Course guide
240EI013 - 240EI013 - Extended Electronics

Last modified: 18/06/2023

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 710 - EEL - Department of Electronic Engineering.

Degree: MASTER'S DEGREE IN INDUSTRIAL ENGINEERING (Syllabus 2014). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** Catalan, Spanish, English

LECTURER

Coordinating lecturer:	Manich Bou, Salvador
Others:	Gómez Pau, Álvaro Parisi Baradad, Vicenç Rodriguez Montañes, Rosa Antonio Calomarde Palomino

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

REQUIREMENTS

- 10,5 ECTS in informatics subjects
- 6 ECTS in electrotechnics subjects
- 7,5 ECTS in electronics subjects
- 6 ECTS in automatic control subjects

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CEMEI07. Ability to design electronic systems and industrial instrumentation.
CEEELECT1. 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.
CEEELECT2. 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.
CEEELECT3. 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.

Basic:
CB6. (ENG) Tenir i comprendre coneixements que aportin una base o oportunitat de ser originals en el desenvolupament i/o aplicació d'idees, sovint en un context d'investigació

TEACHING METHODOLOGY

The subject is divided in theoretical classes (28 hours) and practical laboratory sessions(12 hours).
Theoretical classes: there are a total of 20 classes organized in two sessions per week of 1.5 hours each. This is an activity that runs for a little bit 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. In the evaluation of the theoretical knowledge two examinations, a midterm and a final, will be perfomed too.
Practical laboratory sessions: there are a total 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. The 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 in 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 system control 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 understand the source of interferences in electronic systems.
- To know the different steps followed during the fabrication of integrated circuits.

STUDY LOAD

Type	Hours	Percentage
Hours small group	15,0	13.33
Hours large group	25,5	22.67
Self study	72,0	64.00

Total learning time: 112.5 h

CONTENTS

T0 - Subject overview

Description:
Subject overview: General overview of the subject, summary of different topics and methodology.

Full-or-part-time: 0h 45m
Theory classes: 0h 45m

T1 - Introduction to C language

Description:
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. Simultator. Working methodology. Example of a bang-bang control program.

Full-or-part-time: 1h 45m
Theory classes: 1h 45m

T2 - Introduction to microprocessors

Description:
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.

Full-or-part-time: 3h
Theory classes: 3h

T3 - Microprocessor architectures

Description:
Microprocessor architectures: Princeton architecture. Harvard architecture. Memory map and addressing map. Program memory and data memory organization. Instruction set.

Full-or-part-time: 4h 30m
Theory classes: 4h 30m

T4 - Interruptions

Description:
Interruptions: status register. Stack (hardware and software). Concept of real time. Interruptions: interrupt sources, types, priorities, enabling and activation of interruptions. Definition of interrupt services in C.

Full-or-part-time: 3h
Theory classes: 3h

T5 - Peripherals

Description:
Peripherals: Input/output ports. Timers 0 and 2, PWM unit. Sampling and quantization of an analog signal. Sample&hold unit. Successive approximation ADC converter.

Full-or-part-time: 3h
Theory classes: 3h

T6 - Combinational systems

Description:
Combinational systems: automatic methods for logic expression minimization. Informal and formal specification of logic functions. Binary Decision Diagrams (BDD). BDDs transformation to: C language, truth table and logic expression. Method for ordering variables in BDDs (Dynamic Weight Assignment). Implementation by software of logic functions. Static and dynamic probabilities in digital systems. Calculation of probabilities using BDDs.

Full-or-part-time: 3h
Theory classes: 3h

T7 - Sequential systems

Description:
Sequential systems: definition of synchronous state machine, Mealy and Moore models. Informal and formal specification of a state machine. State diagram and table. Software implementation of state machines: Mealy, implicit Moore and explicit Moore models. State minimization method. Initial state. Ghost states. Robust state machine deployment.

Full-or-part-time: 3h
Theory classes: 3h

T8 - Manufacturing process of integrated circuits

Description:
Manufacturing process of integrated circuits: Production of pure silicon ingots and wafers. Design process of masks from the electronic circuit specification. Photolithography and its related processes. Dice extraction and encapsulation.

Full-or-part-time: 0h 30m
Theory classes: 0h 30m

T9 - Interferences and shielding

Description:
Interference and shielding: The problem of interferences. Sources of interferences. Interference coupling: by conductive, capacitive, inductive and electromagnetic channels. Susceptibility of electronic components and circuits. Types of shielding. Mass and grounding. Interference reduction techniques for PCBs.

Full-or-part-time: 1h 30m
Theory classes: 1h 30m

GRADING SYSTEM

The grading of the subject includes four types of scores, from the less to the most important:
- Participation in class: Npc
- Laboratory work: Npl
- Midterm examination: Nep
- Final examination: Nef

The final score (legal marks) is the sum up Nf = 0,10 x Npc + 0,25 x Npl + 0,25 x Nep + 0,40 x Nef
The final score Nf will be NP (absent) if at least one of the following NPs happen: Npl = NP or Nep = Nef = NP. Otherwise NPs will be substituted by 0s in the Nf formula.
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: Nf = 0,10 x Npc + 0,25 x Npl + 0,65 x Nee where Nee is the score of the extra examination. The other two scores, Npc and Npl will be kept from the regular evaluation of the subject.

EXAMINATION RULES.

Midterm, final and extra examinations are written tests whose duration is indicated in the Academic Calendar and that follow the general rules of the school. They will be closed book tests unless it is explicitly indicated differently by the professor.
The midterm exam consists of 12 questions single choice test, in some questions a justification can be required. The final exam consists of 15 questions single choice test and 1 problem, as in the midterm exam a justification can be requested in some questions. The extraordinary exam consists of 30 questions single choice test.
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.
Regarding the class participation score, the professor will assess attendance, live participation and correct answer to questions.

BIBLIOGRAPHY

Basic:
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