Universidad Rey Juan Carlos

TEACHING GUIDE

Probability and Statistics

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

ACADEMIC YEAR 2026-27

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I.-Subject Identification	
Type	FORMACIÓN BÁSICA
Teaching period	2 course, 1Q semester
Nº of credits	6
Language in wich the subject is taught	English

II.-Presentation

Probability and Statistics form a fundamental basis for the construction of procedures, methodologies, designs, tools and algorithms, present in many of the specific subjects that a Biomedical Engineering undergraduate undertakes in its training process.

The main training objectives of the subject of Probability and Statistics are:

- Highlight the importance of probabilistic models (and their differences from deterministic models) very common in engineering and biomedicine, to describe systems that show unpredictable variations or randomness.
- Provide the student with the ability to define probabilistic models to solve engineering problems, with special attention to biomedical applications.

Prerequisites and recommendations: it is convenient for the student to have taken the Calculus, Algebra and Mathematical Methods of Bioengineering subjects so that you have knowledge about real functions of a variable and multiple variables, sequences and series of functions, multiple differentiation and integration, vector spaces, linear applications and linear systems.

In order to facilitate the passing of the subject and the achievement of the training objectives, students are recommended to read previously the contents of each session of the course, the complete the activities proposed in class and to solve the problems proposed in the recommended bibliography, as well as attending tutorials whenever necessary.

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)

COM19. Laboratory

CON18. Understand the basic concepts of: linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and partial differen-tial equations, numerical methods, numerical algorithms, statistics, and optimization.

CON20. Knowledge and understanding of the mathematics, computation and other basic sciences underlying their engineering specialisation, at a level necessary to achieve the other programme outcomes. (EURACE 1.1)

CON23. Understanding of applicable techniques and methods of analysis, design and investigation and of their limitations in their field of study. (EURACE 5.1)

HAB03. Ability to solve mathematical problems that may arise in engineering. Proficiency in applying knowledge of linear algebra, geometry, differential geometry, differential and integral calculus, differential equations and partial differential equations, numerical methods, numerical algorithms, statistics, and optimization.

HAB17. Ability to analyse complex engineering products, processes and systems in their field of study; to select and apply relevant methods from established analytical, computational and experimental methods; to correctly interpret the outcomes of such analyses. (EU-RACE 2.1)

- 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.A.-Syllabus

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1.1 Mathematical Models as Tools in Analysis and Design

1.2 Deterministic Models

1.3 Probability Models

1.3.1 Statistical Regularity

1.3.2 Properties of Relative Frequency

1.3.3 The Axiomatic Approach to a Theory of Probability

1.3.4 Building a Probability Model

Module 2. Basic Concepts of Probability Theory

2.1 Specifying Random Experiments

2.1.1 The Sample Space

2.1.2 Events

2.1.3 Review of Set Theory

2.1.4 Event Classes

2.2 The Axioms of Probability

2.2.1 Discrete Sample Spaces

2.2.2 Continuous Sample Spaces

2.3 Conditional Probability

2.3.1 Bayes' Rule

2.4 Independence of Events

2.5 Sequential Experiments

2.5.1 Sequences of Independent Experiments

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2.5.4 The Geometric Probability Law

2.5.5 Sequences of Dependent Experiments

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3.3 Expected Value and Moments of Discrete Random Variable

3.3.1 Expected Value of Functions of a Random Variable

3.3.2 Variance of a Random Variable

3.4 Conditional Probability Mass Function

3.4.1 Conditional Probability Mass Function

3.4.2 Conditional Expected Value

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3.5.5 The Uniform Random Variable

Module 4. One Random Variable

4.1 The Cumulative Distribution Function

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4.1.1 The Three Types of Random Variables
4.2 The Probability Density Function
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5.6.1 Expected Value of a Function of Two Random Variables
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6.2 Functions of Several Random Variables
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7.3 The Central Limit Theorem
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IV.B.-Training activities

Type	**Title**
Theoretical sessions	Review of theoretical content, along with examples of exercises of similar difficulty to those in the written assessment tests.
Resolution of exercises, problems, case studies	Problem-solving lessons at the end of each topic or thematic unit.
Experimental and/or technological laboratories	Practicals using python
Academic tutorials	Tutorials upon students' requests
Realización de Pruebas	Two written exams

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V.-Student workload	
Theoretical sessions	30
Resolution of exercises, problems, case studies, etc.	18
Practical sessions in experimental, technological and clinical laboratories, fieldwork, etc.	8
Tests and/or exams	4
Academic tutorials	28
Related activities: conferences, seminars, etc.	20
Preparation of theoretical sessions and self-study	22
Preparation of practical tasks, exercises, case studies, projects, etc.	20
Preparation for tests and/or exams	30
Total student workload	180

VI.-Methodology and academic programme

Type	Period	Content
Theoretical sessions	Week 1 to Week 14	A detailed explanation of the concepts fundamentals together with problem-solving
Resolution of exercises, problems, case studies	Week 1 to Week 14	Problem-solving lessons, including biomedical and biotechnological applications of mathematical and statistical tools.
Experimental and/or technological laboratories	Week 8 to Week 14	Practical exercises using Python
Seminars	Week 1 to Week 17	Attendance at recommended seminars due to its relationship with the degree and/or the subject.
Academic tutorials	Week 1 to Week 17	Students' tutorials requested by email
Tests and/or exams	Week 7 to Week 9	First written exam. This assessment test will be carried out in person in the spaces provided by the university and following the regulations specified by the university.

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Tests and/or exams	Week 15 to Week 17	Second written exam. This assessment test will be carried out in person in the spaces provided by the university and following the regulations specified by the university.

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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 general assessment model is continuous assessment, as established by the Regulations for the assessment of learning outcomes at Universidad Rey Juan Carlos.

Continuous ordinary assessment:

The distribution and characteristics of the assessment tests are those described below. Only in exceptional case and for special reasons may the teacher add changes to the Guide. These changes will require the prior consultation with the Subject Head and the prior and explicit authorisation of the Degree Programme Coordinator, who will notify the Vice-Rector?s office in charge of Academic Affairs of the modifications made. In any case, the changes proposed must take into account the stipulations of the verified report. In order for these changes to take effect, they must be duly communicated at the start of the course to the students using Aula Virtual.

The combination of activities that are not re-assessable cannot exceed 50% of the subject grade and, in general, cannot have a minimum grade (except for the case of laboratory or clinical work placements, where duly justified), and tests which exceed 60% of the subject weighting cannot be added.

Extraordinary assessment:

Students who do not manage to pass the ordinary assessment, or who did not attend, will be subject to completion of an extraordinary assessment to verify their acquisition of the skills established in the guide, only for activities that are re-assessable.

Ordinary assesment

The regular assessment of the course consists of the evaluation of the following three activities:

1. Laboratory/exercises: 20% of the final mark. To facilitate following and preparing the course, a series of practical activities and exercises will be assigned throughout the semester, mainly at the end of each topic or content block. In particular, attendance at, completion of, and submission of the exercises and practical sessions carried out in the computer laboratory are compulsory. These activities are also non-recoverable (i.e., they cannot be retaken or reassessed). Specifically, there will be three graded activities, each carrying the same weight in the final course grade. Attendance will be monitored using the attendance tool available in the URJC App. Together, these activities account for 20% of the final course grade. There is no minimum passing mark required for these activities. The publication of and submission process for exercises and practical assignments will be managed through the Virtual Classroom.

2. First written test: 40% of the final mark. In the same way, to facilitate the following of the subject, the first written test will include the contents of the first lessons defined in the section Contents. This test is compulsory, re-assessable and eliminates the contents of the final written test. To pass it, a minimal qualification of 5/10 will be needed.

3. Second written test: 40% of the final mark. In this second compulsory written test, the rest of the contents of the subject will appear. This test is compulsory, re-assessable and eliminates contents. To pass it, a minimal qualification of 5/10 will be needed.

Extraordinary assesment

In the extraordinary evaluation, those evaluation activities classified as reassessable in the ordinary evaluation will be carried out again, also keeping all its characteristics. Therefore, the extraordinary evaluation will consist of two parts, corresponding to the reassessment of the two written tests, which will have the same weight and the same minimum mark specified in the ordinary evaluation. In this way, to pass the course, each student must complete and pass the reassessment test or tests corresponding to that or those written tests that have not been passed in the ordinary evaluation period.

Revision of final written exams

The following rules will be applied in the revision of the final written exams.

1. The evaluation criteria established by the teacher cannot be discussed during the revision process of the final written exam. Revision of the final written exam cannot include doubt-solving activities. It should focus on solving inconsistencies in the assessment of the final written exams.

2. To be admitted to the revision process students must provide the solution to the final written exams. Those problems for which students do not provide the solution will not be discussed during the review process.

3. The resolution of doubts about problems or questions in the final written exams will be treated in a tutorial which will take place upon request of the students.

4. Plagiarism in any phase of the evaluation process will be sanctioned according to the "Normativa sobre conducta académica

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de la Universidad Rey Juan Carlos".

Class Attendance

Given the practical work methodology of the subject, attendance at classes is not only recommended but also a mandatory activity. Attendance will be monitored through the URJC app and by taking attendance.

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.

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
Probability, Statistics and Random Processes for Electrical Engineering (3rd Edition), **Alberto Leon-Garcia**, Pearson Education, 2009, https://brain.urjc.es/permalink/f/1frnn0d/34URJC_ALMA2151241860004216 Probability, Random Variables, and Random Processes (4th Edition), **Hwei Hsu**, McGraw-Hill Education, 2020, http://brain.urjc.es/permalink/f/1frnn0d/34URJC_ALMA21113355750004216
Consultation bibliography
Biostatistics. A Foundation for Analysis in the Health Sciences. **Wayne W Daniel and Chad L. Cross**. Wiley. 11th edition.https://brain.urjc.es/permalink/34URJC_INST/1lpb4rj/alma991002609882404216 Introducción a la Estadística, **Sheldon M. Ross**, (Special Digital Edition), Reverté, 2022, http://brain.urjc.es/permalink/f/1frnn0d/34URJC_ALMA21126985740004216

IX.-Professors	
Name and surname	CRISTIAN DAVID CHUSHIG MUZO
E-mail address	david.chushig@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	No
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	1
No. of positive evaluations by Docentia	0
Name and surname	MARÍA ÁNGELES RODRÍGUEZ DE CARA
E-mail address	angeles.decara@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

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Number of quinquennia	0
Number of sexennia	1
No. of positive evaluations by Docentia	0

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