Universidad Rey Juan Carlos

TEACHING GUIDE

PHYSIOLOGICAL SIGNALS PROCESSING

GRADO EN INGENIERÍA BIOMÉDICA (INGLÉS) (3º y 4º curso) (2374)

ACADEMIC YEAR 2026-27

Q2803011B UNIVERSIDAD REY JUAN CARLOS
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I.-Subject Identification	
Type	OBLIGATORIA
Teaching period	3 course, 2Q semester
Nº of credits	6
Language in wich the subject is taught	English

II.-Presentation

The main objective of this course is to provide the students with the basic univariate and multivariate physiological signal procesing knowledge. Moreover, students may be able to develop new analysis tools by their own. It is mandatory to have previously taken the following courses: Calculus, Algebra, Mathematical Methods of Bioengineering, Probability and Statistics, Linear Systems and Circuit Appications and Discrete Time Systems.

III.-Learning outcomes

CG01 . Analyze and synthesize problems related to biomedical engineering, solve them and communicate them efficiently.
CG02. Use computational and experimental tools for the analysis and quantification of biomedical engineering problems
CB2 . That students are able to apply their knowledge to their work or vocation in a professional manner and have the skills that are typically demonstrated through the preparation and defense of arguments and problem solving within their field of study.
CB5 . That students have developed the learning skills needed to undertake further studies with a considerable degree of autonomy.
CE01 . Understand or acquire the principles of bioelectrical fundamentals, anatomy, physiology or pathophysiology needed to identify the most appropriate processing technologies for a given problem in biomedical engineering
CE07. Know and understand the principles of signals and biomedical systems in discrete time.
CE09. Use state-of-the-art methods in digital signal processing, especially of medical signals, and perform the necessary mathematical and statistical calculations to propose and make the required modifications in the signal processing techniques

- 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

Unit 0. Review of stochastic processes
- Stochastic processes.
- Mean, variance, covariance, autocorrelation, crosscorrelation.
- Stationarity, ergodicity.
- White noise.

Unit 1. Biolectric signals
- Biolectric signals: on the cellular level.
- Biolectric signals: on the body surface.
- Signal acquisition and analysis.
- Introduction to estimation.

Unit 2. Electroencephalogram
- Electrical activity of the brain.
- EEG signal acquisition, EEG rhythms.
- EEG applications.
- Modeling the EEG signal.
- Artifacts in the EEG, filtering.
- Nonparametric spectral analysis
- Model-based spectral analysis. AR Modeling.

Unit 3. Electrocardiogram
- Cardiac electric signal.
- Heart rhythms.
- ECG signal processing for QRS detection.
- Fetal ECG: Singular Value Decomposition.

Unit 4. Evoked potentials
- Evoked potentials.
- Noise reduction, estimation methods for biomedical signals.
- Joint time-frequency analysis. Spectrogram.

IV.B.-Training activities

Type	Title
Academic tutorials	The theoretical contents of the course are complemented with exercises.
Academic tutorials	Signal acquisition and processing with python. Hands-on sessions
Lectures	Papers and additional resources related to the contents of the lectures.
Other activities	Assistance to lectures.
Other activities	Assistance to tutorships.
Other activities	Exam preparation.
Other activities	Lectures, exercise lessons and laboratories preparation.

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Other activities	Assistance to seminars about the challenge.
Other activities	Exam realization.
Group work	Challenge type groupal project.
Oral presentations	Challenge presentation.

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V.-Student workload	
Theoretical sessions	26
Resolution of exercises, problems, case studies, etc.	20
Practical sessions in experimental, technological and clinical laboratories, fieldwork, etc.	10
Tests and/or exams	4
Academic tutorials	30
Related activities: conferences, seminars, etc.	18
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
Group work	Week 14 to Week 15	Project presentations in groups (challenge).
Theoretical sessions	Week 1 to Week 14	Theory and problem resolution.
Practical sessions	Week 1 to Week 14	Signal acquisition and processing with python. 1. Introductory lab, ECG, and EDA signal acquisition. 2. EEG signals acquisition and processing (part 1). 3. EEG signals processing lab (part 2). 4. ECG signals processing lab. 5. Evoked potential signal processing lab, time-frequency analysis.
Tests and/or exams	Week 16 to Week 17	Partial evaluation of theoretical and practical contents, units 0-2.
Tests and/or exams	Week 16 to Week 17	Partial evaluation of theoretical and practical contents, units 3-4.
Theoretical sessions	Week 3 to Week 12	Reading or additional resources related to the contents of the course, evaluation by a test and/or presentations.

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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

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The **regular call** consists of:

Sistemas de Evaluación	Actividad de Evaluación	Tipo	Ponderación	Nota Mínima
SE02	Partial Exam 1	Re-evaluable	32.5%	4.5 out 10
	Partial Exam 2	Re-evaluable	32.5%	4.5 out 10
SE05	Challenge	Non re-evaluable	25%	No
	Reading test lab 1	Non re-evaluable	2.5%	No
	Reading test lab 2	Non re-evaluable	2.5%	No
	Reading test lab 3	Non re-evaluable	2.5%	No
	Reading test lab 4	Non re-evaluable	2.5%	No

1. Partial exam 1 including theoretical and practical contents (units 0-2) 32.5%. Re-evaluable. Minimum mark 4.5 out 10 points.
2. Partial exam 2 including theoretical and practical contents (units 3-4) 32.5%. Re-evaluable. MInimum mark 4.5 out 10 points
3. Challenge/competition and oral presentation 25% Non re-evaluable. No minimum mark.

•The attendence to the Challenge sessions is mandatory.

4. Readings test related with the labs 10%:

•Reading lab 1 - 2.5%. Non re-evaluable. No minimum mark.
•Reading lab 2 - 2.5%. Non re-evaluable. No minimum mark.
•Reading lab 3 - 2.5%. Non re-evaluable. No minimum mark.
•Reading lab 4 - 2.5%. Non re-evaluable. No minimum mark.

To pass the course minimum global mark of 5 out of 10 points.

Items 3 and 4 are not re-evaluable and do not have minimum marks, since they are part of continuous assessment and/or based on the collective work and group work carried out in the classroom, they do not have a minimum grade.

The final grade would be computed as: Final grade = 0.325*Partial 1 + 0.325*Partial 2 + 0.25*Challenge + 0.025*Reading 1+ 0.025*Reading 2 + 0.025*Reading 3 + 0.025*Reading 4

Extra call

1. Partial exam 1 including theoretical and practical contents (units 0-2) 32.5%
2. Partial exam 2 including theoretical and practical contents (units 3-4) 32.5%

If a student has a minimum of 4.5 out of 10 points in items 1 or 2 from the regular call, he/she may keep this mark for the extraordinary evaluation.

However, if a student has met the minimum required grade in all the re-evaluable activities but still does not achieve a passing overall grade for the course, they may be reassessed during the extraordinary call in one or more of the re-evaluable activities in which, despite having met the minimum grade, they obtained a score lower than 5.

The marks in items 3 and 4 from the regular call are kept.

To pass the course is mandatory to get a minimum of 4.5 out of 10 points in items 1 and 2 and a minimum global mark of 5 out of 10 points.

Evaluation for Early Call (Convocatoria Adelantada)

The evaluation method will be the same as the one established in general terms. In cases where the student has not previously completed continuous assessment items 3 and 4, items 1 and 2 will each carry a weight of 50%. To pass the course, it is necessary to obtain a minimum of 4.5 points in each of the evaluation sections 1 and 2, and a final grade equal to or greater than 5.0

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

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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.

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VIII.-Teaching resources and materials
Basic bibliography
L. Sörnmo and P. Laguna, Bioelectrical Signal Processing in Cardiac and Neurological Applications. Academic Press, Jul. 2005.
Meting Akay. Detection and Estimation of Biomedical Signals. Academic Press, March 1999.
Consultation bibliography
K.J. Blinowska and J. Zygierewicz, Practical Biomedical Signal Analysis Using MATLAB. CRC PressI Llc, Sep. 2011.
Li Hu, Zhiguo Zhang, EEG Signal Processing and Feature Extraction, Springer Nature Singapore Pte Ltd. 2019
A. León García. Probability, Statistics, and Random Processes for Electrical En gineering. Pearson Prentice Hall, 2008.

IX.-Professors	
Name and surname	LAURA MARTÍNEZ MATEU
E-mail address	laura.martinez.mateu@urjc.es
Department	Teoría de la Señal y Comunicaciones y Sistemas Telemáticos y Computación
Campus	Fuenlabrada
Category	Profesor/a Permanente Laboral
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	1
Number of sexennia	1
No. of positive evaluations by Docentia	2
Name and surname	ÓSCAR BARQUERO PÉREZ
E-mail address	oscar.barquero@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	Yes

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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	3
Name and surname	REBECA GOYA ESTEBAN
E-mail address	rebeca.goyaesteban@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	3

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