240EI013 - Extended Electronics

Coordinating unit: 240 - ETSEIB - Barcelona School of Industrial Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering
Academic year: 2017
Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Teaching unit Compulsory)
ECTS credits: 4,5  Teaching languages: Catalan, Spanish, English

Teaching staff

Coordinator: Manich Bou, Salvador
Others: Torrents Dolz, Josep Maria
Gómez Pau, Álvaro
Garcia Gonzalez, Miquel Angel
Parisi Baradad, Vicenç

Opening hours

Timetable: Request an appointment by email.

Prior skills

- Knowledge on circuit analysis
- Knowledge on electrical signals
- Basic concepts about electronic devices
- Basic concepts about amplification
- Knowledge of Boolean and Switching algebra
- Basic concepts of information coding
- Knowledge of combinational and sequential systems
- Basic concepts of structured programming
- Basic concepts of C programming language
- Basic concepts of automatic control

Degree competences to which the subject contributes

Specific:
CEMEI07. Ability to design electronic systems and industrial instrumentation.

CEEEELECT1. Design electronic systems (mixed analogical and digital systems and micro-mechanical systems on silicon, digital systems based on discrete components, logical programable devices and/or microprocessors, electronic instrumentation systems and power electronic systems) and manage development projects and/or commercialization of electronic systems or development projects and/or commercialization of systems in which the electronic subsystems have an important specific weight.
CEEEELECT2. Analyse, diagnose and maintain the electronic systems and manage the maintenance equipment of electronic systems or of systems in which the electronic subsystems have an important specific weight.
CEEEELECT3. Empower for the management of a product (product manager), technical management or innovative management of electronic products or which include electronic subsystems with an important specific weight.
Teaching methodology

The subject is divided in theoretical classes (28 hours) and practical laboratory sessions (12 hours).

Theoretical classes: there are totals of 20 classes organized in two sessions per week of 1.5 hours each. This is an activity that runs for a little more than two months, starting at the beginning of the course. Once theoretical classes have ended, the activity of the subject will focus on the practical laboratory sessions. In theoretical classes the lectures of the subject are mainly presented but not exclusively, since a deeper reading of certain topics can be let as homework according to the professor criterion. In classes, discussion activities and evaluation exercises will also be conducted. For the evaluation of the theoretical knowledge two examinations, a midterm and a final, will be done too.

Practical laboratory sessions: there are totals of 6 sessions of a 2 hours length each. In each one of these, a small instrumentation system will be gradually developed and it will be completed and evaluated in the last session. The first session is not held in laboratory but carried out home, following the indications of the workbook. The participation in the rest of the sessions is mandatory. Final evaluation of the practical work will include both the professor’s assessment of the student’s work and the grading of the report delivered after the last session.

Learning objectives of the subject

- To understand the basic architecture of microprocessors.
- To understand the internal structure of microcontrollers.
- Learn how to program a microcontroller in C language.
- To know the use of debugging and simulation tools specific for microcontrollers.
- Learn how to send and receive analog and digital signals by means of a microcontroller.
- Learn how to design a small instrumentation control system unit able to capture sensor signals and to actuate electromechanical devices.
- To understand the minimization methodologies for combinational systems.
- To know how to design combinational systems.
- To understand the minimization methodologies for sequential systems.
- Learn how to design sequential systems.
- To know the different implementation alternatives for electronic system design.
- To assess different alternative costs.
- To understand the interference phenomenon in electronic systems.
- To know how to correctly apply the shielding techniques.

Study load

<table>
<thead>
<tr>
<th>Total learning time: 112h 30m</th>
<th>Hours large group: 25h 30m</th>
<th>22.67%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours small group: 15h</td>
<td>13.33%</td>
<td></td>
</tr>
<tr>
<td>Guided activities: 0h</td>
<td>0.00%</td>
<td></td>
</tr>
<tr>
<td>Self study: 72h</td>
<td>64.00%</td>
<td></td>
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</tbody>
</table>
## Content

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
<th>Learning time</th>
<th>Practical classes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T0 - Subject overview</strong></td>
<td>Subject overview: General overview of the subject, summary of different topics and methodology.</td>
<td><strong>0h 45m</strong></td>
<td><strong>0h 45m</strong></td>
</tr>
<tr>
<td><strong>T1 - Introduction to C language</strong></td>
<td>Introduction to C language. Basic structure of a program. Definition of constants and labels. Declaration of variables, functions and special functions (interrupt services). Summary of the most common instructions. Development tools: integrated development environment (IDE). Compiler. Programmer/debugger. Simulator. Working methodology. Example of a bang-bang control program.</td>
<td><strong>0h 45m</strong></td>
<td><strong>0h 45m</strong></td>
</tr>
<tr>
<td><strong>T2 - Introduction to microprocessors</strong></td>
<td>Introduction to microprocessors: Basic concepts. Data unit. Control unit. The Von Neumann machine. Machine cycle. Instruction cycle. Historical notes. Applications. Microprocessor computational power. Recent trends in microprocessors.</td>
<td><strong>1h 30m</strong></td>
<td><strong>1h 30m</strong></td>
</tr>
<tr>
<td><strong>T3 - Microprocessor architectures</strong></td>
<td>Microprocessor architectures: Princeton architecture. Harvard architecture. Memory map and addressing map. Program memory and data memory organization. Instruction set.</td>
<td><strong>1h 30m</strong></td>
<td><strong>1h 30m</strong></td>
</tr>
<tr>
<td><strong>T4 - Interruptions</strong></td>
<td>Interruptions: Real time. Interruptions. The stack (hardware and software)</td>
<td><strong>1h 30m</strong></td>
<td><strong>1h 30m</strong></td>
</tr>
</tbody>
</table>
### T5 - Peripherals

**Learning time:** 1h 30m  
Practical classes: 1h 30m

**Description:**  

### T6 - C language for embedded systems

**Learning time:** 1h 30m  
Theory classes: 1h 30m

**Description:**  

### T7 - Combinational systems

**Learning time:** 1h 30m  
Practical classes: 1h 30m

**Description:**  
Logic functions. Function implicants and implicates. The Karnaugh minimization method. SOP and POS minimal expressions. Minimal expressions of partially specified functions. The Quine McCluskey method. Implementation of two gate level functions. Devices for the two gate level implementation: multiplexers, ROMs, PLAs and PALs. Other alternative implementations.

### T8 - Sequential systems

**Learning time:** 1h 30m  
Practical classes: 1h 30m

**Description:**  
The grading of the subject includes four types of scores, from the less to the most important:
- Participation in class: \( N_{pc} \)
- Laboratory work: \( N_{pl} \)
- Midterm examination: \( N_{ep} \)
- Final examination: \( N_{ef} \)

The final score (legal marks) is the sum up \( N_f = 0,10 \times N_{pc} + 0,25 \times N_{pl} + 0,25 \times N_{ep} + 0,40 \times N_{ef} \)

The final score \( N_f \) will be NP (absent) if at least one of the following NPs happen: \( N_{pl} = NP \) or \( N_{ep} = N_{ef} = NP \).

Otherwise, NPs will be substituted by 0s in the \( N_f \) formula.

The score of laboratory work \( N_{pl} \) is the average between the student's work in the sessions and the final report grading.

Absent score \( N_{pl} = NP \) will be applied if unjustified absences occur. Regular laboratory session will not be substituted by alternative activities.

**EXTRA EXAMINATION**

Students not passing the regular evaluation will have the opportunity to recover it in an extra examination held in July, please find out dates in the Academic Calendar. In this case, the legal marks will be calculated according to the following formula: \( N_f = 0,10 \times N_{pc} + 0,25 \times N_{pl} + 0,65 \times N_{ee} \) where \( N_{ee} \) is the score of the extra examination. The other two scores, \( N_{pc} \) and \( N_{pl} \) will be kept from the regular evaluation of the subject.

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**T9 - Design alternatives on Silicon**

**Learning time:** 1h 30m

**Practical classes:** 1h 30m

**Description:**

**T10 - Interferences and shielding**

**Learning time:** 1h 30m

**Practical classes:** 1h 30m

**Description:**
Regulations for carrying out activities

Midterm, final and extra examinations are written exams whose duration is indicated in the Academic Calendar and that follow the general rules of the school. They will be closed book exams unless it is differently indicated by the professor. The midterm examination consists of a test with 9 questions, some of them may require a short hand written justification, and 1 problem. The final examination consists of a test with 12 questions, similarly some of them may require a short hand written justification, and 2 problems. Extra examination consists of 30 questions in which some of them may require hand written justification.

Laboratory exercises are held in groups of maximum two students. During the first session groups are organized and must continue until the last session. In the final report all members of the group must sign their work.

Regarding the class participation score, the professor will assess attendance, live participation and answer given to questions formulated in class.

Bibliography

Basic:


Complementary:


