230031 - SEP - Programmable Electronic Systems

Degree competences to which the subject contributes

**Generical:**
2. ABILITY TO IDENTIFY, FORMULATE AND SOLVE ENGINEERING PROBLEMS Level 3. To identify and model complex systems. To identify methods and tools appropriate to pose the equations and descriptions associated with the models and to solve them. To carry out qualitative analysis and approaches. To determine the uncertainty of the results. To formulate hypotheses and experimental methods to validate them. To set up and manage undertakings. To identify major components and establish priorities. To develop critical thinking.

**Transversal:**
1. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.

Teaching methodology

Lectures
Laboratory classes
Teamwork (unattended)
Individual work (unattended)
Short answer tests (Control)
Long answers test (Final exam)
Laboratory assignments

Learning objectives of the subject

Programming, analysis and design of microprocessor / microcontroller based systems.
Design of digital systems with programmable logic devices.
Increase the knowledge and use of the VHDL hardware description language.

Learning results:

Ability to design, evaluate and implement medium complexity digital systems using programmable logic devices (PLDs, CPLDs, FPGAs).
Ability to describe medium complexity digital systems using the VHDL hardware description language.
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Understanding of the features of commercial programmable logic devices (PLDs, CPLDs, FPGAs).
Ability to design, evaluate and implement digital systems based on microprocessors and microcontrollers.
Ability to program, evaluate and debug applications on systems based on microprocessors and microcontrollers.
Experience in programming and debugging applications on microcontrollers, as well as using their usual interface signals.

Application of the acquired competences to the autonomous completion of a task. Identification of the need for a continuous learning and development of a specific strategy to carry it out.
Identification and modeling of complex systems. Development of qualitative analysis and approximations, establishing the uncertainty of the results. Posing hypotheses and experimental methods to validate them. Identification of major components and definition of tradeoffs and priorities.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 188h</th>
<th>Hours large group:</th>
<th>39h</th>
<th>20.74%</th>
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<tbody>
<tr>
<td></td>
<td>Hours small group:</td>
<td>39h</td>
<td>20.74%</td>
</tr>
<tr>
<td></td>
<td>Self study:</td>
<td>110h</td>
<td>58.51%</td>
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</tbody>
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# Content

## Module 1. Structure and programming model of a microprocessor

### Learning time: 21h 41m
- Theory classes: 8h
- Self study: 13h 41m

### Description:
1.1. Components of a microprocessor system
1.2. Internal structure of registers, stack and queues
1.3. Addressing modes
1.4. Subroutines

## Module 2. Memory subsystem

### Learning time: 16h 15m
- Theory classes: 6h
- Self study: 10h 15m

### Description:
2.1. Structure and timing of microprocessor bus
2.2. Memory mapping and decoding
2.3. Memory types (SRAM, DRAM, SDRAM, Flash, EEPROM)
2.4. Cache memory
2.5. Virtual memory

## Module 3. Input/output subsystem

### Learning time: 16h 15m
- Theory classes: 6h
- Self study: 10h 15m

### Description:
3.1. Access to input/output devices
3.2. Interrupts
3.3. Serial and parallel interfaces

## Module 4. Practical aspects of digital design

### Learning time: 24h 24m
- Theory classes: 9h
- Self study: 15h 24m

### Description:
4.1. Programmable devices
4.2. Timing features of digital primitives
4.3. Synchronization
4.4. Synchronous design techniques
4.5. Area and timing considerations for the synthesis of digital systems
### Module 5. Design of control subsystems

**Learning time:** 16h 15m  
Theory classes: 6h  
Self study: 10h 15m

**Description:**
- 5.1. Principles of algorithmic design  
- 5.2. Coding  
- 5.3. Timing and frequency synthesis subsystems

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### Module 6. Design of data processing subsystems

**Learning time:** 16h 15m  
Theory classes: 6h  
Self study: 10h 15m

**Description:**
- 6.1. Multipliers  
- 6.2. ALUs

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### Laboratory

**Learning time:** 82h 30m  
Laboratory classes: 41h 15m  
Self study: 41h 15m

**Description:**
- Introduction to the development tools for microcontrollers.  
- Analysis and programming of systems based on microcontrollers.  
- Introduction to the CAD tools for the design, simulation and synthesis of digital systems.  
- Analysis and design of digital systems using FPGAs.

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### Planning of activities

- **(ENG) Proves de resposta curta (Control)**
- **(ENG) Pràctica de laboratori**
- **(ENG) Proves de resposta llarga (Examen Final)**
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Qualification system
- 50 % Final exam
- 30 % Laboratory assignments
- 20 % Control

In this course the following generic competences will be assessed:
- Autonomous learning (High level)
- Capability of identifying, formulating and solving engineering problems (High level)

Bibliography

Basic: