# Digital Electronics

**Academic Year: ( 2022 / 2023 )** **Review date: 20-05-2022**

**Department assigned to the subject: Department of Electronic Technology**

**Coordinating teacher: LINDOSO MUÑOZ, ALMUDENA**

**Type: Basic Core ECTS Credits : 6.0**

**Year : 1 Semester : 1**

**Branch of knowledge: Engineering and Architecture**

## 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

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 continous assessment.

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

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

## 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