Course guide
270013 - CI - Computer Interfacing

Last modified: 30/01/2024

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: 2023 **ECTS Credits:** 6.0 **Languages:** Catalan, Spanish

LECTURER

Coordinating lecturer: ANTONIO CAMACHO SANTIAGO

Others:

Primer quadrimestre:
FABIO FRANCISCO BANCHELLI GRACIA - 23, 31, 32
ANTONIO BENEDICO BLANES - 11, 21, 22, 23, 51, 52, 53
ALEIX BOIXADER COMA - 12, 13
ANTONIO CAMACHO SANTIAGO - 21, 22, 34, 43
IVÁN DEL PINO BASTIDA - 31, 41, 42, 43
ENRIC XAVIER MARTIN RULL - 41, 42, 43
CARLOS MORATA NÚÑEZ - 11, 12, 13, 31, 32, 33, 34
KILIAN PEIRO CONDE - 21, 23, 41, 42
MANUEL VINAGRE RUIZ - 51, 52, 53

Segon quadrimestre:
ANTONIO BENEDICO BLANES - 11, 12, 13, 41, 42
ALEIX BOIXADER COMA - 11, 12, 13
ANTONIO CAMACHO SANTIAGO - 11
CARLOS MORATA NÚÑEZ - 11, 12, 13, 41, 42
KILIAN PEIRO CONDE - 12, 41, 42

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.

Generical:
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.
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STUDY LOAD

Type	Hours	Percentage
Guided activities	6,0	4.00
Self study	84,0	56.00
Hours small group	30,0	20.00
Hours large group	30,0	20.00

Total learning time: 150 h

CONTENTS

Introduction

Description:
Definition of interface. Types of interfaces. Interface levels. Typical interface mechanisms. Example interfaces.

Microcomputer architecture

Description:
Microcomputers. Families. Block diagram of a specific microcontroller with its features and functions. Instruction cycle stages. Pipe-line execution of instructions. The arithmetic logic unit (ALU). Data paths. Special registers. Memory. Instruction format. Addressing modes. Assembly language structure (instructions, guidelines, examples of use).

Input/output ports

Description:
I/0 port structure. * status and control data registers * bidirectional pin operation * bus connection. Three-state output. Z state. Technological considerations. Connections to external loads. Input device connections. Signal multiplexing.

Interrupts

Description:
Synchronisation mechanisms: polling, interrupts. Parameters: latency, priority, throughput, service time. Interrupt sources. Hierarchy. Masking. Priorities. Daisy chain. Interrupt sequences. Interrupt vectors. Service routines. Programming guide. Saving and restoring context. Exceptions and interrupts.

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:
Timing and frequency aspects of analogue signals. Nyquist-Shannon sampling theorem. Analogue-digital converters. Digital-analogue converters. Example application.

Serial communication interfaces

Description:
Types and characteristics of communication interfaces. Synchronous serial interface (SSI). A real example (RS232). Synchronous serial interface (SSI). A real example (SPI). USB for peripheral devices.

Buses and DMA

Description:
Width, frequency and transfer concepts. Bus width, bus frequency, transfer rate. Bus hierarchies. Bus rearrangement and the PCIe bus. Bus partitioning and addressing concepts. Bus controllers. The concept of bridge. Modifying address, width and frequency spaces, buffering. Bus peripheral controllers. Bus transfer acceleration. DMA. DMA levels. DMA operation. Classical functioning modes. Calculating transfers with DMA.

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: 12h
Theory classes: 6h
Self study: 6h

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: 11h
Theory classes: 5h
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: 5h
Laboratory classes: 2h
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

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: 4h
Laboratory classes: 2h
Self study: 2h

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: 4h
Laboratory classes: 2h
Self study: 2h

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: 4h
Laboratory classes: 2h
Self study: 2h

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: 4h
Laboratory classes: 2h
Self study: 2h

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: 4h
Laboratory classes: 2h
Self study: 2h

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: 4h
Laboratory classes: 2h
Self study: 2h

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.

Full-or-part-time: 6h
Laboratory classes: 4h
Self study: 2h

First partial test

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

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

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

Examination practice

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

Related competencies :
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Sustainability conference

Description:
Awareness of the footprint of information technologies

Full-or-part-time: 2h
Guided activities: 2h

Technology for Everyone TxT

Description:
Awareness of the effects of technology. Manipulation of computers.

Full-or-part-time: 2h
Guided activities: 2h

Competence in 3rd language

Description:
Proficiency test in a third language

Full-or-part-time: 2h
Guided activities: 2h

GRADING SYSTEM

* During the course will take a minimum of 2 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 +0.35 NL

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

BIBLIOGRAPHY

Basic:
- Huang, H.-W. PIC microcontroller: an introduction to software and hardware interfacing. Clifton Park: Thomson/Delmar Learning, 2005. ISBN 1401839673.
- Patterson, D.A.; Hennessy, J.L. Computer organization and design: the hardware/software interface. 5th ed. Elsevier Morgan Kaufmann, 2014. ISBN 9780124077263.