Digital Electronics

Academic Year: (2023 / 2024) **Review date: 21-04-2023**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: GARCIA VALDERAS, MARIO

Type: Electives ECTS Credits : 6.0

Year : 4 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

- Electronics Engineering Fundamentals (2nd)

SKILLS AND 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.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG1. Ability to solve problems with initiative, decision-making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering.
CG3. Ability to design a system, component or process in the field of Industrial Technologies to meet the required specifications
CG4. Knowledge and ability to apply current legislation as well as the specifications, regulations and mandatory standards in the field of Industrial Engineering.
CG5. Adequate knowledge of the concept of company, institutional and legal framework of the company. Organisation and management of companies.
CG6. Applied knowledge of company organisation.
CG8. Knowledge and ability to apply quality principles and methods.
CG9. Knowledge and ability to apply computational and experimental tools for the analysis and quantification of Industrial Engineering problems.
RA1. Knowledge and understanding: Have basic knowledge and understanding of science, mathematics and engineering within the industrial field, as well as knowledge and understanding of Mechanics, Solid and Structural Mechanics, Thermal Engineering, Fluid Mechanics, Production Systems, Electronics and Automation, Industrial Organisation and Electrical Engineering.
RA2. Engineering Analysis: To be able to identify engineering problems within the industrial field, recognise specifications, establish different resolution methods and select the most appropriate one for their solution
RA3. Engineering Design: To be able to design industrial products that comply with the required specifications, collaborating with professionals in related technologies within multidisciplinary teams.
RA4. Research and Innovation: To be able to use appropriate methods to carry out research and make innovative contributions in the field of Industrial Engineering.
RA5. Engineering Applications: To be able to apply their knowledge and understanding to solve problems and design devices or processes in the field of industrial engineering in accordance with criteria of cost, quality, safety, efficiency and respect for the environment.

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

- R. Tokheim Digital Electronics, McGraw-Hill.
- null FPGA Manufacturers web pages. Xilinx: www.xilinx.com; Altera: www.altera.com; , .., Various.
- Bryan Mealy, Fabrizio Tappero Free Range VHDL. The no-frills guide to writing powerful code for your digital implementations, ., 2013
- Smith, D.J. HDL chip design, Doone, 1997
- T. L. Floyd Digital Fundamentals, Prentice-Hall.

ADDITIONAL BIBLIOGRAPHY

- D. D. Gajski Principios de Diseño Digital, Prentice-Hall.
- J. F. Wakerly Digital Design Principles and Practices, Pearson Education.