Course guide
340608 - SETR-R2007 - Embedded and Real Time Systems

Unit in charge: Vilanova i la Geltrú School of Engineering
Teaching unit: 707 - ESAII - Department of Automatic Control,
710 - EEL - Department of Electronic Engineering.

Degree: MASTER'S DEGREE IN AUTOMATIC SYSTEMS AND INDUSTRIAL ELECTRONICS (Syllabus 2012). (Optional subject).

Academic year: 2022  ECTS Credits: 5.0  Languages: Catalan

LECTURER

Coordinating lecturer: Ramon Guzmán Solà
Others: Ramon Guzmán Solà
Rafael Ramos Lara
Mariano López García

TEACHING METHODOLOGY

LEARNING OBJECTIVES OF THE SUBJECT

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self study</td>
<td>80,0</td>
<td>64.00</td>
</tr>
<tr>
<td>Hours large group</td>
<td>15,0</td>
<td>12.00</td>
</tr>
<tr>
<td>Hours small group</td>
<td>30,0</td>
<td>24.00</td>
</tr>
</tbody>
</table>

Total learning time: 125 h
## Theory

**Description:**
The course is divided into two parts. On the one hand, the student will gain the basic knowledge of embedded systems, both from the point of view of architecture and from the point of view of programming. On the other hand, the student will understand the particular problems of real-time systems, and the features that differentiate them from other computer systems. They will learn the most important methods used to develop highly reliable real-time systems, especially those related to time measurement, resource use planning, prevention and tolerance, failures, and the organization of the software and its application. Special consideration will be given to process control applications. Various techniques will be proposed to develop these applications and the mechanisms needed to evaluate their performance will be established.

The subject is divided into two parts.

### A) Embedded systems

**UNIT 1:** Introduction to embedded systems and Atmel AVRs.
- 1.1 Introduction to embedded systems.
- 1.2 Introduction to Atmel AVRs.
- 1.3 Characteristics of the ATmega328P μC.

**SUBJECT 2:** Internal architecture of the ATmega328P μC.
- 2.1 Internal architecture of the ATmega328P μC.
- 2.2 Memory spaces

**SUBJECT 3:** I / O ports, Analog Comparator, Analog-Digital Converter and Interruptions.
- 3.1 I / O ports
- 3.2 Analog comparator.
- 3.3 Analog-Digital Converter.
- 3.4 Interruptions.
- 3.5 External interruptions.

**SUBJECT 4:** Timers and communication ports: USART, TWI (I2C) and SCI.
- 4.1 Timers.
- 4.2 USART.
- 4.3 TWI (I2C) - Two Wire serial Interface.
- 4.4 SPI - Serial Peripheral Interface

### Practices:

- Q1: Introduction to the ARDUINO platform.
- Q2: Temperature measurement with AD22103 sensor and On-Chip sensor.
- Q3: Geomagnetic guidance system with ARDUINO.
- Q4: PID control of a DC motor.

### B) Real time

**SUBJECT 1:** Introduction to the systems of real time
**SUBJECT 2:** Cyclic systems.
**SUBJECT 3:** Task scheluders
**SUBJECT 4:** Sharing of recusros

### Practices:

- Q1: Initialization to trueTime in Matlab environment
- Q2: Design of a control system using the trueTime tool

**Full-or-part-time:** 220h
Theory classes: 125h
Practical classes: 15h
Self study : 80h

GRADING SYSTEM

The final mark is obtained from the marks of both parts, Embedded systems and real time.

The mark of embedded systems is obtained as: \( NF_1 = 0.4 NT_1 + 0.6 NP_1 \)
where
Nota sistemes encastats: \( NF_1 = 0.4 NT_1 + 0.6 NP_1 \)
on
\( NT_1 \) is the mark obtained from the theory of embedded systems
\( NP_1 \) is the mark obtained in the laboratory from the different practices: \( NP_1 = (P_1 + P_2 + P_3 + P_4) \cdot 0.25 \)

The mark of real time is obtained as: \( NF_2 = 0.4 NT_2 + 0.6 NP_2 \)
where
\( NT_2 \) is the mark obtained from the theory of real time: \( NT_2 = \max(0.5(C_1 + C_2)) \) and \( C_1 \) is the mark of the first exam and \( C_2 \) is the mark of the second exam
\( NP_2 \) is the mark obtained in the laboratory from the different practices.
The mark of the subject is calculated as: \( NF = 0.5 NF_1 + 0.5 NF_2 \)