Digital Electronics

Academic Year: (2024 / 2025) **Review date: 26-04-2024**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: GARCIA VALDERAS, MARIO

Type: Compulsory ECTS Credits : 6.0

Year : 3 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Fundamentals of Electronic Engineering

OBJECTIVES

By the end of this subject, students will be able to have:
- A systematic understanding of the key aspects and concepts of their branch of engineering in digital electronics.
- Coherent knowledge of their branch of engineering including some at the forefront of the branch in digital electronics.
- The ability to apply their knowledge and understanding of digital electronics to identify, formulate and solve engineering problems using established methods.
- The ability to apply their knowledge and understanding to develop and realise designs of digital circuits to meet defined and specified requirements.
- An understanding of methodologies for the design and description of digital circuits, and an ability to use them.
- Workshop and laboratory skills.
- The ability to select and use appropriate equipment, tools and methods, as FPGAs, hardware description languages, simulation and logic synthesis tools for digital circuits.
- The ability to combine theory and practice to solve problems of digital electronics.
- An understanding of applicable techniques and methods in digital electronics, and of their limitations.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Representation of information in digital systems
   - Numbering systems
   - Conversions between numbering systems
   - Binary codes
2. Boolean algebra and logic gates
   - Fundamental postulates and properties of Boolean algebra
   - Boolean functions and expressions
   - Logic gates. Logic functions implementation and minimisation
3. Introduction to digital circuit design and implementation
   - Technologies for the implementation of digital circuits
   - Hardware description languages
   - Design flow: simulation and automatic synthesis
   - Basic design concepts in VHDL
4. Combinational circuits
   - Encoders and decoders
   - Multiplexers and demultiplexers
   - Comparators
   - Association of combinational circuits
   - Implementation of logical functions with combinational circuits
5. Arithmetic combinational circuits and description in VHDL
   - Representation of signed numbers: Sign-Magnitude, 1-Complement and 2-Complement systems
   - Binary arithmetic: addition, subtraction, multiplication

- Representation of real numbers
- Addition, subtraction and multiplication circuits
- Arithmetic-Logic Units (ALU)

6. Bistables
- Asynchronous and synchronous bistables
- Bistable control logics
- Time characteristics
- Synchronous circuits
- Circuits with bistables: chronograms

7. Registers and counters
- Registers
- Counters
- Applications with counters

8. Synchronous sequential circuits
- Finite state machines: Moore and Mealy models
- Counters as state machines
- Analysis of synchronous sequential circuits
- Synthesis of synchronous sequential circuits

9. Memories
- Types and characteristics of memories according to their technology
- Types and characteristics of memories according to their functionality
- Description in VHDL.

10. Simulation and synthesis of digital circuits described in VHDL.
- VHDL for simulation and synthesis
- Test benches and simulation models
- Synthesis. Resources and timing. Constraints

11. Digital systems: structure and implementation
- Structure: data path and control
- Programmable logic devices (FPGA)
- Custom integrated circuits (ASICs)
- Microprocessors

LEARNING ACTIVITIES AND METHODOLOGY

Lectures: 50%, 1 session/week (2 hours)
Practice: 36%, 1 session/week (2 hours)
Lab. Practice: 14%, 4 sessions, (2 hours each)
Personal assistance, as scheduled by the teacher

ASSESSMENT SYSTEM

% end-of-term-examination:	45
% of continuous assessment (assigments, laboratory, practicals…):	55

Continuous evaluation system based on:
- 1st partial exam: 20%
- 2nd partial exam: 20%
- Lab practice work (compulsory): 15%
- Final exam: 45%, minimum mark 3.5/10.

BASIC BIBLIOGRAPHY

- . FPGA Manufacturers web pages. Xilinx: www.xilinx.com; Altera: www.altera.com; , ..

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

- R. Tokheim Digital Electronics, McGraw-Hill.

- Smith, D.J. HDL chip design, Doone, 1997

- T. L. Floyd Digital Fundamentals, Prentice-Hall (several editions).

ADDITIONAL BIBLIOGRAPHY

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

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