Microprocessor based digital systems

Academic Year: (2023 / 2024) **Review date: 12/02/2024 12:33:18**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher: SANCHEZ REILLO, RAUL

Type: Electives ECTS Credits : 6.0

Year : Semester :

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

The lecturers strongly advise students who want to take this course have previously studied both "Digital Electronics" and "Electronic Components and Circuits". "Digital Electronics" covers combinational and sequential digital electronics, acquiring knowledge about the digital building blocks. The second, "Electronic Components and Circuits", it is important to know the basic electronic components and electronic wiring plate or breadboard test and evaluate its operation using basic tools and laboratory equipment.
It is also very important that the student is able to program a computer application. Therefore, the Faculty strongly recommends the students to have passed subjects like "Programming", "Systems Programming" and "Systems Architecture".
Another subject that can help students for this course is "Systems and Circuits", with allows the analysis of electronic circuits.

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG4. Solve mathematical, physical, chemical, biological and technological problems that may arise within the framework of the applications of quantum technologies, nanotechnology, biology, micro- and nano-electronics and photonics in various fields of engineering.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CG7. Undertake further specialized studies, both in physics and in the various branches of engineering.
CE13. Understand and handle solid state physical principles relevant to engineering and, in particular, semiconductors for application in electronic and photonic components, as well as the fundamentals and applications of analog and digital electronics and microprocessors.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.
RA4. To be able to successfully manage themselves in the complex situations that might arise in their academic or professional fields of study and that might require the development of novel approaches or solutions.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

OBJECTIVES

The main objective is that the student learns about microprocessor technology, and how to analyse and develop solutions based on such technology. The student will learn about microprocessors, their internal architecture, the use of microcontrollers and the most used peripherals. Programming will be done using C-language, using a semi-professional Integrated Development Environment (IDE). The student will also learn about how to debug solutions, in order to be able to detect errors and develop robust solutions.
With all this in mind, the partial objectives are:
- To know the basics of the different microprocessor internal architectures.
- To learn the benefits of using microcontrollers.
- To learn to use an IDE to develop microcontroller-based systems
- To apply medium/high-level programming languages to develop solutions for microprocessors/microcontrollers
- To learn to use the most common microcontroller peripherals.
- To be able to analyse microprocessor-based solutions
- To be able to develop microprocessor-based solutions

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to microprocessor based digital systems
2. Software Development: Integrated Development Environment
    2.1. C language integrated development environment.
    2.2. Peripherals I/O Libraries
3. General Input/Output Pins
4. Exceptions and Interrupt Systems
5. Timers
6. Analog/Digital and Digital/Analog Conversion
7. Serial Asynchronous Communication
8. Serial Synchronous Communication
9. Additional functionalities: RTC, Watchdog, Power consumption, etc.
10. System design examples and analysis
11. Architecture of a microprocessor/microcontroller system.
    11.1. Central Processing Unit (CPU).
    11.2. Memory Structure.
    11.3. Interface Modules.
12. Machine level programming: Assembler.
    12.1. Machine instructions and addressing modes.

LEARNING ACTIVITIES AND METHODOLOGY

The course competences provide certain skills as a result of the program, through different activities. For each program outcome, we briefly describe the activities provided within the course:
- In the course, exercises are held where students have to complete/develop their programs to meet certain requirements. They are asked to interpret and develop electronic circuits, block diagrams and flowcharts.
- The course includes a laboratory design exercise, with an initial set of specifications that the students

must meet by the end of the term. The problem is a manageable version of an electronic system design, that the students must solve using the given resources (microcontroller development board, debugger, peripherals).
- Design and analysis examples are presented to the students as guidance on good programming practices and electronic design techniques, showing how to use specific peripherals to solve different problems.
- The students must be able to comment their program code appropriately, develop program flow diagrams, use schematic capture programs for their designs. This will be evaluated comprehensively in laboratory works.
- The students are required to work using engineering tools such as a microcontroller Integrated Development Environment (IDE) program, a development board, as well as a debugger.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

The evaluation of the course will be based on the following criteria:
1.- Mandatory laboratory exercises, evaluating the progress achieved, with a total weight of 40% of the final mark. Progress will be evaluated by testing performance on the course development board, while knowledge will be evaluated through an individual laboratory exam to be done after completing all laboratory sessions. A minimum mark of 4 out of 10 is needed for the individual lab exam in order to achieve the complete lab mark. If the lab exam mark is below 4 out of 10, then the lab mark will be multiplied by 0.45.
2.- Final exam including analysis and design exercises, with a total weight of 60% of the final mark. To pass the subject, a minimum mark of 4 over 10 is requested in the final exam.

BASIC BIBLIOGRAPHY

- Development system manufacturer Development system manual, Development system manufacturer.

- Lecturers Collection of exercises , UC3M - Electronics Technology Department.

- Lecturers Collection of notes, slides and additional documentation, UC3M - Electronics Technology Department.

- Microcontoller Manufacturer Microcontroller datasheet, Microcontoller Manufacturer .

ADDITIONAL BIBLIOGRAPHY

- [Clements] Alan Clements Principles of Computer Hardware, Oxford University Press.

BASIC ELECTRONIC RESOURCES

- Raul Sánchez Reíllo, et. al. . Curso OCW "Sistemas Digitales Basados en Microprocesadores": https://ocw.uc3m.es/course/view.php?id=260