing and anti-imaging. (45'), problem solving (1h)		Quiz - midterm (30')	4	Review, self-study and problem-solving (4h)			RA6
7	2	Safety in biomedical instrumentation. Insulation amplifiers. (2h)			4	Review, self-study and problem-solving (4h)			RA4, RA8, RA9
8	2	Electrodes and examples of biomedical systems. (45'), problem solving (1h)			4	Review, self-study and problem-solving (4h)			RA1,RA2
9	2	Review (1h)		Quiz + Mid-term exam (1h)	4	Review, self-study and problem-solving (4h)			RA1 to RA9
10	2	Specific instrumentation topic list; group assignment, group work (2h)			4	Group Work (4h)			RA10
11	2	Supervised group work (2h)			4	Group Work (4h)			RA1 to RA10
12	2	Supervised group work (2h)			4	Group Work (2h)		Presentation preparation (2h)	RA1 to RA10
13	2	Presentations (2h)			4	Group Work (2h)		Presentation preparation (2h)	RA1 to RA10
14	2	Presentations (2h)		Final project presentations (2h)	4	Review, self-study and problem-solving (4h)			RA1 to RA10
15	2			Final exam	6	Review, self-study and problem-solving (6h)			RA1 to RA10