Universidad Rey Juan Carlos

TEACHING GUIDE

Bioelectric Fundamentals

GRADO EN INGENIERÍA BIOMÉDICA (INGLÉS) (1º y 2º curso)

ACADEMIC YEAR 2026-27

Q2803011B UNIVERSIDAD REY JUAN CARLOS
Fecha firma: 08/11/2026 02:38 | Hash: 1072a13878fa647b8750b3d6eddac547.

Publication date: 02-07-2026

Q2803011B UNIVERSIDAD REY JUAN CARLOS
Fecha firma: 08/11/2026 02:38 | Hash: 1072a13878fa647b8750b3d6eddac547.

I.-Subject Identification	
Type	FORMACIÓN BÁSICA
Teaching period	2 course, 2Q semester
Nº of credits	6
Language in wich the subject is taught	English

II.-Presentation

The subject presents the fundamentals of electricity and magnetism and the bioelectric and biomagnetic mechanisms of living organisms. More specifically, the student will achieve the following objectives:
1. To learn the creative process that leads to asking questions about the reasons behind the mysteries of life and rigorously. searching for answers.
2. To know and analyze the reasons for the main historical questions and the solutions found from the origins of electricity and magnetism to current knowledge in bioelectricity.
3. To differentiate the different mathematical and physical tools of field theory in order to understand and apply them.
4. To understand the electrical and magnetic mechanisms in the different components present in a circuit.
5. To assimilate the electromagnetic joint concepts and the mechanism of the electromagnetic wave.
6. To identify the elements of the cell (understanding them as elements of a circuit) that enable the bioelectric processes to be studied.
7. To delve into vector concepts and bioelectric potentials produced in cells.
8. To understand the mechanisms that enable electrical propagation in living organisms' bodies.
9. To distinguish the field concepts seen above in the extracellular environment.
10. To know the principles of cardiac electrophysiology.
For the best achievement of these objectives, knowledge of the following subjects or subjects is required:
- Calculus.
- Programming Fundamentals.
- Algebra.
- Physics.
- Mathematical methods of Bioengineering

III.-Learning outcomes

CON05. Understand or acquire the principles of bioelectrical fundamentals, ana-tomy, physiology or pathophysiology needed to identify the most appropriate processing technolo-gies for a given problem in biomedical engineering.
CON10. Un-derstand electrical and magnetic phenomena at the cellular level, analyze the physical basis of ra-diation interaction with the body and its applications in biomedicine, understand the concepts of continuum mechanics and fluid mechanics and their applications in biomedicine.
CON21. Knowledge and understanding of engineering fundamentals underlying their specialisation, at a level necessary to achieve the other programme outcomes, including some awareness at their forefront. (EURACE 1.2)
HAB09. Solve physical problems in biomedical engineering using knowledge of kinematics, dynamics, electromagnetism, waves, fluids, bioelectricity, and biomechanics.

- Key for degrees not adapted to RD 822/21: **CB** - basic competences, **CG** - generic competences, **CE** - specific competences, **CT** - transversal competences.
- Key for degrees adapted to RD 822/21: **CON** - knowledge, **COM** - competences, **HAB** - skills.

Q2803011B UNIVERSIDAD REY JUAN CARLOS
Fecha firma: 08/11/2026 02:38 | Hash: 1072a13878fa647b8750b3d6eddac547.

IV.-Contents

IV.A.-Syllabus

Part 1 - Electrostatics.
•Electric field.
•Gauss' Law.
•Electric potential.
•Dielectrics and capacity.
•Current and resistance.
•Introduction to circuits
•Magnetic fields.
•Magnetic sources.
•Farady's Law.
•Inductance.
•Altern current.
•Maxwell's Equations.
•Electromagnetic fields.
Part 2 - Bioelectricity.
•Vector analysis review.
•Sources and fields.
•Bioelectric potentials.
•Ionic channels.
•Action potentials.
•Impulse propagation.
•Extracellular fields.
•Cardiac electrophysiology.

IV.B.-Training activities

Type	Title
Theoretical sessions	Theoretical masterclass.
Practical sessions	Electrostatics, Magnetostatics, and Bioelectricity labs.
Resolution of exercises, problems, case studies	Electrostatics, Magnetostatics, and Bioelectricity problems.
Test and/or exams	Partial continued evaluation tests.
Test and/or exams	Final evaluation tests.
Academic tutorials	Specific tutorial sessions demanded by each student.

Q2803011B UNIVERSIDAD REY JUAN CARLOS
Fecha firma: 08/11/2026 02:38 | Hash: 1072a13878fa647b8750b3d6eddac547.

V.-Student workload	
Theoretical sessions	25
Resolution of exercises, problems, case studies, etc.	20
Practical sessions in experimental, technological and clinical laboratories, fieldwork, etc.	11
Tests and/or exams	4
Academic tutorials	40
Related activities: conferences, seminars, etc.	8
Preparation of theoretical sessions and self-study	25
Preparation of practical tasks, exercises, case studies, projects, etc.	25
Preparation for tests and/or exams	22
Total student workload	180

VI.-Methodology and academic programme		
Type	**Period**	**Content**
Theoretical sessions	Week 1 to Week 16	Master class.
Resolution of exercises, problems, case studies	Week 1 to Week 16	Solving theoretical-practical questions.
Practical sessions	Week 1 to Week 16	Labs.
Seminars	Week 15 to Week 16	Seminars on selected and related topics.
Academic tutorials	Week 1 to Week 16	Tutorial sessions for specific doubts of the student.

Q2803011B UNIVERSIDAD REY JUAN CARLOS
Fecha firma: 08/11/2026 02:38 | Hash: 1072a13878fa647b8750b3d6eddac547.

VII.-Assessment methods

The general assessment method is continuous as established in the *Regulation for the Assessment of Learning Outcomes* of Rey Juan Carlos University.
All the assessment systems established in the degree report must be employed, except for those that have a minimum weight of 0%, which can be used by professors in the academic years they consider relevant. Each assessment system may be applied through one or more assessment activities, consistent with the system. No assessment activity can exceed individually 60% of the overall grade for the subject.
The sum of non re-evaluable activities cannot exceed 40% of the overall grade for the subject and, in general, should not have an established minimum grade (except for practical activities in which, strictly speaking, the conditions of the ordinary call cannot be reproduced in the extraordinary call).
Those students who do not manage to pass the subject in the ordinary call, or do not attend this first call, may attend the extraordinary call only for failed re-evaluable assessment activities.
The distribution and characteristics of the assessment activities are described below.

VII.A.-Description and weight of the assessment activities

Evaluation System	Evaluation Activity	Date	Weights		Re-evaluated on extraordinary	Minimum grade
SE01 (Progressive evaluation of concept understanding)	Part I: making problems and tests	Part I: weeks 1 to 6.	Part I: 5%.	Total: 15%	Yes	5
	Part II: problem delivery.	Parte II: weeks 7 to 16	Part II: 10%.		Yes	5
SE02 (Written exam on course concepts)	Part I: partial written exam	Part I: week 6	Part I: 30%.	Total: 65%	Yes	5
	Part II: written partial exam.	Part II: ordinary call	Part II: 35%.		Yes	5
SE05 (Memo and practice presentation)	Practices (Part I and II): memo delivery.	During learning periasod.	Fundamentals: 5% Cell bioelectricity: 10% Body bioelectricity: 5%	Total: 20%	Yes	5

Calculation of the Final or Overall Grade. The final grade is calculated as the weighted average of the grades obtained in the assessment activities, according to the indicated percentages, provided that the minimum required grade has been achieved for each of them. Based on the above, in order to pass the course, the weighted average must not be lower than 5.
• If one or more assessment activities have not been passed with the minimum required grade, the final grade for the course will be the average of all completed assessment activities, with the condition that it cannot exceed 4.
• If the student has not taken any assessable test, the final grade will be "Not presented".
Extraordinary Call In the extraordinary call, students will only take the assessment activities corresponding to the tests they have not passed. Therefore, to calculate the final grade in this session, the grades from the assessment activities passed in the regular session and the grades obtained in the reassessed activities will be used.
Early Call. The evaluation method for the early call will be the same as the one generally established for the extraordinary session.

VII.B. Assessment of students with academic exemption from class attendance

Q2803011B UNIVERSIDAD REY JUAN CARLOS
Fecha firma: 08/11/2026 02:38 | Hash: 1072a13878fa647b8750b3d6eddac547.

Having Academic Exemption from Class Attendance (DAAC) does not imply that students are automatically exempt from participating in the continuous assessment activities or in the training activities of compulsory attendance as established in the teaching guide. Once the exemption has been granted, students must contact the subject's teaching staff, who will propose the adaptations he/she may consider relevant, as long as they guarantee the acquisition and adequate assessment of the learning goals established. Students must maintain adequate communication with the teaching staff so that they may provide information on the dates for training and assessment activities, if these are not established in the programme and available for students at the time of achieving the exemption.
Subject with possibility of academic exemption: Yes.

VII.C. Review of assessment activities

In accordance with the Regulation for the Assessment of Learning Outcomes of Rey Juan Carlos University.

VII.D.-Students with a disability or special educational needs

In order to guarantee equal opportunities, non-discrimination, universal accessibility and academic success, students with disabilities or especial education needs may request curricular adaptations to follow their studies. These adaptations will be provided by the Unit of Attention to People with Disabilities of Rey Juan Carlos University, in accordance with the regulation which regulates the service for the Attention of People with Disabilities at the University. This Unit will issue a report for curricular adaptations, so that students with disabilities or special education needs must contact the service (at e-mail discapacidad.programa@urjc.es) in order to provide relevant information for different educational alternatives.

VII.E.-Academic behaviour, academic integrity and honesty

Rey Juan Carlos University is fully committed to the highest standards of academic integrity and honesty, so studying at the URJC means assuming and subscribing to the values of integrity and academic honesty set out in the University's Ethical Code. To support this process, the University has Rey Juan Carlos University's Academic Conduct Regulation as well as different tools (anti-plagiarism, supervision...) that offer a collective guarantee for the full development of these essential values.

Q2803011B UNIVERSIDAD REY JUAN CARLOS
Fecha firma: 08/11/2026 02:38 | Hash: 1072a13878fa647b8750b3d6eddac547.

VIII.-Teaching resources and materials
Basic bibliography
- Serway, Raymond A., y Jewett, John W. Phisics for Scientists and Engineers with Modern Physics, Ninth Edition. Brooks/Cole, Boston, MA (USA), 2014. This book is used as a manual for Parts I and II of the subject. It contains the theory and a good number of solved questions. Further reading is recommended, corresponding to the sections seen in class as a first approximation. The book is available openly to the student by open licence from the authors themselves. - Tipler, Paul A. Física para la Ciencia y la Tecnología. Volumen 2, Electricidad y Magnetismo; Luz; Física Moderna; Mecánica Cuántica, Relatividad y Estructura de la Materia. Cuarta Edicion, 2000, Editorial Reverté. This book is available in our library and in eLibro. - Plonsey, R. and Barrr, Roger C. Bioelectricity, A Quantitative Approach. Third Edition. Springer, New York (NY, USA) 2007. This book is used as a manual for part III of the subject. It contains the theory and a good number of questions with solution. Further reading is recommended, corresponding to the sections seen in class as a first approximation. - José María Ferrero Corral; José María Ferrero y de Loma-Osorio; Javier Saiz Rodríguez; Antonio Arnau Vives. "Bioelectrónica: señales bioeléctricas". Editorial Universidad Politécnica de Valencia, 1994. This book represents a good alternative and complement to Plonsey&Barr, for part III. It is in Spanish, and available under request from Universidad Politécnica de Valencia.
Consultation bibliography
- Boron, Walter F. / Boulpaep, Emile L. "Medical physiology a cellular and molecular approach". Philadelphia. Saunders Elsevier cop. 2009. - Hobbie, Russel K.; Roth, Bradley J. Intermediate Physics for Medicine and Biology. Springer, 2007. - Cameron, Skofronick y Grant. Physics of the Body (2nd edition). Medical Physics Publishing. 1999. - Benedek, George B; Villars, Felix HM. Physics with Illustrative Examples from Medicine and Biology. Statistical Physics. Springer, 2000. - Elements of Electromagnetics. Sadiku Matthew. Oxford University Press Inc. ISBN: 978019069862. 2021.

IX.-Professors	
Name and surname	JOSÉ LUIS ROJO ÁLVAREZ
E-mail address	joseluis.rojo@urjc.es
Department	Teoría de la Señal y Comunicaciones y Sistemas Telemáticos y Computación
Campus	Fuenlabrada
Category	Catedrático/a de Universidad
Academic degree	Doctor
Person responsible for the subject	Yes
Tutorial timetable	Para consultar las tutorias póngase en contacto con el/la profesor/a a través de correo electrónico
Number of quinquennia	5
Number of sexennia	4
No. of positive evaluations by Docentia	6
Name and surname	SERGIO MUÑOZ ROMERO

Q2803011B UNIVERSIDAD REY JUAN CARLOS
Fecha firma: 08/11/2026 02:38 | Hash: 1072a13878fa647b8750b3d6eddac547.

E-mail address	sergio.munoz@urjc.es
Department	Teoría de la Señal y Comunicaciones y Sistemas Telemáticos y Computación
Campus	Fuenlabrada
Category	Titular de Universidad
Academic degree	Doctor
Person responsible for the subject	No
Tutorial timetable	Para consultar las tutorias póngase en contacto con el/la profesor/a a través de correo electrónico
Number of quinquennia	2
Number of sexennia	2
No. of positive evaluations by Docentia	2

Q2803011B UNIVERSIDAD REY JUAN CARLOS
Fecha firma: 08/11/2026 02:38 | Hash: 1072a13878fa647b8750b3d6eddac547.