Universidad Rey Juan Carlos

TEACHING GUIDE

DIGITAL SYSTEMS AND MICROPROCESSORS

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	3
Language in wich the subject is taught	English

II.-Presentation

This course expands on the skills previously acquired in the field of digital electronics, addressing sequential digital systems, which depend on time and a digital memory. Sequential digital circuits, including bistables, memories, registers and counters, are described and design techniques using state diagrams are presented. Digital design tools and programmable and configurable electronic devices are described and used, in particular microcontrollers using the Arduino platform, or FPGAs programmed using VHDL. The use of different types of sensors in the design of analog and digital electronic systems is described.
The course is oriented to practical activities, where the necessary theoretical concepts are used to help solve real design problems where different types of sensors and electronic devices can be used to achieve a solution according to the proposed objective.

Recommended previous knowledge: Analog and digital electronics, digital combinational circuits.

III.-Learning outcomes

CG02. Use computational and experimental tools for the analysis and quantification of biomedical engineering problems
CB1. Proven knowledge and understanding of an area of study based on general secondary education and at a level which, although supported by advanced text books, also includes certain aspects that imply knowledge from the forefront of the field of study.
CE16. Understand the basic concepts of linear systems and related functions and transforms, theory of electrical circuits, electronic circuits, the physical principle of semiconductors and logic families, electronic devices, and their application to solve problems in biomedical engineering.
CE17. Designing instruments for medical applications
CE18 .Use sensors, controllers and biomedical signal acquisition systems for the evaluation and design of biomedical devices and systems

- 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 1. "Fundamentals of sequential logic. Bistable devices".
1.1- Concept of sequential circuit. Synchronous and asynchronous systems.
1.2- Asynchronous bistables.
1.3- Synchronous bistables.
1.4- Conversions between bistables.

Topic 2. Registers and counters. Registers and counters.
2.1- Concept of registers and types of registers.
2.2- Synchronous and asynchronous counters. Design and implementation.

Topic 3. Finite state automata. State machines (Mealy and Moore).
3.1- Concept of state machine or automaton. Classification: Moore machines and Mealy machines.
3.2- Design of Moore and Mealy machines.

Topic 4. Design of practical applications with Microcontrollers and FPGAs.
4.1- Introduction to Microprocessors and Microcontrollers. Architecture, core, input and output ports.
4.2- Introduction to FPGAs. Architecture, core, input and output ports.
4.3- Programming languages for programmable logic devices, Basic design of combinational and sequential circuits with Arduino and VHDL.
4.4- Design of basic electronic applications with Arduino, Sensors and FPGAs.

IV.B.-Training activities

Type	Title
Experimental and/or technological laboratories	AF7. Laboratory practices. The scripts of the programming practices of applications on microcontrollers (Arduino) and on FPGA (using VHDL language) will be available in the Virtual Campus of the course. They are intended to introduce the basics of microcontroller management, as well as VHDL through the realization of applications that take advantage of the peripherals of the development boards, through projects that will be carried out through the laboratory sessions.
Lectures	AF1. Theoretical classes on blackboard or with presentation, encouraging active participation.
Academic tutorials	AF2. Problem solving by the students under the supervision of the teacher. Exercises of analysis/design of digital circuits proposed by the teacher and to be solved autonomously by the student.
Realización de Pruebas	AF9. Individual or group completion of a laboratory project for each topic studied.

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V.-Student workload	
Theoretical sessions	17
Resolution of exercises, problems, case studies, etc.	3
Practical sessions in experimental, technological and clinical laboratories, fieldwork, etc.	7
Tests and/or exams	3
Academic tutorials	24
Related activities: conferences, seminars, etc.	0
Preparation of theoretical sessions and self-study	15
Preparation of practical tasks, exercises, case studies, projects, etc.	15
Preparation for tests and/or exams	6
Total student workload	90

VI.-Methodology and academic programme

Type	Period	Content
Tests and/or exams	Week 16 to Week 16	Ordinary exam.
Academic tutorials	Week 1 to Week 15	Individualized tutoring (or in small groups) will be arranged by appointment with the teacher on a flexible schedule to be agreed upon with the student.
Experimental and/or technological laboratories	Week 10 to Week 15	MD3. The objective of the practical sessions is to confront the student with an application so that he/she can solve it by making decisions according to what has been learned. Design and implementation of digital systems using microcontrollers (Arduino, PIC) and configurable devices (FPGAs).
Practical sessions	Week 1 to Week 10	MD2. Performance of explanatory exercises for each section. At the end of each topic, completion of exam-type exercises.
Theoretical sessions	Week 1 to Week 10	Development of exercises to put into practice the concepts acquired during the theoretical session.

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Theoretical sessions	Week 1 to Week 10	Some readings will be proposed in advance to be discussed in class and/or put into practice.
Theoretical sessions	Week 1 to Week 10	MD1. Master class that will include a high degree of practice due to the characteristics of the subject. At the end of each topic there will be exam-type exercises. The orientation will be practical.
Experimental and/or technological laboratories	Week 10 to Week 15	AF3. There will be 6 guided PRESENTED practice sessions of 2 hours/session, in the laboratory and during class time. These practices are an introduction to digital systems design tools. Arduino development boards will be used, configured through the Arduino environment using a hardware description language. The scripts of the practices will be available well in advance in the Virtual Classroom. The schedule of practices will be prepared at the beginning of each course according to the academic calendar and will be made known to students on the first day of class

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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 assessment method to be used will consist of a written test (theoretical part) and the performance of laboratory practices (the latter may be evaluated through the fulfillment of demonstrative milestones in the laboratory). Both evaluation methods are face-to-face, except those indicated in the URJC learning results evaluation regulations.
The theoretical part will have a value or weight of 60% of the final grade of the course.
At the end of the academic and ordinary course there will be an exam to evaluate the theoretical part in person, ordinary exam. The date of the ordinary exam is established by the university and cannot be modified, except in those justified cases established in the URJC learning results evaluation regulations.
To pass the theoretical part, the student must achieve a grade higher or equal to 5.
The laboratory practices constitute 40% of the final grade of the course. They require compulsory attendance and cannot be reevaluated. They are evaluated by means of the overcoming of demonstrative milestones, ordered gradually by level of complexity, verifiable by the teacher directly in the laboratory bench. To pass the laboratory part the grade must be greater or equal to 5.
Students will be evaluated continuously during the course through the laboratory sessions and projects.
There will be 2 lab sessions using FPGAs and 4 projects (with their previous lab sessions) using Arduino, for a total of 6 continuous evaluation activities in the lab part. The final grade of the labs part is the average sum of the 6 activities.
All projects (Arduino) will be done individually or in groups depending on the number of students participating in the course. For each project is required the delivery of:
•A report
•The program code of the project
•A demonstration video of the correct operation of the project.

Partial or total plagiarism of VHDL or Arduino codes in the laboratory will result in failure of the course.
The use of applications or web pages where artificial intelligence is used for the development of the sessions or laboratory projects will result in the failure of the subject.
The partial or total plagiarism of one or more projects will result in the failure of the course.
To pass the course the following two conditions must be fulfilled:
• To have passed the theoretical part with a grade equal to or higher than 5.
•To have passed the laboratory part with a grade equal to or higher than 5

If any of the above conditions is not met, the course will be considered failed.
The course will be considered passed if, firstly, the two conditions described above are met, and secondly, when the final grade of the course (sum of the theoretical part and laboratories) is greater than or equal to 5
In the extraordinary call, only the evaluable parts will be reevaluated, that is, only the theoretical part. The laboratory part will not be reevaluated in this call.
To include the final grade of the laboratories in the final grade of the course, it is required, firstly, to have passed the laboratories part, and secondly, to have passed the theoretical part.

Assessment	Type	Porcentage	Date	Subjects
SE1 Ordinary call	Reevaluated	60%	From week 16	T1 to T4
SE2_Laboratory and projects	Not-reevaluated	40%	Week 10-15	The overcoming of the milestones
SE1_extraordinary call	Not-reevaluated	60%	From week 17	T1 to T4.

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
"Digital Design: Principles and Practices", Wakerly, Prentice-Hall, (4th Edition) "Fundamentos de sistemas digitales", Thomas L. Floyd. Prentice Hall. 2006.
Consultation bibliography
"Arduino. Curso Práctico de Formación" de Óscar Torrente Artero (2013), Rc Libros, 588 pp, ISBN-13: 978-8494072505, http://www.amazon.es/Arduino-Curso-Pr%C3%A1ctico-De-Formaci%C3%B3n/dp/8494072501 "Guía de Usuario de Arduino" de Rafael Enríquez Herrador (2009), Universidad de Córdoba http://www.uco.es/aulasoftwarelibre/wp-content/uploads/2010/05/Arduino_user_manual_es.pdf. “Diseño de circuitos digitales con VHDL”. Machado, Borromeo. http://hdl.handle.net/10115/4045 (BURJC Digital) “Problemas resueltos de electrónica digital”. Machado, Borromeo. http://hdl.handle.net/10115/5727 (BURJC Digital)

IX.-Professors	
Name and surname	ÁNGEL LUIS ÁLVAREZ CASTILLO
E-mail address	angelluis.alvarez@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	No
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	5
No. of positive evaluations by Docentia	3
Name and surname	ROBINSON CRUZOE GUZMÁN MARTÍNEZ
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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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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	1

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