

Course guide

270061 - DSBM - Design of Microcomputer-Based Systems

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). (Optional subject).

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

LECTURER

Coordinating lecturer: ENRIC XAVIER MARTIN RULL

Others: Primer quadrimestre:
ENRIC XAVIER MARTIN RULL - 10

Segon quadrimestre:
FABIO FRANCISCO BANCHELLI GRACIA - 10

PRIOR SKILLS

High-level language programming (preferably C). Programming in assembly language for microcomputer. Knowledge of microcomputer architecture. Knowledge of Operating Systems. Knowledge of how the various electronic components: R, L, C, MOS diodes and transistors. Analysis of electronic circuits in DC. Calculation of voltages, currents and consumption. Know how to represent numbers in binary and hexadecimal base, its operations and perform arithmetic-logic. Knowing how the different logic gates and combinational and sequential blocks. Learn to analyze and synthesize logic circuits. Understand the structure and operation of the processor. Understand the operation and the memory hierarchy of a computer. Correctly understand documentation written in English. Learn basic English writing technical documentation.

REQUIREMENTS

- Prerequisite CI

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:

CEC1.1. To design a system based on microprocessor/microcontroller.

CEC2.2. To program taking into account the hardware architecture, using assembly language as well as high-level programming languages.

CEC2.3. To develop and analyse software for systems based on microprocessors and its interfaces with users and other devices.

CEC3.1. To analyse, evaluate and select the most adequate hardware and software platform to support embedded and real-time applications.

CEC3.2. To develop specific processors and embedded systems; to develop and optimize the software of these systems.

CT7.2. To evaluate hardware/software systems in function of a determined criteria of quality.

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

There will be a complementation between classes of theory and problems, lectures are reinforced with examples showing the possible alternatives and solutions to common problems. Some topics will be proposed for self-assessment exercises that students can be aware of your progress, and may ask teacher support in case it detects any deficiency. The practical sessions will take place in situ in the laboratory teaching department in the FIB. There will be two practices that require large cumulative work of students in the preparation of a project.

LEARNING OBJECTIVES OF THE SUBJECT

1. Given an application, determine for each task: its duration, the maximum waiting time, time critical care, and plan the right strategy to meet these requirements.
2. Identify the critical regions of a program and schedule properly due to bugs in open source data compartment.
3. Determine the parts of the code needed to be programmed in assembler, and can be programmed in high level language.
4. Sizing the timing of the watchdog correctly, and placing the 'kicks' the watchdog properly within the code.
5. To determine the most appropriate software architecture for a particular application, based on the number of processes, the computational requirements of these and immediate response.
6. Determine the best serial communication interface for communication between two integrated circuits (processors, processor-interface).
7. Build routines minimum hardware abstraction interface for all communications.
8. Place adequate protections to a microprocessor system for its connectivity to the outside.
9. Protecting against noise reception and a microprocessor system.
10. Sizing correctly sampling frequency of one or more signals according to their nature and the computational load of micro.
11. Setting a reference voltage AD converter with appropriate values $\square\square$ from the signal dynamic range and resolution required.
12. Interpret the representation of a periodic signal in a Bode diagram and its decomposition in Fourier series.
13. Given an electronic circuit find its input and output impedances.
14. To extract the correct values $\square\square$ of the electrical characteristics published by the manufacturer in the technical reference manuals.
16. Select the appropriate device (transistor, relay, triac, optocoupler) for connecting external loads to the processor pins. Sizing the components necessary to successfully make the connection.
17. Designing and correctly interpret the schema of an electronic circuit.
18. Defender design hardware or software-based microprocessors in a presentation in front peers (target practice).
19. Draw and correctly interpret time charts.
20. Learning to use laboratory components: Oscilloscopes, logic analyzer, etc. .. (Target practice)
21. Schedule a system with different sensors and interfaces to fulfill requirements of execution. (Target practice)
22. Design and implement a microcontroller solution for a given problem. (Target practice)

STUDY LOAD

Type	Hours	Percentage
Self study	84,0	56.00
Hours large group	18,0	12.00
Hours small group	30,0	20.00
Hours medium group	12,0	8.00
Guided activities	6,0	4.00

Total learning time: 150 h

CONTENTS

Introduction.

Description:

Characteristics of microprocessor based systems. Type, common solutions to market.



Hardware Issues

Description:

Hardware for microcomputer-based systems. Circuits, components, time diagrams, schematic design. Input/output, power and energy.

Software Aspects of microprocessor based systems.

Description:

Optimization and code inspection. Startup, linkatge, location code, bootloaders. Concurrence, context switching, task management, interrupts, RTOS. Typical algorithms for data gathering and system control.

Interfaces between systems. Communications.

Description:

Description Interface I2C, SPI, CAN, Ethernet, Bluetooth, RF.

Protections, security, electromagnetic compatibility.

Description:

Robust to noise, the system microprocessor protection, electromagnetic compatibility. Watchdog, NMI, redundancy, monitorization.

ACTIVITIES

Introduction

Description:

View the types of solutions available. Evaluate the most appropriate for a problem. To understand the representation and the associated figures.

Specific objectives:

17, 19

Full-or-part-time: 6h

Theory classes: 2h

Self study: 4h

Practice 1

Description:

Learn to use the tools build in ASM and C Language Understanding the architecture of the microcomputer.

Specific objectives:

20

Full-or-part-time: 8h

Laboratory classes: 4h

Self study: 4h

Hardware for micro-computer boards.

Description:

Circuits, components, basic diagrams, time diagrams, schematic design tools ...

Specific objectives:

12, 13, 14, 16, 17

Related competencies :

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Full-or-part-time: 10h

Theory classes: 2h

Practical classes: 2h

Self study: 6h

Practice 2

Description:

Laboratory tools: analyzer, Oscilloscopes, emulator and simulator. ICD, debug.

Specific objectives:

20

Full-or-part-time: 4h

Laboratory classes: 2h

Self study: 2h

Practice 3

Description:

Launching the microcontroller, soft and hardware tests.

Specific objectives:

21

Full-or-part-time: 4h

Laboratory classes: 4h

CT1. Control Theory 1

Description:

There will be an exercise in basic circuits in assembling a microcomputer

Specific objectives:

10, 11, 12, 13, 14, 16, 17, 19

Related competencies :

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Full-or-part-time: 5h

Guided activities: 1h

Self study: 4h

I / O and analog impulse.

Description:

Concepts / O, connecting sensors, bridges, resolution, accuracy. Concepts related to frequency, sampling frequency dividers.

Specific objectives:

10, 11, 12

Full-or-part-time: 17h

Theory classes: 3h

Practical classes: 4h

Self study: 10h

Practice 4

Description:

Practical I / O We developed an exercise to work on a system microcontroller interfaces.

Specific objectives:

21

Full-or-part-time: 10h

Laboratory classes: 6h

Self study: 4h

PL1. Lab Test 1

Description:

There will be an exercise spot on the hardware aspects of the microcomputer system.

Specific objectives:

20, 21

Full-or-part-time: 6h

Guided activities: 2h

Self study: 4h

Noise protection, support MS.

Description:

Study of protection against electrical noise and EM radiation. Ensure compatibility of systems designed with the other existing systems.

Specific objectives:

8, 9

Full-or-part-time: 6h

Theory classes: 1h

Practical classes: 1h

Self study: 4h

Practice 5

Description:

Practice miniprojecte the system expandable USB

Specific objectives:

17, 18, 19, 22

Related competencies :

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Full-or-part-time: 15h

Laboratory classes: 9h

Self study: 6h

CT2. Control Theory 2

Description:

We will exercise all the interconnection of a microcontroller on a board and its I / O

Specific objectives:

6, 7, 10, 17, 19

Full-or-part-time: 5h

Guided activities: 1h

Self study: 4h

Interfaces between systems

Description:

Explained the basic concepts of communication interfaces I2C, SPI, CAN, Ethernet, Bluetooth, RF ... to be worked in practice.

Specific objectives:

6, 7

Full-or-part-time: 7h

Theory classes: 2h

Practical classes: 1h

Self study: 4h

Monitoring Systems

Description:

Study of the functioning of monitoring systems microcontrollers: Watchdog, NMI, redundancy ...

Specific objectives:

4

Full-or-part-time: 6h

Theory classes: 1h

Practical classes: 1h

Self study: 4h

Software for Microcontrollers

Description:

Optimization and code inspection, startup, linkatge, location code, bootloaders. Concurrency, context switches, interrupt management, tasks and RTOS.

Specific objectives:

1, 2, 3, 5

Full-or-part-time: 16h

Theory classes: 3h

Practical classes: 3h

Self study: 10h

CT3. Control Theory 3

Specific objectives:

1, 2, 3, 4, 5

Full-or-part-time: 7h

Guided activities: 1h

Self study: 6h

Preparing presentations and practical work

Description:

To help and guide students to prepare their practical work displayed at the end of the course.

Specific objectives:

18

Related competencies :

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Full-or-part-time: 6h

Self study: 6h

PTL. Presentation of Laboratory work

Description:

It will be presented to Professor practical laboratory work and will be check its operation.

Specific objectives:

8, 9, 18, 22

Related competencies :

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Full-or-part-time: 7h

Guided activities: 3h

Self study: 4h

CT4. Control theory 4

Description:

Evaluation for typical algorithms in microcontrollers. Software aspects.

Specific objectives:

1, 2, 5

Full-or-part-time: 5h

Guided activities: 1h

Self study: 4h

GRADING SYSTEM

The grade for this course will be obtained from the weighted average of the marks of theory (40%), laboratory practices (40%) and final work (20%)

$NF = 0.1 CT1 + 0.1 CT2 + 0.1 CT3 + 0.1 CT4 + 0.40 PL + 0.2 TF$ (CT = control theory, PL = Laboratory, TF = Final Work)

The laboratory mark (PL) will be obtained while doing practical work in the lab. There will be at least two partial deliveries of the practices.

In addition students must deliver a design of an embedded system based on a real problem. This work will be presented at the end of the course and will produce the mark TF. The docs for this design will be written in English. The quality of design, the selection of components and clarity of the presentation will be evaluated.

With the report in english and the presentation of the final work a grade for the Cross-Competence (G3.2) will be obtained.

BIBLIOGRAPHY

Basic:

- Catsoulis, J. Designing embedded hardware. 2nd ed. O'Reilly, 2005. ISBN 9780596007553.
- Simon, D.E. An embedded software primer. Addison-Wesley, 1999. ISBN 020161569X.
- Koopman, P. Better embedded system software. Drumnadrochit Press, 2010. ISBN 9780984449002.

Complementary:



- Williamson, T. Designing Microcontroller Systems for Electrically Noisy Environments: AP-125 Application note. Intel, 1996.
- Horowitz, P.; Hill, W. The art of electronics. 3rd ed. Cambridge University Press, 2015. ISBN 9780521809269.
- Pallas Areny, R. Sensores y acondicionadores de señal. 4a ed. Marcombo Boixareu, 2003. ISBN 8426713440.