Course guides
270013 - CI - Computer Interfacing

Unit in charge: Barcelona School of Informatics
Teaching unit: 707 - ESAII - Department of Automatic Control.
Degree: BACHELOR’S DEGREE IN INFORMATICS ENGINEERING (Syllabus 2010). (Compulsory subject).
Academic year: 2021   ECTS Credits: 6.0   Languages: Catalan, Spanish

LECTURER
Coordinating lecturer: - Manel Frigola Bourlon (manel.frigola@upc.edu)
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- Toni Benedico Blanes (toni.benedico@upc.edu)

PRIOR SKILLS
Students are expected to be able to:
Program in a high-level language (preferably C).
Program in an assembly language.
Understand the functioning of different electronic components: R, L, C, diodes, MOS transistors.
Understand DC electronic circuits and voltage, current and consumption calculations.
Represent numbers in the binary and hexadecimal bases and performing arithmetic and logical operations on them.
Understand the functioning of the different logic gates and combinational and sequential blocks.
Understand how to analyse and synthesise logic circuits.
Understand processor structure and operation.
Understand the architecture and operation of a simple computer.
Understand computer memory operations and hierarchy.
Understand documents written in English.

REQUIREMENTS
- Prerequisite EC
- Prerequisite F
- Prerequisite IC
DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CT2.3. To design, develop, select and evaluate computer applications, systems and services and, at the same time, ensure its reliability, security and quality in function of ethical principles and the current legislation and normative.
CT2.5. To design and evaluate person-computer interfaces which guarantee the accessibility and usability of computer systems, services and applications.
CT4.1. To identify the most adequate algorithmic solutions to solve medium difficulty problems.
CT5.2. To know, design and use efficiently the most adequate data types and data structures to solve a problem.
CT5.3. To design, write, test, refine, document and maintain code in an high level programming language to solve programming problems applying algorithmic schemas and using data structures.
CT5.6. To demonstrate knowledge and capacity to apply the fundamental principles and basic techniques of parallel, concurrent, distributed and real-time programming.
CT6.2. To demonstrate knowledge, comprehension and capacity to evaluate the structure and architecture of computers, and the basic components that compound them.
CT7.1. To demonstrate knowledge about metrics of quality and be able to use them.
CT7.2. To evaluate hardware/software systems in function of a determined criteria of quality.
CT7.3. To determine the factors that affect negatively the security and reliability of a hardware/software system, and minimize its effects.
CT8.1. To identify current and emerging technologies and evaluate if they are applicable, to satisfy the users needs.
CT8.4. To elaborate the list of technical conditions for a computers installation fulfilling all the current standards and normative.

General:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

TEACHING METHODOLOGY

No distinction is drawn between theory and problem-solving classes. Theory is reinforced with examples showing alternatives and solutions to interface problems.
Self-assessment exercises are proposed in the various topics so that students can assess their own progress. Students may consult the lecturer as necessary.
The practical sessions will take place in situ in the FIB teaching laboratory. An essential requirement for each practical is to have performed a pre-set task (to be specified).
LEARNING OBJECTIVES OF THE SUBJECT

1. Explain the various functions and define the main parameters of an I/O interface.
2. Describe the block configuration for various input/output subsystems.
3. Given the specifications for a particular microcomputer, program the various subsystems necessary to exchange data with the outside world and create and maintain programs that implement inputs and outputs using digital, analogue, pulse, parallel, serial, synchronous and asynchronous interfaces.
4. Identify the components and signals in different block diagrams for microcomputer architecture and indicate their use. They should be able to identify data and instruction paths and determine the value of the different registers involved in each execution phase for a given instruction.
5. Given a diagram for a simple electronic circuit connected to a specific microcomputer pin, quantify the different technological parameters (intensities, voltages, resistance, noise, maximums, etc.), identify possible sources of error and size the different components.
6. Quantify the resolution of an I/O operation and calculate quantification and sampling errors.
7. Program multiplexed input and output operations for a given interconnection diagram for a device with a microcomputer and calculate sampling frequencies.
8. Describe how to handle an interrupt from request to end of service and calculate, given a program and microcomputer specifications, the service time for an interrupt, latency time and the order in which different requests are served.
9. Program, given the specifications for a microcomputer and for all possible interrupt sources, service routines for the different interrupts while ensuring guaranteed time of service, program context recovery and restoration and identify critical regions.
10. Explain the characteristics of different types of storage, choose suitable storage for a specific context and measure width and capacity for different memories and the width of access buses.
11. Size the number of bits and work frequency for a timer and generate a signal of a specific frequency and duty cycle and lags for the desired duration. Students should also be able to accurately measure the period or frequency of an input signal, the instant when a pulse event occurs and the interval between two events.
12. Define and explain serial communication parameters, features and possible errors. Explain the differences in serial communication standards (UART, SPI, I2C, 1-Wire, CAN, etc.).
13. Describe the main features and functions of the USB bus and hub.
14. Describe the types and formats of USB packets, the packet transaction protocol in the presence and absence of errors, different types of endpoints and their performance in terms of speed, bus use, bandwidth warranty and error handling.
15. Locate a peripheral in the hierarchy of buses in the computer architecture.
16. Calculate the minimum expected transfer time between a memory and a device or between devices. They should also be able to draw the data path for different types of transfers and locate bottlenecks in multiple transfers between devices.
17. Quantify bus throughput at different levels (internal bus, local bus, system bus, expansion bus, peripheral buses) and explain the features of a bridge between buses.
18. Describe the basic I/O interconnection device configuration with DMA transfer and link DMA operational modes with the operations of different buses in the computer hierarchical structure. They should also be able to compare transfer time in a bus with and without DMA.
19. Correctly interpret technical descriptions, block diagrams, electronic diagrams and schedules in reference manuals and prepare the documentation necessary to transfer knowledge and ideas (block diagrams, electronic diagram, flowcharts, state diagrams, component lists, etc.).
20. Understand hardware in relation to the installation, maintenance, identification, manipulation and interconnection of systems and apply device connection techniques to microcomputer pins.

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
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<td>Hours small group</td>
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<td>20.00</td>
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<td>Guided activities</td>
<td>6,0</td>
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<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>20.00</td>
</tr>
<tr>
<td>Self study</td>
<td>84,0</td>
<td>56.00</td>
</tr>
</tbody>
</table>

Total learning time: 150 h
## CONTENTS

### Introduction

**Description:**

### Microcomputer architecture

**Description:**

### Input/output ports

**Description:**

### Interrupts

**Description:**

### Impulse inputs and outputs

**Description:**
Programmable time controller diagram. Main time controller working modes. Time controllers to count asynchronous events. Generating output impulses using IT. Generating modulated signals in pulse width modulation (PWM) using IT.

### Analogue Interfaces

**Description:**

### Serial communication interfaces

**Description:**
**Buses and DMA**

**Description:**

**ACTIVITIES**

**Development of item 1 of the course**

**Specific objectives:**
1, 2, 19

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 2h  
Theory classes: 2h

**Development of item 2 of the course**

**Specific objectives:**
1, 2, 3, 4, 6, 10, 16, 19

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 10h  
Theory classes: 4h  
Self study: 6h

**Development of item 3 of the course**

**Specific objectives:**
1, 2, 3, 4, 5, 7, 19, 20, 22

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 10h  
Theory classes: 4h  
Self study: 6h
Development of item 4 of the course

Specific objectives:
4, 8, 9, 22

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 5h
Theory classes: 2h
Self study: 3h

Development of item 5 of the course

Specific objectives:
1, 2, 3, 4, 6, 11, 19, 22

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 5h
Theory classes: 2h
Self study: 3h

Development of item 6 of the course

Specific objectives:
1, 2, 3, 4, 6, 7, 19

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 5h
Theory classes: 2h
Self study: 3h
Development of item 7 of the subject

Specific objectives:
1, 2, 3, 4, 12, 13, 14, 19, 20

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 15h
Theory classes: 6h
Self study: 9h

Development of the subject item 8

Specific objectives:
1, 2, 15, 16, 17, 18, 19, 21, 22

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 10h
Theory classes: 4h
Self study: 6h

Practice 1

Specific objectives:
19, 20, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 5h
Laboratory classes: 2h
Self study: 3h
### Practice 2

**Specific objectives:**
3, 4, 5, 19, 20, 21, 23

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 3h  
Self study: 3h

### Practice 3

**Specific objectives:**
3, 4, 19, 20, 21, 22, 23

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 5h  
Laboratory classes: 2h  
Self study: 3h

### Practice 4

**Specific objectives:**
3, 4, 19, 20, 21, 22, 23

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 5h  
Laboratory classes: 2h  
Self study: 3h
Practice 5

**Specific objectives:**
3, 4, 5, 7, 19, 20, 21, 22, 23

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 5h
Laboratory classes: 2h
Self study: 3h

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Practice 6

**Specific objectives:**
3, 4, 9, 19, 20, 21, 22, 23

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 5h
Laboratory classes: 2h
Self study: 3h

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Lab 7

**Specific objectives:**
3, 4, 6, 11, 19, 20, 21, 22, 23

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 5h
Laboratory classes: 2h
Self study: 3h
Practice 8

Specific objectives:
3, 4, 6, 11, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 5h
Laboratory classes: 2h
Self study: 3h

Practice 9

Specific objectives:
3, 4, 5, 6, 7, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 5h
Laboratory classes: 2h
Self study: 3h

Practice 10

Specific objectives:
3, 4, 5, 12, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 5h
Laboratory classes: 2h
Self study: 3h
Practice 11

Specific objectives:
3, 4, 12, 13, 14, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 5h
Laboratory classes: 2h
Self study: 3h

Practice 12

Specific objectives:
3, 4, 12, 13, 14, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 5h
Laboratory classes: 2h
Self study: 3h

Practice 13

Specific objectives:
3, 4, 12, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Full-or-part-time: 5h
Laboratory classes: 2h
Self study: 3h

Practice 14

Specific objectives:
3, 4, 5, 7, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.
**First partial test**

**Specific objectives:**
1, 2, 3, 4, 5, 6, 7, 10, 19, 20, 21

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 9h 30m  
Guided activities: 1h 30m  
Self study: 8h

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**Second partial test**

**Specific objectives:**
2, 3, 4, 6, 7, 8, 9, 11, 19, 20, 21, 22

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 9h 30m  
Guided activities: 1h 30m  
Self study: 8h

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**Third partial test**

**Specific objectives:**
2, 3, 4, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

**Full-or-part-time:** 9h 30m  
Guided activities: 1h 30m  
Self study: 8h

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**Practical implementation of a microcomputer**

**Specific objectives:**
3, 4, 5, 19, 20, 21, 23

**Related competencies:**
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<th>Timers Practice</th>
<th>Specific objectives:</th>
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<td>Related competencies:</td>
<td>G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.</td>
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Practice counters

Specific objectives:
3, 5, 6, 9, 11, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Practice converter A / D

Specific objectives:
3, 4, 5, 6, 7, 9, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Practice serial com

Specific objectives:
3, 4, 9, 12, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Practice mouse

Specific objectives:
3, 4, 9, 13, 14, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

Practice USB

Specific objectives:
3, 4, 9, 13, 14, 19, 20, 21, 22, 23

Related competencies:
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.
### Practice 1Wire

**Specific objectives:**
3, 4, 5, 9, 12, 19, 20, 21, 22, 23

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

### Practice touchscreen and GLCD

**Specific objectives:**
3, 4, 5, 6, 7, 9, 19, 20, 21, 22, 23

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

### Final Exam

**Description:**
Only those students who have requested within the deadline

**Specific objectives:**
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.

### Examination practice

**Specific objectives:**
3, 4, 5, 6, 7, 8, 9, 11, 19, 20, 21, 22, 23

**Related competencies:**
G3. THIRD LANGUAGE: to know the English language in a correct oral and written level, and accordingly to the needs of the graduates in Informatics Engineering. Capacity to work in a multidisciplinary group and in a multi-language environment and to communicate, orally and in a written way, knowledge, procedures, results and ideas related to the technical informatics engineer profession.
GRADING SYSTEM

* During the course will take a minimum of 3 written tests corresponding to different parts of the course. Be made individually. Obtained a note (NT) from the average of the assessments.

* The grade laboratory NL obtained from the average of the individual assessments of practices. There will be between 10 and 14 evaluable practices during the year. The written tests will contain lab questions that will help to individualise the marks.

Students repeat the practices that are approved to be validated practices NL = 5.

* The final grade for the course comes from:

\[ NF = 0.65NT + 0.35NL \]

* It is a necessary condition for passing the subject and presented properly perform laboratory practices.

BIBLIOGRAPHY

Basic: