Digital Electronics

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

Department assigned to the subject: Department of Electronic Technology

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

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.

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

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.