Universidad de Alcalá

TEACHING GUIDE

Bioengineering

Degree in
Information System Engineering (GISI)
Computer Engineering (GIC)
Computer Science Engineering (GII)

Universidad de Alcalá

Academic Year 2024/2025

4th Year - 2nd Semester (GISI+GIC+GII)

Approved by the EPS School Board on June 14th, 2024

TEACHING GUIDE

Course Name:	**Bioengineering**
Code:	**780030 (GISI+GIC+GII)**
Degree in:	**Information System Engineering (GISI)** **Computer Engineering (GIC)** **Computer Science Engineering (GII)**
Department and area:	**Electrónica** **Electronic Technology**
Type:	**Optional (Generic) (GISI+GIC+GII)**
ECTS Credits:	**6.0**
Year and semester:	**4th Year - 2nd Semester (GISI+GIC+GII)**
Teachers:	Juan Manuel Miguel Jiménez (coordinator)
Tutoring schedule:	It will be communicated at the beginning of the course
Language:	Spanish/English Friendly

1. COURSE SUMMARY

This course on Bioengineering aims to introduce students to the study of instrumentation and methods used in Biomedical Engineering.

Basics of electrophysiology, acquisition, processing and transmission of biomedical signals are studied. Diagnostic and therapeutic medical instrumentation is also discussed, as well as telemedicine and telesurgery systems.

In order to make the most of the course, it is recommended to have some previous knowledge related to the undergraduate course of Foundations of Programming.

2. SKILLS

Basic, Generic and Cross Curricular Skills.

This course contributes to acquire the following basic, generic and corss curricular skills:

en_CG1 - Ability to conceive, write, organize, plan, develop and sign projects in the field of computer engineering that are intended, in accordance with the knowledge acquired as established in section 5, annex 2, of resolution BOE-A -2009-12977, the conception, development or exploitation of computer systems, services and applications.

en_CG4 - Ability to define, evaluate and select hardware and software platforms for the development and execution of computer systems, services and applications, in accordance with the knowledge acquired as set out in section 5, annex 2, of resolution BOE-A-2009 -12977.

en_CG6 - Ability to conceive and develop centralized or distributed computer systems or architectures integrating hardware, software and networks in accordance with the knowledge acquired as set out in section 5, annex 2, of resolution BOEA-2009-12977.

en_CG8 - Knowledge of the basic subjects and technologies, which enable them to learn and develop new methods and technologies, as well as those that provide them with great versatility to adapt to new situations.

en_CG9 - Ability to solve problems with initiative, decision making, autonomy and creativity. Ability to know how to communicate and transmit the knowledge, skills and abilities of the profession of Computer Engineering Engineer.

en_CB1 - That students have demonstrated to possess and understand knowledge in an area of study that is based on general secondary education, and is usually found at a level that, although supported by advanced textbooks, also includes some aspects that involve knowledge from the forefront of their field of study.

en_CB2 - That the students know how to apply their knowledge to their work or vocation in a professional manner and possess the competencies that are usually demonstrated through the elaboration and defense of arguments and the resolution of problems within their area of study.

en_CB3 - That students have the ability to 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.

en_CB4 - That students can transmit information, ideas, problems and solutions to both a specialized and non-specialized public.

en_CB5 - That the students have developed those learning skills necessary to undertake further

studies with a high degree of autonomy.

en_TRU1 - Capacity of analysis and synthesis.

en_TRU2 - Oral and written competencies.

en_TRU3 - Ability to manage information.

en_TRU4 - Autonomous learning skills.

en_TRU5 - Team work.

Specific Skills

This course contributes to acquire the following specific skills:

en_CIC1 - Ability to design and build digital systems, including computers, microprocessor-based systems and communications systems.

en_CIC7 - Ability to analyze, evaluate, select and configure hardware platforms for the development and execution of computer applications and services.

Learning Outcomes

Upon successful completion of this course, students will be able to:

- **RA1**: Describe the basic concepts of electrophysiology that are related to technology.
- **RA2**: Understand the physiological principles in the origin of the main medical signals.
- **RA3**: Develop practical IT and Robotic applications for Biomedical Engineering.

3. CONTENTS

Content Blocks	Total number of hours
Topic 1: Introduction to Bioengineering. Definition. Brief history. Goals. Application areas. Medical instrumentation.	8 hours
Topic 2: Basic concepts of Electrophysiology. Membrane potential. Action potential. Refractory and accommodation periods. Propagation of the action potential.	10 hours
Topic 3: Medical signals. Cardiac System. ECG analysis. Pacemakers and defibrillators. Electroencephalography. Evoked potentials.	24 hours
Topic 4: Applications of ITs in Biomedical Engineering. Telemedicine and Telecare. Telesurgery and Virtual Reality. Medical Robotics.	14 hours

4. TEACHING - LEARNING METHODOLOGIES. FORMATIVE ACTIVITIES.

4.1. Credits Distribution

Number of on-site hours:	60 hours (56 hours on-site + 4 exams hours)
Number of hours of student work:	90
Total hours	150

4.2. Methodological strategies, teaching materials and resources

In the teaching and learning process the following training activities will be undertaken:

- Theoretical Classes and example solving.
- Practical Classes: laboratory and exercise solving.
- Tutorials: individual and/or in groups.

The following complementary resources, among others, will also be available for use:

- Attendance at conferences, seminars or scientific discussions which are related to the module content.
- Watching videos about the content of this subject.

In the course of the year, both theoretical and practical activities and tasks will be proposed to the students. Different practical tasks will be undertaken at the same time as theoretical concepts are taught, so that students can experiment both individually and in groups, thus consolidating their knowledge of the concepts they have learned.

In order to complete these practical tasks, the students will have access to an area in the laboratory with the necessary instrumentation (oscilloscope, power supply, signal generator) and a computer with biomedical signal acquisition and processing software. In this subject, it is proposed that the practices be carried out in groups of two students.

In the course of the module, the students must make use of different bibliographic resources, so that they familiarize with the type of documentation that they will use professionally in their future.

The faculty will provide the students with the necessary materials for the follow-up of the subject (theoretical foundations, exercises and problems, lab guides, audiovisual references, etc.) so that the student can meet the objectives of the subject, as well as achieve the expected skills.

The students will have scheduled group and individual tutorials throughout the semester, according to their needs. Either individually or in small groups, these tutorials will solve the questions and strengthen their knowledge. In addition, they will help to carry out an adequate follow-up of the students and to evaluate the teaching-learning methods.

5. ASSESSMENT: procedures, evaluation and grading criteria

Preferably, students will be offered a continuous assessment model that has characteristics of formative assessment in a way that serves as feedback in the teaching-learning process.

5.1. PROCEDURES

The evaluation must be inspired by the criteria of continuous evaluation (Learning Assesment Guidelines, LAG, art 3). However, in compliance with the regulations of the University of Alcalá, an alternative process of final evaluation is made available to the student in accordance with the Learning Assesment Guidelines as indicated in Article 10, students will have a period of fifteen days from the start of the course to request in writing to the Director of the Polytechnic School their intention to take the non-continuous evaluation model adducing the reasons that they deem convenient. The evaluation of the learning process of all students who do not apply for it or are denied it will be done, by default, according to the continuous assessment model. The student has two calls to pass the subject, one ordinary and one extraordinary.

Ordinary Call

Continous Assessment:

Consisting in taking and passing two basic theoretical knowledge tests (TCBs), all laboratory practices (PP.LL.) and two laboratory knowledge tests (TCLs) throughout the semester.

Assessment through final exam:

Consisting in taking and passing a basic theoretical knowledge test (TCB), all laboratory practices (PP.LL.) and a laboratory knowledge test (TCL).

Extraordinary Call

Consisting in taking and passing a basic theoretical knowledge test (TCB), all laboratory practices (PP.LL.) and a laboratory knowledge test (TCL), each of which may be recognized if the student has already passed the equivalent part in the ordinary call.

5.2. EVALUATION

EVALUATION CRITERIA

The assessment criteria measure the level in which the competences have been acquired by the student. For that purpose, the following are defined::

- **CE1**: The student shows capacity and initiative when solving practical problems of Bioengineering.
- **CE2**: The student can implement a technological design of a system for an application in Bioengineering.
- **CE3**: The student has acquired knowledge about electrophysiology, medical signals and applications of the IT in Biomedical Engineering.

GRADING TOOLS

The work of the student is graded in terms of the assessment criteria above, through the following tools:

1. **Basic Theoretical Knowledge Tests (TCB1 and TCB2)**: Two tests will be taken throughout the

course that will consist of a series of multiple choice questions that will address the basic theoretical aspects of the topics taught.

2. **Laboratory knowledge tests (TCL1, TCL2):** Simple tests, on the practices carried out in which the student must demonstrate the programming skills acquired. They will be taken in the same session as TCB1 and TCB2, respectively.
3. **Laboratory sessions (PP.LL.)**: The student must acquire biomedical signals and implement programs to process them so that they provide solutions to practical cases. It will be necessary to integrate the knowledge acquired and to make use of the bibliographic resources and computer tools available. The student must also be able to write clear and accurate reports about the work done in the laboratory.

GRADING CRITERIA

In the ordinary call-continuous assessment the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Weight in the final grade
en_CG1,en_CG6,en_CG8,en_CG9, en_CIC1, en_CB1, en_CB3, en_CB5, en_TRU1, en_TRU3	RA1, RA2, RA3	CE1, CE3	TCB1	30%
			TCB2	30%
en_CG1, en_CG4, en_CG6, en_CG8, en_CIC7, en_CB2, en_CB4, en_TRU2, en_TRU4, en_TRU5	RA3	CE1, CE2	TCL1, TCL2, PP.LL.	40%

To consider the continuous assessment passed, (demonstrating the acquisition of competencies) students must meet the following conditions:

- They have attended at least 50% of the theoretical classes.
- They have taken both basic knowledge tests (TCBs) and laboratory tests (TCLs).
- They have passed the evaluation of competences related to the laboratory practices. A student acquires these competences if he or she completes all the practices.
- They have satisfactorily passed the evaluation of the competencies related to all the theoretical tests (TCB1+TCB2) and practical tests (TCL1+TCL2). A student acquires these competences if his or her average grade in these tests is equal to or greater than 50% of its maximum.
- The final weighted grade of all the continuous assessment tests is equal to or greater than 5 out of 10.

The student who follows the continuous assessment model will be considered not taken in the ordinary call, when he or she does not take the first TCB1 and TCL1 tests.

In the ordinary call-final evaluation, the relationship between the competences, learning outcomes, criteria and evaluation instruments is as follows.

Skill	Learning Outcomes	Evaluation criteria	Grading Tool	Weight in the final grade
en_CG1, en_CG4, en_CG6, en_CG8, en_CIC7, en_CB2, en_CB4, en_TRU2, en_TRU4, en_TRU5	RA3	CE1, CE2	TCL, PP.LL.	40%
en_CG1,en_CG6,en_CG8,en_CG9, en_CIC1, en_CB1, en_CB3, en_CB5, en_TRU1, en_TRU3	RA1, RA2, RA3	CE1, CE3	TCB	60%

To pass this subject according to this model, the student should get at least 50% of the maximum grade

in each part (TCB, TCL). To pass this subject according to this model, the student must obtain a final weighted grade resulting from the two parts (TCB, TCL) equal to or greater than 50% of the maximum grade obtainable, and have completed all laboratory practices (PP.LL.).

Extraordinary call

Students who do not pass the subject in the ordinary call will have the extraordinary call, which will consist of a general test with the same scheme and percentages as that of the final evaluation model.

Those students who have been evaluated for the laboratory practices in the ordinary call and have not passed them, must repeat and pass them. In the case of students who take directly the extraordinary call without having taken the ordinary one, they must present the same laboratory practices.

Students who have passed the theoretical or practical part in the ordinary call can carry forward the grade for the passed part.

6. BIBLIOGRAPHY

6.1. Basic Bibliography

- Documentation prepared by the teaching staff, which will be provided directly to the students, or on the web page.
- Video-classes covering the theoretical knowledge of this subject.
- Medical instrumentation. J.G. Webster; editor, 2nd edition. John Wiley & Sons, Houghton Mifflin Company, Boston. 1995.
- Bioelectrónica. José Mª Ferrero Corral. Ed. Universidad Politécnica de Valencia. 1994
- Web pages related to this subject that will be previously selected by the teaching staff.

6.2. Additional Bibliography

- Instrumentación y medidas biomédicas. L. Cromwell, F. Weibell, E. Pfeiffer, l. Uselman. Ed. Marcombo, 1980. 5. Anatomía humana (3 vol). Rouviere
- Fisiología médica. Tresguerres.
- Fisiología. Guyton
- Física e instrumentación médicas. Juan R. Zaragoza. Ed: Massson - Salvat
- Introducción a la bioingeniería. Ed: Marcombo.
- Instrumentación quirúrgica. Joanna Fuller. Ed: Paramericana.
- Bio-medical telemetry. R. S. Mackay. IEEE Press.
- Biomedical signal processing. Metin Akay. Ed: Academic Press.
- Cybersurgery. Richard Satava. Ed: Advisory Board.
- Engineering approaches to mechanical and robotic design for minimally invasive

Disclosure Note

During the evaluation tests, the guidelines set out in the Regulations establishing the Rules of Coexistence of the University of Alcalá must be followed, as well as the possible implications of the irregularities committed during said tests, including the consequences for committing academic fraud according to the Regulation of Disciplinary Regime of the Students of the University of Alcalá.