Universidad Rey Juan Carlos

# TEACHING GUIDE

# Overview of Biomedical Engineering

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

## ACADEMIC YEAR 2026-27

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| I.-Subject Identification | |
|---|---|
| **Type** | OBLIGATORIA |
| **Teaching period** | 1 course, 2Q semester |
| **Nº of credits** | 3 |
| **Language in wich the subject is taught** | English |

## II.-Presentation

The course offers an overview of Biomedical Engineering and its impact on medicine, exploring how technological advances have enabled the measurement of vital signals and the acquisition of images of the human body. We will examine how electricity has been used to record and stimulate organs and systems, as well as the revolution brought about by the discovery of X-rays and other medical imaging techniques. We will analyze the evolution of surgery up to the development of minimally invasive and robotic surgery. We will explore artificial organs, prostheses, and implants and their importance in improving quality of life. We will address hospital information systems and the management of medical data, information, and imaging. We will reflect on the present and the near future of medicine, with the disruptive role of artificial intelligence, personalized medicine, and nanotechnology as key drivers.
The course aims to help students understand how technology has transformed medicine and the role of biomedical engineers in this process

## III.-Learning outcomes

COM16. Ability to identify, formulate and solve engineering problems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to recognise the importance of non-technical ¿societal, health and safety, environmental, economic and industrial ¿ constraints. (EURACE 2.2)
COM17. Ability to develop and design complex products (devices, artefacts, etc.), processes and systems in their field of study to meet established requirements, that can include an awareness of non-technical ¿ societal, health and safety, environmental, economic and industrial¿ considerations; to select and apply relevant design methodologies. (EURACE 3.1)
COM25. Ability to recognise the need for and to engage in independent life-long learning. (EURACE 8.1)
COM26. Ability to acquire further knowledge autonomously and follow develop-ments in science and technology. (EURACE 8.2)
CON16. Un-derstand the evolution of biomedical engineering as a discipline of knowledge, as well as its current role as a primary technological agent in the fields of healthcare, research, and business.
CON17. Understand the fundamentals associated with robotics, its current state, future trends, and its application in the field of biomedical engineering.
CON22. Awareness of the wider multidisci-plinary context of engineering. (EURACE 1.3)

- 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.

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## IV.-Contents

### IV.A.-Syllabus

**Topic 0: Introduction to Biomedical Engineering**
- Definition and objectives of Biomedical Engineering
- Fields of work such as instrumentation, medical image processing, bioinformatics, biomaterials, biomechanics, clinical engineering, etc.
- The role of the biomedical engineer within the healthcare system and in society

**Topic 1: The first medical signals and images at the beginning of the 19th century**
- The impact of measuring body temperature, pulse, and listening to the sounds of the body
- The development of the first diagnostic instruments to see more and hear better: microscopes and stethoscopes

**Topic 2: Recording electrical signals and bodily stimulation from the late 19th century onwards**
- Electrocardiography
- Electroencephalography
- Electromyography
- Pacemakers and electrical neurostimulation

**Topic 3: The revolutionary discovery of X-rays on the cusp of the 20th century**
- The discovery by Wilhelm Conrad Röntgen
- Conventional radiography, fluoroscopy and angiography
- Computed tomography

**Topic 4: New medical imaging techniques in the second half of the 20th century**
- Ultrasound in medicine and the development of echography
- Magnetic resonance imaging
- Nuclear medicine

**Topic 5: The evolution towards minimally invasive surgery**
- Anaesthesia
- Artificial respirators and surgical support equipment
- Laparoscopy and endoscopy
- The application of lasers in surgery
- Robotic and remote surgery

**Topic 6: Artificial organs, prostheses and implants**
- Extracorporeal circulation and haemodialysis
- Internal and external prostheses
- The evolution of implants in medicine

**Topic 7: Health information systems**
- Healthcare structure and information systems in Spain
- Standards for exchanging medical data, information and images
- Hospital Information Systems (HIS) and electronic health records
- Medical image capture and storage systems (PACS)
- Telemedicine

**Topic 8: The present and near future of medicine**
- Image processing and the introduction of AI
- Wearable devices and continuous monitoring
- Personalised medicine (genetic modifications and tailor-made drugs)
- Nanotechnology applied to health

### IV.B.-Training activities

| Type | Title |
|---|---|

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| | |
|---|---|
| Theoretical sessions | Attendance at theoretical classes where students receive the lecturers presentations, ask questions, and take notes actively. |
| Resolution of exercises, problems, case studies | Attendance and active participation in non-lecture classes where problems are solved or other learning activities are carried out, such as case study presentations, report reviews, etc. |
| Academic tutorials | Group tutorials where students raise their questions and these are answered by the lecturer. |
| Oral presentations | Public presentation and defence of students projects |
| Group work | Group project on a medical technique or piece of equipment not addressed during lectures. |
| Individual work | Independent study by the student, both before and after theoretical classes and problem-solving sessions, completing exercises related to each topic in the syllabus. |
| Test and/or exams | Completion of tests or problem-solving exams related to each unit of the course. |

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| V.-Student workload | |
|---|---|
| Theoretical sessions | 19 |
| Resolution of exercises, problems, case studies, etc. | 5 |
| Practical sessions in experimental, technological and clinical laboratories, fieldwork, etc. | 4 |
| Tests and/or exams | 2 |
| Academic tutorials | 15 |
| Related activities: conferences, seminars, etc. | 9 |
| Preparation of theoretical sessions and self-study | 17 |
| Preparation of practical tasks, exercises, case studies, projects, etc. | 4 |
| Preparation for tests and/or exams | 15 |
| Total student workload | 90 |

**VI.-Methodology and academic programme**

| Type | Period | Content |
|---|---|---|
| Experimental and/or technological laboratories | Week 13 to Week 13 | Visit to the Medical Imaging Department of Fuenlabrada/Alcorcón Hospital. |
| Theoretical sessions | Week 9 to Week 11 | Attendance at theoretical classes on topics 5 and 6, where students receive the lecturer's presentations, ask questions, and take notes actively. |
| Experimental and/or technological laboratories | Week 11 to Week 11 | Visit to the Museum of the Royal Academy of Medicine. |
| Theoretical sessions | Week 12 to Week 12 | Attendance at theoretical classes on topic 7, where students receive the lecturer's presentations, ask questions, and take notes actively. |
| Theoretical sessions | Week 14 to Week 14 | Attendance at theoretical classes on topic 8, where students receive the lecture's presentations, ask questions, and take notes actively. |
| Group work | Week 15 to Week 15 | Oral presentation and defence of group projects prepared by the students. |

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| | | |
|---|---|---|
| Tests and/or exams | Week 17 to Week 17 | A multiple-choice and/or problem-solving and/or essay-type exam covering the entire syllabus of the course. |
| Theoretical sessions | Week 8 to Week 8 | Attendance and active participation in non-lecture-based sessions where problems relating to the first four topics are solved. |
| Theoretical sessions | Week 1 to Week 8 | Attendance at lectures on the first four topics, plus the introductory topic, during which students listen to the lecturer¿s presentations, ask questions and actively take notes. |

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## 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

Assessment will be ongoing; therefore, students must complete the assigned activities throughout the course and pass the corresponding final exam to pass the course.
The grade for the regular exam period will be calculated by adding the scores obtained on each of the following assessment activities:

- **Eight multiple-choice exams** (one per topic) throughout the academic term (15% of the final grade). This is a cumulative activity that cannot be retaken in the extraordinary examination period (there is no minimum grade).
- Preparation of a **technical data sheet** for one item of equipment observed during the visit to the Museum of the Royal Academy of Medicine, and for another item seen during the visit to the Medical Imaging Department of the Hospital of Fuenlabrada/Alcorcón (10% of the final mark). A minimum score of 5 out of 10 is required in order for this mark to be averaged with the other assessment activities. This assessment activity can be retaken in the extraordinary examination period.
- Completion of a **group project** related to a piece of medical equipment not explicitly covered in the module (10% of the final grade). A minimum score of 5 out of 10 is required in order for this mark to be averaged with the other assessment activities. This assessment activity can be retaken in the extraordinary examination period.
- **Oral defence** of the group project, related to a piece of medical equipment not explicitly covered in the module (15% of the final grade). A minimum score of 5 out of 10 is required in order for this mark to be averaged with the other assessment activities. This assessment activity can be retaken in the extraordinary examination period.
- A **theory exam** covering the content covered in the module (50% of the final grade). A minimum mark of 5 out of 10 is required in order for this to be averaged with the other assessment activities. This assessment activity can be retaken in the extraordinary examination period.

Extraordinary Exam Session: All retake-eligible assessment activities that were not passed (in which the minimum grade was not achieved) will be administered.
Should any student need to be assessed during an early assessment period, they will be required to complete all assessment tasks except for the visit to the Museum and the Hospital. In this case, the group assignment will be replaced by a less complex one that can be completed individually.

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

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.

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**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.

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| VIII.-Teaching resources and materials |
|---|
| **Basic bibliography** |
| Enderle, J., Blanchard S. &Bronzino, J. 2005. Introduction to Biomedical Engineering, 2a ed. Elsevier Academic Press. |
| **Consultation bibliography** |

| IX.-Professors | |
|---|---|
| **Name and surname** | EVA MILARA HERNANDO |
| **E-mail address** | eva.milara@urjc.es |
| **Department** | Teoría de la Señal y Comunicaciones y Sistemas Telemáticos y Computación |
| **Campus** | Fuenlabrada |
| **Category** | Profesor/a Ayudante Doctor/a |
| **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** | 0 |
| **Number of sexennia** | 0 |
| **No. of positive evaluations by Docentia** | 0 |

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