Universidad de Alcalá

TEACHING GUIDE

Electronic Control Systems Design

Master's Degree in Electronic Engineering

University of de Alcala

Academic Year 2023/2024

1st Term

TEACHING GUIDE

Name of the course:	**Electronic control systems design**
Code:	**202937**
Degree	**Master's Degree in Electronic Engineering**
Department & Area of Expertise:	**Department:** Electronics **Area:** Electronic Technology
Type:	**Compulsory**
ECTS credits:	**4,5**
Semester:	**First**
Teaching staff	**Cristina Losada, Felipe Espinosa**
Office hours:	**Check at UAH website (Virtual Platform)**
Mode	**Semi face-to-face / Blended learning**
Language Classes Offered:	**Spanish (English Friendly)**

1. INTRODUCTION

This course is located in the Control and Power Electronics subject of the Master's Curriculum.
This course provides advanced theoretical and practical training in electronic control systems for Electronic Engineers, both with a research/academic and professional profile.
It has a double objective: to address advanced knowledge on identification, control (linear and non-linear) and systems estimation; as well as its electronic implementation applied to an actual process control.

2. SKILLS AND LEARNING RESULTS

This course provides the Basic, General and Specific Competences detailed below:

Basic Competences	
CB6	Obtain and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.

CB7	That students know how to apply the acquired knowledge and their problem-solving capacity in new or little-known environments within broader (or multidisciplinary) contexts related to their area of study.
CB10	That students obtain the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

General Competences	
CG2	Conceive, design, implement and maintain an electronic system in a specific application.
CG3	Acquire skills for understanding new technologies for use in electronic systems and their proper use and integration for solving new problems or applications.
CG6	Adopt the scientific method as a fundamental work tool to be applied in both the professional and research fields.

Specific Competences	
CE1	Ability to design electronic systems both at the conceptual level, based on specific specifications, and at the system level, using modelling and simulation tools, as well as at the subsystem level using, among others, hardware description languages.
CE3	Ability to handle advanced tools, techniques and methodologies for designing electronic and photonic systems or subsystems.
CE4	Ability to design a device, system or application that meets some specifications, using a systemic and multidisciplinary approach and integrating advanced modules and tools that are specific to the field of Electronic Engineering.
CE7	Ability to experimentally verify in the laboratory the compliance with the specifications required of a new electronic and photonic system after its design.
CE9	Ability to identify merit factors and effective comparison techniques to obtain the best solutions for scientific and technological challenges in the field of Electronic Engineering and its applications.
CE10	Ability to apply optimization techniques for the development of electronic circuits and subsystems.
CE11	Ability to carry out effective information searches, and to identify the state of the art of a technological problem in the field of electronic and photonic systems, as well as its possible application to the development of new systems.
CE12	To know the current state of knowledge and future trends in some of the following areas: power electronics, control electronics, microelectronics and photonics.
CE13	Ability to identify from a conceptual, but also practical, point of view which are the main scientific and technological challenges in different electronic systems applications, as well as in their integration and use.

On the other hand, the expected learning results from this course are the following:

RAP1. Know advanced digital electronic systems based on processors, making use of different types and memory accesses.

RAP2. Design digital electronic systems based on programmable devices using advanced techniques and high-level languages.

3. CONTENTS

Content units	Total class hours
Block 1. Electronic control systems design tools	**9 h**
Topic 1: Simulation, design and implementation tools of electronic control systems.	
Block 2. Multivariate systems identification	**6 h**
Topic 2: Multivariate systems identification.	
Block 3. Control design techniques	**12 h**
Topic 3: Linear control design techniques. Robust control.	
Topic 4: Non-linear design techniques. Lyapunov based controllers.	
Block 4. Estimators design techniques	**6 h**
Topic 5: Stochastic estimators design techniques: KF, EKF, UKF.	
Block 5. Application example	**12 h**
Topic 6: Robotic application. Power electronic application.	
	45 hours

Students are also provided, on the **course website** (UAH virtual platform: http://www.uah.es/aula_virtual), with a detailed description of each lesson that includes:

- Contents each face-to-face class.
- Available resources for each lesson.

- Work that the students must perform before and after classes in the hours allotted for their work.

4. TEACHING METODOLOGIES – LEARNING ACTIVITIES

4.1. Credit distribución (specified in hours)

Number of hours for lecturers:	22,5 h fase-to-face 22,5 h online
Number of hours of work by student:	67,55 h
Total hours	112,5 h

4.2. Methodological strategies, teaching materials and resources

The teaching-learning process will be carried out through the following activities:

Theory classes and practical lectures for exercises	17,5 h
Theoretical-practical lectures and practical laboratory classes	15 h
Tutorials	12,5 h
Others: individual work, virtual classroom and tests	67,5 h
Total hours	112,5 h

Throughout the course, students will be proposed activities and tasks so that they can experiment and strengthen the concepts acquired.

To carry out the laboratory practice, common in both modalities, students will have a work place with a computer and the necessary elements to experiment with design techniques of electronic control systems.

During the learning process of the course, students must use different bibliographic sources and electronic resources, so that they become familiar with the environments that they will use in the research or professional fields.

The Virtual Classroom will be used as a synchronous (videoconference) and asynchronous (recordings) teaching tool, and will favor interaction and debate between teacher and students: forums, chat and e-mail.

5. ASSESSMENT: Procedures, assessment and marking criteria

Preferably, students will be offered a system of continuous assessment that has formative evaluation characteristics, so that it serves as feedback in the students' teaching-learning process.

5.1. Assessment procedures

The proposed evaluation process is inspired by the continuous assessment, although, respecting the regulations of the University of Alcalá, an alternative final-exam assessment process is offered to students[1].

5.2. Assessment criteria

The Assessment Criteria must take into account the degree of acquisition of the competences by students. For this, the following criteria are defined.

- C1: That the student is able to correctly solve problems related to the design of processor-based electronic systems using different typologies and memory accesses.
- C2: That the student is able to solve problems related to digital electronic systems based on programmable devices using advanced techniques and high-level languages.
- C3: That the student implements digital electronic systems that provide solutions to the proposed problems, integrating the knowledge acquired, making use of bibliographic resources and computer tools at their disposal.
- C4: That the student is able to generate correctly written, clear and precise documentation on the work done in the laboratory.
- C5: That the student presents and defends in a clear and reasoned way their proposals for the resolution of the proposed problems.

5.3. Assessment tools

This section lists the assessment instruments, in face-to-face and semi face-to-face modes, that will be applied:

- Test of basic knowledge consisting of multiple choice questions addressing the basic theoretical aspects of the topics taught.

[1] Students will have a period of 15 days to request to the Master's Degree Director their intention to use the final evaluation model (non continuous), citing the reasons they deem appropriate, according to the indicated in the regulations governing the learning assessment processes (approved by Governing Council of September 2021).

- Exercises related to the design of electronic control systems in the form of practical problems.
- Laboratory practices, consisting of the design, simulation and implementation of practical applications of control systems. A report of the work carried out will be individually presented.

The evaluation system of the acquired competences will consist of:

1. Assessment of the theoretical part (PT) 50%
An intermediate assessment (PEI) and a final assessment (PEF), which may include open-ended questions (questions) and multiple-choice questions.

2. Assessment of the practical part in the laboratory (PP) 50%.
Continuous assessment of the work carried out in the laboratory

The overall grade for the course will be the weighted mark with the percentages indicated, provided that at least 30% of the maximum mark has been achieved in each set of tests assessed (theory and practical).

5.4. Grading criteria

5.4.1. Continuous assessment:

a) **Ordinary call.** Students will be assessed continuously through tests distributed throughout the academic period. The weight percentages of such tests on the final grade, as well as the relationship between the criteria and assessment instruments of the subject, is as follows:

Learning results	Assessment criteria	Assessment instruments	Grading weight
RAP1, RAP2	CE1, CE2, CE5	PT (PEI)	20%
		PT (PEF)	30%
	CE3, CE4, CE5	PP	50%

A student will be considered to have participated in the teaching-learning process and therefore have attended the ordinary call if he/she attends any of the scheduled instruments (PT or PP).

Students will be considered to have passed the course if they achieve a weighted global grade equal to or greater than 5 (out of 10) among all the grading instruments, having obtained a minimum grade in each of the parts (PT and PP) of at least 30% of the maximum grade.

b) **Extraordinary call**. Those students who do not pass the ordinary call will be entitled to an extraordinary call. The theoretical part (PT) will be assessed through a test-type exercise and questions, and the practical part (PP) through a practical laboratory exam. The weight percentages of such parts, as well as the relationship between the criteria, assessment instruments and the learning results of the subject, is as follows:

Learning results	Assessment criteria	Assessment instruments	Grading weight
RAP1, RAP2	CE1, CE2, CE5	PT	50%
	CE3, CE4, CE5	PP	50%

Students will be considered to have passed the course if they achieve a weighted global grade equal to or greater than 5 (out of 10) among all the grading instruments, having obtained a minimum grade in each of the parts (PT and PP) of at least 40% of the maximum grade.

5.4.2. Non-continuous assessment:

Ordinary and extraordinary call

Those students who choose the final assessment model (non-continuous), both in the ordinary and extraordinary calls, must pass: the theoretical part (PT) through a test-type exercise and questions, and the practical part (PL) through a practical lab exam. The weight percentages of such tests on the final grade, as well as the relationship between the criteria, assessment instruments and the learning results of the subject, is as follows:

Learning results	Assessment criteria	Assessment instruments	Grading weight
RAP1, RAP2	CE1, CE2, CE5	PT	50%
	CE3, CE4, CE5	PP	50%

Students will be considered to have passed the course if they achieve a weighted global grade equal to or greater than 5 (out of 10) among all the grading instruments, having obtained a minimum grade in each of the parts (PT and PP) of at least 40% of the maximum grade.

6. BIBLIOGRAPHY

6.1 Basic bibliography

- Documentation developed by the teachers of the course.
- Equipment guides, instrumentation and software tools used in laboratory Electronic Control Systems Design.
- Discrete time control systems. 2nd Edition. Author: K. Ogata.
  Editorial: Prentice Hall.
- Optimal state estimation. Dan Simon. ISBN-13 978-0-471-70858-2. 2006
- Multivariable feedback control. Analysis and design. Autor: S. Skogestad and I. Postlehwaite. Editorial John Wiley & Sons.

6.2 Complementary bibliography

- System Identification: Theory for the User. 2nd Edition. Author: Lennart Ljung. Prentice-Hall 1999.
- Optimal state estimation. Dan Simon. ISBN-13 978-0-471-70858-2. 2006
- A survey of recent results in networked control systems. Jo.ao P. Hespanha Payam Naghshtabrizi Yonggang Xu.
  http://www.ece.ucsb.edu/~hespanha/published/ncs_v15p.pdf
- Digital Control Engineering. Analysis and design. Author: M. Sam Fadali.
  Edit. Elsevier. 2009.
- The Art of Control Engineering. Authors: K. Dutton y otros. Edit. AddisonWesley.
- An introduction to the Kalman Filter. Authors: G. Welch and G. Bishop. TR95-041. May. 23, 2003.