The basic objective of this subject is to introduce to the student in the design and the implementation of complex digital systems of industrial application. The subject concentrates in the design based on languages of description hardware (HDL) and on systems microprocessors. Emphasis in the physical implementation takes control of the systems and of the related problems hardware.
Subject 1: Introduction to the digital electronic systems

Description:
Objectives
This first introductory subject tries that the student acquires a general vision on the design of digital systems and its application to the industrial world. The concepts and the habitually used terminology, as well as some examples are also introduced that help to locate and to define the thematic contents of the subject.

Contents
1. Introduction.
1.2 Stages, criteria and alternatives of design.
1.3 Definition of basic concepts and software tools.
1.4 Examples of digital electronic systems applied to the industrial surroundings.

Activities, knowledge, abilities, aptitudes
When finalizing this subject the student will have to be able of:
- To assimilate the complexity and to know the evolution that has undergone the design of digital systems in the last decades.
- To understand the different phases involved in the processes of design at the moment used.
- To know the definition concepts and used terminology, as well as the software tools, jointly with its main advantages and limitations.
- To include/understand the necessity of the digital electronic systems in the scope of the robotics, the communications, the control and like solution for an ample fan of industrial applications.

Planning
1 of presentation of subject + 3 hours

Commentaries
The contents are developed following the chapters introductory of the bibliographical references [1], [2] and [3].
### Subject 2: Alternatives hardware in industrial applications

**Description:**

Objectives  
The objective of this thematic block is that the student acquires criteria to select the optimal platform hardware as solution to a specific problem of digital design. The different alternatives that exist, as well as the most important benefits are described resumidamente that they offer each of them. Emphasis in the diversity of solutions and its suitability based on the specific characteristics of each application becomes.

Contents  
2.1 Introduction.  
2.2 Digital microprocessors and microcontrollers.  
2.3 Digital processors of signal (DSP).  
2.4 PLD (CPLD and FPGA)  
2.5 Comparative of benefits: Complexity, price, speed, consumption, immunity to the noise, etc.

Activities, knowledge, abilities, aptitudes  
When finalizing this subject the student will have to be able of:  
- To know the different used platforms hardware in digital design.  
- To meet the generic benefits each of them, as well as the particular aspects and differentiators in the programmable case of the microprocessors and devices.  
- To enable the student to select the alternative of design adapted for a concrete casuistry.

Planning  
4 hours.

Commentaries  
The contents are developed following different chapters from 4 the bibliographical references [1], [5] and [6].
Subject 3: Synthesis of high level of digital systems

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<th>Description:</th>
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<td>Objectives</td>
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<tr>
<td>In this subject an introduction to language VHDL becomes, as basic tool of design that allows to describe complex digital systems with a high-level language. The structures and suitable styles of description are introduced more according to the casuistry, as well as you rule to follow for being able to secure a clear and structured programming. The subject finalizes presenting/displaying different alternatives from design, where the most important aspects are put of relief that they allow to obtain a correct synthesis.</td>
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<th>Contents</th>
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<tr>
<td>3.1 Introduction: the description languages hardware of high level.</td>
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<tr>
<td>3.2 Language VHDL.</td>
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<tr>
<td>3.2.1 Basic examples and styles of description.</td>
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<td>3.2.2 Syntactic elements of the language. Sequential and concurrent programming.</td>
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<td>3.2.3 Description of data flow.</td>
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<td>3.2.4 Algorithmic behavioral description.</td>
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<td>3.2.5 Structural description.</td>
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<td>3.2.6 Packages and libraries.</td>
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<td>3.3 Examples of design.</td>
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<tr>
<th>Activities, knowledge, abilities, aptitudes</th>
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<tr>
<td>The student will have to be able of:</td>
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<tr>
<td>- To describe digital systems of form structured with a high-level language like VHDL.</td>
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<td>- To know the different styles from description that provides VHDL.</td>
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<td>- To evaluate the suitability and utility of each of them, dependant of the complexity and the stage implied in the design.</td>
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<tr>
<td>- To take advantage of and to apply methodology of hierarchic design. To describe systems by means of VHDL that allow to their reusability forming part of other more complex systems.</td>
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Planning
12 hours of theory + 2 hours of problems.

Commentaries
The contents are developed following the chapters of the bibliographical references [1] - [3] and [12]. Even so in these same references examples and exercises can be found.
Subject 4: Oriented language VHDL to synthesis and simulation

**Description:**

Objectives
The objectives of this subject are several. On the one hand it is tried that the student assimilates certain rules and styles of programming that facilitate the work and avoid errors in the synthesis process. The description stands out especially to obtain combinacionales and sequential circuits. Even so, a speech point is dedicated on the design of synchronous and asynchronous systems, emphasizing, by means of some examples, the associate problems and their solution. On the other hand language VHDL like tool is simulation for digital circuits. Elements are introduced that solely have meaning in simulation surroundings: retardations, signalings, proving stands, etc.

Contents
4.1 Introduction.
4.2 Basic restrictions and structures.
4.2.1 Combinacional logic.
4.2.2 Sequential logic.
4.3 Synchronous and asynchronous systems.
4.4 Description of a machine of states.
4.5 Simulation and proving stands.

Activities, knowledge, abilities, aptitudes
The student will have to be able of:
- To describe in VHDL circuits that the sintetizador can interpret without ambiguities like sequential combinacionales or.
- To include/understand the importance of the synchronous designs to avoid real problems of operation (metaestabilidad, clock skew, etc.).
- To know the description correct you scheme of finite states (FMS) in VHDL. To know how to interpret when a digital circuit can be focused and be designed like so.
- To use the elements that the language allows to verify the operation of the circuit in simulation.
- To use the proving stands for the functional test of designs VHDL.

Planning
8 hours + 2 hours of problems + 6 hours intervention of groups.

Commentaries
The contents are developed following the references bibliographical [1] - [3] and [7]. Even so in these same references examples and exercises can be found.
Subject 5: Concepts advanced in digital design

**Description:**

Objectives
This last chapter has a double objective. In the first place that the student knows the present subjects in the digital design microelectronic, and on the other hand to serve as platform for those students who want to attend the optative subject of advanced Digital Design. In particular, the subject begins dynamically presenting/displaying the reconfigurable FPGA; device that allows to increase the densidad functional of an application makes specific (processed by area unit) in comparison with a static implementation on a ASIC or nonreconfigurable device. In the following point the nuclei (IP) re-usable are introduced, like resource that allows to approach complex digital designs without an increase of the time of development (fast prototype). In order to finish, Chip, that is to say, circuits formed by several subsystems integrated in a same chip is described to the System on (FPGA, micros, coprocessors, encriptadores, etc.) that developing very specific tasks of concurrent form.

Contents
- 5.1 Introduction.
- 5.2 Dynamic Reconfigurabilidad.
- 5.3 Modules IP (Intellectual propety).
- 5.4 Systems in a chip (System where Chip)
- 5.5 Example of system: Smart cards for restricted access.

Activities, knowledge, abilities, aptitudes
The student will have to be able of:
- To have a clear vision of the present state of the digital microelectronic design, and to know towards where he is evolving.
- To assimilate the utility of the software modules in complex designs.
- To dynamically understand the integrated potentiality of the reconfigurable devices, systems and to identify its applications in the industrial world.

Planning
3 hours.

Commentaries
The contents are developed following 6 4 the references bibliographical [] and [].
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**Practices**

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<th>Description:</th>
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<td><strong>Objectives</strong></td>
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<tr>
<td>The practices of the subject try that the student gets worse the knowledge obtained in the theory classes. The content of the program of practices has been oriented to the design in VHDL of digital systems of average complexity. One has chosen like work surroundings the software tools of Graphics Mentor and the plates hardware of Digilent for the programming of FPGA and CPLD as well as the plate of 2 development PICDEM extra.</td>
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**Contents**

- Practice 1. Introduction to the tool software FPGA Advantage and language VHDL (2 sessions)
- Practice 2. Design and implementation of a digital chronometer (2 sessions)
- Practice 3. Control of a screen LCD (2 sessions)
- Practice 4. Design of a splitter using a microcontroller PIC (1 session)

**Activities, knowledge, abilities, aptitudes**

The student will have to be able of:

- To know and to use of effective form the software tools that Mentor offers for the programming of programmable devices. To begin in the design of moderately complex digital systems in VHDL. To reinforce the knowledge on the internal structure and principle of operation of the microprocessors

**Commentaries**

The bibliographical material to realize these practical ones is the same that the described one for the theory program. In addition the bibliographical references and the material can be used that appears in the educational guide for the subject of Digital Systems II of the degree electronic Systems.

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**Qualification system**

The qualification of the subject considers all the work carried out throughout the course, and simultaneously it gives a final opportunity to those students who have not followed the course with the sufficient dedication. In particular, the qualification is obtained choosing the maximum of $0.7 \times C_5 + 0.15 \times C_3 + 0.15 \times C_4$ and $0.7 \times (C_1 \times 0.25 + C_2 \times 0.25 + C_5 \times 0.5) + 0.15 \times C_3 + 0.15 \times C_4$ where:

- $C_1$ = mark of the first partial test.
- $C_2$ = mark of the second partial test.
- Average $C_3$ = mark of the work to present/display in class.
- Average $C_4$ = mark of the practices.
- $C_5$ = mark of the final test.
Bibliography

Basic:


Complementary: