Course guide
320036 - ELODIG - Digital Electronics

Last modified: 19/04/2023

Unit in charge:	Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit:	710 - EEL - Department of Electronic Engineering.

Degree:	BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer:	Gabriel José Capellá Frau
Others:	Gabriel José Capellá Frau Montserrat Corbalán Fuertes

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. ELO: Knowledge of the foundations and applications of digital electronics and microprocessors

5. ELO: Capability for designing analog , digital and power electronic systems.

Transversal:
2. SELF-DIRECTED LEARNING - Level 1. Completing set tasks within established deadlines. Working with recommended information sources according to the guidelines set by lecturers.
3. TEAMWORK - Level 1. Working in a team and making positive contributions once the aims and group and individual responsibilities have been defined. Reaching joint decisions on the strategy to be followed.
4. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.

TEACHING METHODOLOGY

- Face-to-face lecture sessions.
- Face-to-face practical class work sessions.
- Face-to-face practical laboratory work sessions.
- Self learning and exercises.
- Preparation and completion of group activities subject to assessment.

In the face-to-face lecture sessions, the lecturer will introduce the basic theory, concepts, methods and results for the subject and will use examples to facilitate students' understanding.

Practical class work will be covered in three types of sessions:
a) Sessions in which the lecturer will provide students with guidelines to analyse data for solving problems by applying methods, concepts and theoretical results (85%).
b) Examination sessions (15%).

Practical laboratory work will be covered by two types of sessions:
a) Sessions in which the lecturer provides students with guidelines to design logic circuits in order to solve the assigned problems (20%).
b) Sessions in which students test and verify that their designs work properly to solve the assigned problems (80%).

Students will be expected to study on their own so that they become familiar to concepts and are able to solve the exercises set, whether manually or with the help of a computer.

Students are due to present in spoken and written format a proposal to solve a problem or assignement in order to have their communication skills assesed.

LEARNING OBJECTIVES OF THE SUBJECT

This subject introduces students to the design of digital systems. Students will become familiar to CAD tools for designing digital systems and learn how to implement them using programmable logic devices. They will build on the specific and transversal competencies associated with coursework, as described below.

STUDY LOAD

Type	Hours	Percentage
Hours medium group	30,0	20.00
Hours large group	15,0	10.00
Hours small group	15,0	10.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

TOPIC 1: BINARY CODES AND NUMBER SYSTEMS

Description:
1.1. Binary, octal and hexadecimal number systems.
1.2. Representation of natural, integer and floating-point numbers.
1.3. Binary codes: concept, types and properties.
1.4. Numeric codes: BCD and continuous codes.
1.5. Error-detection codes.
1.6. ASCII character code.

Specific objectives:
- Representation of numerical data in several formats.
- Representation of non-numerical data.
- Codes for error-detecting in data transmission/reception.

Full-or-part-time: 7h
Theory classes: 1h
Practical classes: 2h
Self study : 4h

TOPIC 2: INTRODUCTION TO LOGIC CIRCUIT TECHNOLOGIES

Description:
2.1. Integrated circuit technology.
2.2. Operating characteristics of a logic family.
2.3. Output topologies.
2.4. Standard integrated circuits.
2.5. Programmable logic devices.

Specific objectives:
- Functional characteristics of digital integrated circuits.
- Structures of programmable logic devices.
- Design process with programmable logic devices.

Related activities:
Monitored software introduction sessions.

Full-or-part-time: 18h
Theory classes: 2h
Practical classes: 4h
Laboratory classes: 3h
Self study : 9h

TOPIC 3: COMBINATIONAL SYSTEMS

Description:
3.1. VHDL description of combinatorial systems
3.2. Combinatorial circuit applications: decoders, encoders, code converters, multiplexers, comparators.
3.3. Circuits for error detection and error correction.

Specific objectives:
- An understanding of the most frequently used combinatorial circuits and their applications.
- The ability to analyse and synthesise digital circuits using combinational blocks.

Related activities:
- Implementation of a multiplexed display

Full-or-part-time: 19h
Theory classes: 2h
Practical classes: 4h
Laboratory classes: 2h
Self study : 11h

TOPIC 4: BINARY ARITHMETIC

Description:
4.1. Binary addition and subtraction.
4.2. Structure of arithmetic circuits.
4.3. Two's-complement operations.
4.4. BCD adders.

Specific objectives:
- An understanding of the structure of digital arithmetic circuits.
- The ability to carry out two's-complement arithmetic operations.
- An understanding of circuits for arithmetic operations in BCD codes.

Related activities:
Design and implementation of circuits capable of performing arithmetic operations.

Full-or-part-time: 17h
Theory classes: 2h
Practical classes: 4h
Laboratory classes: 2h
Self study : 9h

TOPIC 5: SEQUENTIAL CIRCUITS: FLIP-FLOPS, REGISTERS AND COUNTERS

Description:
5.1. Concept of bi-stable circuit: flip-flop (D, T and J-K types)
5.2. Registers: Parallel- register, shift register and universal register
5.3. Register design in VHDL.
5.4. Counters: types and classification.
5.5. Binary and non-binary aschronous counters.
5.6. Synchronous counters.
5.7. Shift-register-based counters.
5.8. VHDL counters.

Specific objectives:
- Knowledge of the various types of counters and their applications.
- Designing asynchronous and synchronous counters.

Related activities:
Design and implementation of several counters and shift registers

Full-or-part-time: 27h
Theory classes: 3h
Practical classes: 6h
Laboratory classes: 4h
Self study : 14h

TOPIC 6: REGISTERS AND COUNTERS

Description:
6.1. Concept of a state machine.
6.2. Moore and Mealy models.
6.3. Synthesis of synchronous sequential circuits.
6.4. Synthesis with programmable logic devices.

Specific objectives:
- Design and implementation of sequential digital circuits using the Moore and/or Mealy models.

Related activities:
Design and implementation of various counting circuits and registers.

Full-or-part-time: 30h
Theory classes: 4h
Practical classes: 8h
Laboratory classes: 4h
Self study : 14h

TOPIC 7: SEMICONDUCTOR MEMORIES

Description:
7.1. Different types of memory classifications.
7.2. Structure of a random-access memory (RAM). Buses. Memory capacity.
7.3. Operation cycles.
7.4. Types of ROM. Applications
7.5. Static and dynamic RAM memories. Applications.

Specific objectives:
Knowledge of the different types of memories and their applications

Full-or-part-time: 14h 30m
Theory classes: 1h
Laboratory classes: 2h
Self study : 11h 30m

GRADING SYSTEM

- 1st-exam (parcial) weight: 25%
- 2nd-exam (final) weight: 45%
- Laboratory: 20%
- Handouts/Presentations: 10%

For those students who meet the requirements and submit to the reevaluation examination, the grade of the reevaluation exam will replace the grades of all the on-site written evaluation acts (tests, midterm and final exams) and the grades obtained during the course for lab practices, works, projects and presentations will be kept.
If the final grade after reevaluation is lower than 5.0, it will replace the initial one only if it is higher. If the final grade after reevaluation is greater or equal to 5.0, the final grade of the subject will be pass 5.0.

EXAMINATION RULES.

Students are expected to have passed Electronic Systems.

BIBLIOGRAPHY

Basic:
- Floyd, Thomas L. Fundamentos de sistemas digitales [on line]. 11a ed. Madrid: Pearson Educación, 2016 [Consultation: 09/05/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=6120.

Complementary:
- Wakerly, John F. Diseño digital: principios y prácticas. 3a ed. México: Pearson Educación, 2001. ISBN 9789702607205.