320036 - ELODIG - Digital Electronics

Coordinating unit: 205 - ESEIAAT - Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2019
Degree: BACHELOR'S DEGREE IN INDUSTRIAL ELECTRONICS AND AUTOMATIC CONTROL ENGINEERING (Syllabus 2009). (Teaching unit Compulsory)
ECTS credits: 6

Teaching languages: Catalan, Spanish

Coordinator: 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.
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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 assignment in order to have their communication skills assessed.

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

<table>
<thead>
<tr>
<th>Total learning time: 150h</th>
<th>Hours large group:</th>
<th>15h</th>
<th>10.00%</th>
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<tbody>
<tr>
<td></td>
<td>Hours medium group:</td>
<td>30h</td>
<td>20.00%</td>
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<tr>
<td></td>
<td>Hours small group:</td>
<td>15h</td>
<td>10.00%</td>
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<tr>
<td></td>
<td>Self study:</td>
<td>90h</td>
<td>60.00%</td>
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### Content

<table>
<thead>
<tr>
<th>TOPIC 1: BINARY CODES AND NUMBER SYSTEMS</th>
<th>Learning time: 7h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 1h</td>
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<td></td>
<td>Practical classes: 2h</td>
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<td>Self study: 4h</td>
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**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.

<table>
<thead>
<tr>
<th>TOPIC 2: INTRODUCTION TO LOGIC CIRCUIT TECHNOLOGIES</th>
<th>Learning time: 18h</th>
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<tbody>
<tr>
<td></td>
<td>Theory classes: 2h</td>
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<tr>
<td></td>
<td>Practical classes: 4h</td>
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<tr>
<td></td>
<td>Laboratory classes: 4h</td>
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<td>Self study: 9h</td>
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**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.

**Related activities:**
Monitored software introduction sessions.

**Specific objectives:**
- Functional characteristics of digital integrated circuits.
- Structures of programmable logic devices.
- Design process with programmable logic devices.
### TOPIC 3: COMBINATIONAL SYSTEMS

**Learning time:** 19h  
- Theory classes: 2h  
- Practical classes: 4h  
- Laboratory classes: 2h  
- Self study: 11h

**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.

**Related activities:**
- Implementation of a multiplexed display

**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.

### TOPIC 4: BINARY ARITHMETIC

**Learning time:** 17h  
- Theory classes: 2h  
- Practical classes: 4h  
- Laboratory classes: 2h  
- Self study: 9h

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

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

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

**Learning time:** 27h  
Theory classes: 3h  
Practical classes: 6h  
Laboratory classes: 4h  
Self study: 14h

**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 asynchronous counters.  
5.6. Synchronous counters.  
5.7. Shift-register-based counters.  
5.8. VHDL counters.

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

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

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### TOPIC 6: REGISTERS AND COUNTERS

**Learning time:** 30h  
Theory classes: 4h  
Practical classes: 8h  
Laboratory classes: 4h  
Self study: 14h

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

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

**Specific objectives:**  
- Design and implementation of sequential digital circuits using the Moore and/or Mealy models.
### TOPIC 7: SEMICONDUCTOR MEMORIES

**Learning time:** 14h 30m  
- Theory classes: 1h  
- Laboratory classes: 2h  
- Self study: 11h 30m

**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

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### Qualification 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.

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### Regulations for carrying out activities

Students are expected to have passed Electronic Systems.

### Bibliography

**Basic:**


**Complementary:**