Digital Electronics

Academic Year: (2024 / 2025) **Review date: 20-01-2025**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: PORTELA GARCIA, MARTA

Type: Basic Core ECTS Credits : 6.0

Year : 1 Semester : 1

Branch of knowledge: Engineering and Architecture

LEARNING OUTCOMES

CB1: Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2: Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CG3: Knowledge of basic and technological subject areas which enable acquisition of new methods and technologies, as well as endowing the technical engineer with the versatility necessary to adapt to any new situation.
CG13: Understanding and command of basic concepts of linear systems and related functions and transformers. Electrical circuit theory, electronic circuits, physical principles of semiconductors and logic families, electronic and photonic devices, materials technology and their application in resolving problems characteristic of engineering.
ECRT9: Ability to analyze and design combinational and sequential circuits, synchronous and asynchronous circuits, and use of microprocessors and integrated circuits.
RA1: Knowledge and Understanding. Knowledge and understanding of the general fundamentals of engineering, scientific and mathematical principles, as well as those of their branch or specialty, including some knowledge at the forefront of their field.
RA2: Analysis. Graduates will be able to solve engineering problems through an analysis process, identifying the problem, recognising specifications, establishing different methods of resolution, selecting the most appropriate one and implementing it correctly. They must be able to use various methods and recognize the importance of social constraints, human health, safety, the environment, as well as commercial constraints.
RA5: Applications. Graduates will have the ability to apply their knowledge and understanding to solve problems, conduct research, and design engineering devices or processes. These skills include knowledge, use and limitations of materials, computer models, process engineering, equipment, practical work, technical literature and information sources. They must be aware of all the implications of engineering practice: ethical, environmental, commercial and industrial.

OBJECTIVES

The objective of this course is to introduce students to the operation, analysis, and design of digital circuits. The fundamentals of hardware description languages and digital circuit design in VHDL will also be introduced.
At the end of this course, the following skills will have been acquired:
- Know the purpose and basic operation of digital circuits
- Analyze and use digital circuits
- Design digital circuits

DESCRIPTION OF CONTENTS: PROGRAMME

1. Number systems and information representation

1.1. Number Systems
1.2. Number Systems Conversions
1.3. Binary Codes
2. Boolean Algebra and logic functions
2.1. Postulates and fundamental properties of Boolean Algebra
2.2. Boolean functions and expressions
2.3. Logic gates. Implementation of logic functions
2.4. Minimization of logic functions
3. Introduction to design and implementation of digital circuits
3.1. Technologies for implementing digital circuits
3.2. Hardware description languages
3.3. Design flow: simulation and automatic synthesis
3.4. Basic concepts of VHDL design
4. Combinational circuits and VHDL description
4.1. Basic combinational circuits
4.1.1. Encoders
4.1.2. Decoders
4.1.3. Multiplexers
4.1.4. Demultiplexers
4.1.5. Comparators
4.2. Association of basic combinational circuits
4.3. Logic function implementation using combinational circuits
5. Arithmetic combinational circuits and VHDL description
5.1. Representing signed numbers
5.2. Sign and magnitude, 1s-complement and 2s-complement
5.3. Binary Arithmetic
5.3.1. Addition and subtraction
5.3.2. Multiplication and division
5.4. Representing real numbers
5.5. Addition and Subtraction Circuits
5.6. Circuits for multiplication
5.7. Arithmetic Logic Units (ALUs)
6. Flip-Flops and VHDL description
6.1. Asynchronous flip-flops
6.2. Synchronous flip-flops
6.3. Flip-flop control logic
6.4. Timing characteristics
6.5. Synchronous circuits
6.6. Circuits with flip-flops: chronograms
7. Synchronous sequential circuits and VHDL description
7.1. Finite State Machines
7.1.1. Moore model
7.1.2. Mealy model
7.2. Synchronous Sequential Circuits Analysis
7.3. Synchronous Sequential Circuits Synthesis
8. Registers and Counters and VHDL description
8.1. Registers
8.2. Counters
8.2.1. Synchronous counters
8.2.2. Counter as a Finite State Machine
8.2.3. Counter applications
9. Memories and VHDL description
9.1. Memory types
9.2. Characteristics of memories
9.3. Internal organization of a memory
9.4. Extension of memory size
9.5. Memory access chronograms
9.6. Applications
10. Digital Systems
10.1. Structure of a digital system
10.1.1. Data path
10.1.2. Control Unit
10.2. Introduction to digital systems design

10.2.1. ASICs
10.2.2. Programmable logic devices
10.2.3. Microprocessors

LEARNING ACTIVITIES AND METHODOLOGY

- 40% Lectures: 2,4 ECTS. Intended to reach the specific competences of the course. Students will receive class notes and reference books in order to work and get in-depth knowledge on the course contents.
- 40% Problem classes: 2,4 ECTS. Oriented to exercise resolution and Ongoing Evaluation.
- 20% Lab practices: 1,2 ECTS. Design and development of digital circuits using simulation tools with the aid of the professor

ASSESSMENT SYSTEM

% end-of-term-examination:	0
% of continuous assessment (assigments, laboratory, practicals…):	100

Assessment: 100% on-going evaluation.

On-going evaluation is decomposed into:
- Midterm exams: Exam 1 (35%) y Exam 2 (50%)
- Lab Practice and exercises: 15%.

Students must attend all laboratory sessions to complete continuous assesment

Second call grade is 100 % of the final exam mark.

BASIC BIBLIOGRAPHY

- Abramovici, M. Digital system testing and testable design, Computer Science Press, 1990

- B. Mealy Free Range VHDL. The no-frills guide to writing powerful code for your digital implementations, open-source (http://www.freerangefactory.org/).

- FLOYD, T.L Digital Systems Fundamentals, Prentice Hall.

- HAYES, J.P. Introduction to Digital Logic Design, Addison Wesley.

- J. M. Rabaey Circuitos Integrados Digitales: Una perspectiva de diseño, Prentice Hall, 2000

- Tocci R.J., Widmer N.S., Moss, G.L. Digital Systems: Principles and Applications, Pearson Prentice Hall.

ADDITIONAL BIBLIOGRAPHY

- D. D. Gajski Principios de Diseño Digital, Prentice-Hall.

- J. F. Wakerly Digital Design Principles and Practices, Pearson Education.

- Javier García Problemas resueltos de Electrónica Digital, Paraninfo/Thomson.

BASIC ELECTRONIC RESOURCES

- Enrique San Millán Heredia, Luis Entrena Arrontes, Celia López Ongil, Mario García Valderas, Marta Portela García, Almudena Lindoso Muñoz . Digital Electronics: http://ocw.uc3m.es/tecnologia-electronica/digital-electronics