Universidad de Alcalá

TEACHING GUIDE

DIGITAL ELECTRONICS

Degree in Electronic Engineering and Industrial Automation

University of Alcalá

Academic Year 2019/2020

2nd Year – 1st Semester

TEACHING GUIDE

Name of the course:	**DIGITAL ELECTRONICS**
Code:	**600028**
Degree:	**Graduate in Electronic Engineering and Industrial Automation**
Department & Area of Knowledge:	**Electronics / Electronic Technology**
	Compulsory
ECTS credits:	**6**
Year & semester:	**2nd year / 1st semester**
Teachers:	View website[1]
Office hours:	View website[2]
Language Classes Offered:	**English**

1. INTRODUCTION

The aim of this course is to introduce students to the study and basic design of digital systems, both combinational and sequential. Hardware Description Languages (HDL) and Programmable Logic Devices (PLD) are presented. On this basis, it is possible to address systems based on microprocessors, microcontrollers, system-specific hardware, etc. that will be discussed in subsequence subjects.

For better understanding of the course, it will be necessary to have prior knowledge acquired in the course of Circuit Theory. It is particularly interesting to have attended and passed lab part of this subject.

2. COMPETENCES

Competences of generic and professional nature:

This course will enable the student to acquire the following skills, as defined in Section 3 of the Annex to the Order CIN/352/2009.

- **TR2:** knowledge of basic topics and technologies that enable to learn new methods and technologies, as well as providing the student with high capacity to adapt to new situations.
- **TR3**: Capacity to solve problems showing initiative, take decisions, creativity, critical reasoning and knowledge communication, skills and capabilities in the field of Industrial Engineering.

[1] https://www.uah.es/es/estudios/estudios-oficiales/grados/asignatura/Electronica-Digital-600028
[2] https://www.uah.es/es/aula-virtual/

- **TR4**: Knowledge applicable to make measurements, calculations, estimations, technical valuations, working plans and reports and other similar work.

- **TR9**: Capacity to work in a multilingual and multidisciplinary environment.

Profesional competences:

This course will also enable the student to acquire the professional skills, as defined in Section 5 of the Annex to the Order CIN/351/2009.

CEI3: Knowledge of the basics and applications of digital electronics and microprocessors.

CEI6: Capacity to design digital, analogue and power systems.

Learning results

LR1. Design simple digital systems with HDLs

LR2. Understand the logic functions that describe a digital system, as well as its implementation with basic logic gates.

LR3. Identify the different combinational circuits used in digital systems

LR4. Use the necessary techniques and circuits to implement the basic binary-arithmetic operations

LR5. Use the different sequential systems.

3. CONTENTS

Content units	Total class hours (L / Prob / Lab)
Introduction. Overview of digital circuits. Boolean algebra. Basic logic gates. Synthesis and implementation of logic functions. Basics of logic families: voltage levels, currents and compatibility. Tristate gates. Open collector logic gates. Wired logic connections.	5 / 2 / 0
Analysis and design of combinational digital circuits: multiplexers, demultiplexers, decoders and drivers (*BCD-7s*), encoders, comparators and binary arithmetic circuits. Introduction to FPGA and VHDL	7 / 6 / 8
Analysis and design of sequential digital circuits: bistables, registers and counters.	8 / 6 / 4
Synthesis of sequential systems. Sequential systems design: Moore and Mealy automata.	4 / 4 / 0

These contents add up to 56 hours of lectures, problems and lab and, coupled to two-hour mid-term tests and two hours of final evaluation, make 58 hours in a classroom setting.

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 in-person classes.
- Available resources for each lesson.
- Work that the students must perform before and after classes in the hours allotted for their work.

4. METHODOLOGY OF TEACHING AND LEARNING. TRAINING ACTIVITIES

4.1. Credit distribution

Hours in a classroom setting:	58 hours (56 in-person classes + 2 final evaluation)
Time of student work on their own:	92 hours
Total:	150 hours

4.2. Methodological strategies, teaching materials and resources

In the teaching-learning process the following training activities will be held:

- *Lectures* (theory classes) given in large groups based on presentations that allow the teacher to introduce the skills necessary for the proper development of the learning process. These classes will present essential contents, subject of a reasoned conceptual learning, subsequently used to develop broader skills.
- *Practical classes* taught in small groups based mainly on solving exercises and problems. The aim of these classes is to promote meaningful learning that will allow students to deepen the knowledge acquired, relate and apply it creatively in order to solve situations, as the course progresses, that will gradually become more similar to real-world engineering problems.
- *Lab classes* taught exclusively in small groups and based on practical circuit implementation, scheduled so that they serve as a complement for better understanding of the concepts acquired in the room sessions, through practical experimentation.
- *Tutorship sessions*: individual or group sessions.
- *Student previous or subsequent work*: essential part of the teaching-learning process that will be guided and described in detail in the student's notebook quoted above.

The following additional resources may also be used:

- Individual and group works, which could pose, in addition to its realization, the relevant public presentation to the rest of the class to stimulate discussion.
- Attendance at conferences, meetings or discussions related scientific field.

In the lab classes, the students will have at their disposal a work station provided with the basic equipment (oscilloscope, power supply end signal generator) and a computer with HDL design and simulation software. In this course, *lab should be carried out in groups of two students*.

Throughout the learning process in the course, students will use different bibliographic and electronic resources, in order to become familiar with the environments of documentation they will use professionally in the future. In addition, teachers will provide own materials developed specifically for the course (theoretical papers, collections of exercises and problems, practice manuals, audiovisuals, etc.) so that students can meet the course objectives and achieve the competences described.

Students will be provided throughout the semester with tutorship in group (if requested by the students themselves) or individual. Whether individually or in small groups, this tutorship will resolve doubts and consolidate the knowledge acquired. Also it will help to make appropriate monitoring and assess the proper functioning of the mechanisms of teaching and learning.

Finally, the whole development of the subject will be detailed on the website of the course (see table at the beginning of the document). All resources developed for the subject, such as slides, exercise statements and solutions, statements of problems for practices, detailed schedules for each group and class, mid-term exams marks and any other information that teachers consider appropriate for the proper teaching and learning process will be available on the website.

5. ASSESSMENT: Procedures, assessment and marking criteria

5.1 ASSESSMENT CRITERIA

Firstly, students have two methods of assessment: continuous or final assessment. To optimize the teaching-learning process, teachers of the subject urge students to choose the continuous model but respecting the regulations of the University of Alcalá, an alternative final-exam assessment process is offered. Observing these rules, **students will have a period of fifteen days from the start of the course to apply their intention to invoke the final assessment model providing relevant reasons. Written applications must be addressed to Polytechnic University School Director.** The evaluation of the learning process for those students who do not request non-continuous assessment or whose application is refused will be done, by default, according to the model of continuous assessment, described in following paragraphs.

Continuous assessment implies and/or allows for the following:

- The student knows, by means of real and objective tests, his evaluation criteria.
- The student knows regularly the results of his learning process.

- Provide the teacher with objective information about subject evolution
- Intermediate tests do not release any contents from the final test, as long as this one aims at evaluating globally all the competences of the course.

According to current UAH regulations (rules governing the processes of learning assessment approved by the Governing Council of March 24, 2011, Article 6, paragraph 4), and, as long as the laboratory module is considered as an essential part to reach the capacities aimed by the Digital Electronics course, **attendance to all the lab practicals, as well as successfully completing them, is considered as an essential and also compulsory element** for the course assessment, either under continuous assessment or final evaluation format. **For this reason, lab practicals are common and mandatory, both for continuous and final assessment too.**

5.1 Assesment Criteria

The following assessment criteria are stated:

AC1: The student solves correctly analysis and design problems of combinational and sequential circuits, synchronous and asynchronous. The student must be able to solve new problems, different from the ones addressed in the classes.

AC2: The student is able to integrate all conceptual knowledge explained in the theoretical sessions to solve new problems in a creative and original way.

AC3: The student explains and shows in a clear way the solutions proposed

AC4: The student implements practical real circuits as a solution to a problem stated integrating his theoretical knowledge, using discrete components and HDLs too, and making use of bibliography and informatics.

AC5: The student is able to generate, clearly presented, concise and rigorous technical reports.

5.2 Assesment procedure (tools)

The following assessment tools will be used:

1. Mid-term exams **(MT)**: one or two mid-term exams that consist of a number of questions (analysis and / or synthesis) on specific aspects of the syllabus covered by the lectures, exercises classes and lab along the whole course.
2. **LP:** Three lab projects **(LP1, LP2, LP3)** covering the whole subject knowledge including combinational and sequential circuits. They are continuously assessed along the practical sessions.
3. **FE:** A final exam that consists of a number of questions (analysis and / or synthesis) on specific aspects of the syllabus covered by the lectures and exercises classes along the whole course.

5.3 Assesment procedure (marking criteria)

Continous assessment, ordinary exam.

Competences	Learning results	Assessment criteria	Assessment tool	Evaluation weights
TR2, TR3, CEI-3, CEI-6	LR2-LR5	AC1-AC3	**MT (s)**	**40%**
			FE	**40%**
TR4, TR9, CEI-3, CEI-6	LR1-LR5	AC4-AC5	**LP**	**20%**

A student will successfully pass the course following the continuous assessment model if he or she shows that has acquired the theoretical and practical skills, which means:

- The student has attended and performed the three laboratory practicals, and has successfully passed the evaluation of the lab skills and competences. A student is considered to have successfully reached these skills if he or she has attended and completed all the lab practicals. The evaluation of the lab skills along the course may also include either practical and/or more conceptual questions, asked by the teacher by means of an oral or written test

- Obtaining a mark equal or greater than the 45% of the maximum possible total mark in the theory-tests carried out (hence successfully passing the evaluation of the skills and competences related to theory tests).

- The student must obtain a final global mark equal to or greater than 5 (out of 10) calculated as a weighted average with the percentages detailed before.

The student who follows the continuous assessment process is considered as *not presented,* in case he does not perform, apart from the laboratory practicals, the final exam (FE).

Final assessment, ordinary exam.

Competences	Learning results	Assessment criteria	Assessment tool	Evaluation weights
TR2, TR3, CEI-3, CEI-6	LR2-LR5	AC1-AC3	**FE**	**80%**
TR4, TR9, CEI-3, CEI-6	LR1-LR5	AC4-AC5	**LP**	**20%**

In order to pass the course, the same criterion applies in this case. The student must show that he/she has successfully acquired the practical skills corresponding to the lab sessions (i.e., he/she has attended and carried out all the scheduled regular lab practicals, as explained in previous sections), and has obtained a mark equal or greater than the 45% of the maximum possible total mark in the theory-tests carried out (hence successfully passing the evaluation of the skills related to theory tests). The final global mark must be equal to or greater than 5 (out of 10) calculated as a weighted average with the corresponding percentages detailed for the extra exam session.

Final assessment, extraordinary exams

Competences	Learning results	Assessment criteria	Assessment tool	Evaluation weights
TR2, TR3, CEI-3, CEI-6	LR2-LR5	AC1-AC3	**FE**	**80%**
TR4, TR9, CEI-3, CEI-6	LR1-LR5	AC4-AC5	**LP**	**20%**

As for the other two modalities, to successfully pass the course the student must show that he/she has successfully acquired the practical skills corresponding to the lab sessions (i.e., he/she has attended and carried out all the scheduled regular lab practicals, as explained in previous sections), and has obtained a mark equal or greater than the 45% of the maximum possible total mark in the theory-tests carried out (hence successfully passing the evaluation of the skills related to theory tests). The final global mark must be equal to or greater than 5 (out of 10) calculated as a weighted average with the corresponding percentages detailed for the extra exam session.

6. BIBLIOGRAPHY

Course notes specifically prepared by teachers which will be provided to students directly through the website of the course (including slides, notes, data sheets and collections of exercises).

Websites on the topic of the course to be selected in advance by the faculty.

Digital Fundamentals. Thomas L. Floyd. Prentice Hall. Comprehensive and detailed introduction to digital electronics covering all aspects of the syllabus except the design of synchronous sequential circuits. It is especially interesting because of the number of solved examples and exercises.

Digital Systems. Principles and Applications. Ronald. J. Tocci. Prentice Hall. It is also a book with a broad introduction to digital electronics that fits quite well the basic concepts of this course.