Program	09TT - Engineering in Telecommunication Technologies and Services

Course number and name	
Number	95000060
Name	Digital Electronic Systems Design Diseño de Sistemas Electrónicos Digitales
Semester	Y4-S7

Credits and contact hours	
ECTS Credits	6
Contact hours	60

Coordinator's name	Ángel Fernández Herrero

Specific course information

Description of course content

In this course, previous knowledge on digital electronics is elaborated and extended. The course is divided into two parts: a theoretical one, including problem solving, and a laboratory. Special emphasis is made on the latter as essential for the assimilation of acquired knowledge and drive to the professional practice.
Promoted skills are the following:

- Practical design of digital electronic systems
- Use of professional CAD tools for digital design
- Specification with VHDL language and simulation techniques
- Synthesis and simulation of digital systems on FPGAs

List of topics to be covered

Theory: 1. Design of hardware systems (ASICs and FPGAs, design methodology and software tools, synthesis and simulation), 2. Timing in digital systems (hazards and glitches, critical path, synchronous design, maximum frequency, clock skew and jitter, asynchronous inputs), 3. Sequential systems and signal processing (controllers and datapaths, pipelining, digital filters, fixed-point implementations), 4. Arithmetic operators in hardware (tradeoffs in architectures for adders and multipliers)

Laboratory: 1. The VHDL language, 2. Practical considerations for design and simulation, 3. Common mistakes using VHDL

Prerequisites or co-requisites

Students are recommended to have successfully completed the previous required courses: 95000018 – Digital Electronics; 95000025 - Electronic Circuits

Course category in the program

_ R (required)	× E (elective)	__ SE (selective elective)

Specific goals for the course
Specific outcomes of instruction
RA491: To know technological alternatives available nowadays for creating digital electronic systems and the methodology and development tools used to design and debug those as highly complex systems they are. RA492: To understand the timing of digital systems, including phenomena that increase their effects when those become more complex and faster, and to know the implications on the design of synchronous systems. RA493: To know the fundamental concepts associated with the pipelining technique and to be able to apply it to increase the operating frequency of a digital system. RA494: To know how the performance of a digital system can be improved by studying the tradeoffs that appear between different architectures available on specific cases of common use, such as basic arithmetic operators. RA495: To know the use of hardware development techniques for digital systems in an important field of application, such as real-time signal processing. RA496: To know a significant set of VHDL language elements. Special relevance has the description of state machines, due to their importance in the design of controllers. RA497: To be able to reuse previously implemented components for the specification of a system, as an essential basement for building highly complex systems. RA498: To be able to create a test plan to verify the functionality of a digital design, write it as a VHDL test bench, and apply it effectively during debugging by behavioral and post-route simulations. RA499: To understand the concept of synthesizable code and to be able to efficiently write correct VHDL code, with the aim of effectively creating working developments. RA500: To be able to use the VHDL language and available hardware development tools for the practical implementation of digital systems with different complexities.
Student outcomes addressed by the course
CG6, CG9, CG10, CG12, CE-SE1, CE-SE3, CE-SE5, CE-SE7

Bibliography and supplemental materials
– J. F. Wakerly, *Digital Design: Principles and Practices*, Prentice Hall, 4th Ed., 2007. – Jan M. Rabaey, A. Chandrakasan, B. Nikolic, *Digital Integrated Circuits: A Design Perspective*, Prentice Hall, 2nd Edition, 2003. – P. J. Ashenden, *The Designer's Guide to VHDL*, Morgan Kaufmann, 2nd Ed., 2003. – Volnei A. Pedroni, *Circuit Design with VHDL*, The MIT Press, 2004. – WEB: http://moodle.upm.es/titulaciones/oficiales

Teaching methodology			
× **lectures**	× **problem solving sessions**	__ **collaborative actions**	× **laboratory sessions**
Other:	The last assignment of the laboratory part is a PBL		