



## Course guides

### 230019 - DGD - Digital Design

**Last modified:** 29/04/2020

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

**Degree:** BACHELOR'S DEGREE IN AUDIOVISUAL SYSTEMS ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN ELECTRONIC SYSTEMS ENGINEERING (Syllabus 2009). (Compulsory subject).  
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SCIENCE AND TECHNOLOGY (Syllabus 2010). (Compulsory subject).  
BACHELOR'S DEGREE IN TELECOMMUNICATIONS SYSTEMS ENGINEERING (Syllabus 2010). (Compulsory subject).  
BACHELOR'S DEGREE IN NETWORK ENGINEERING (Syllabus 2010). (Compulsory subject).  
BACHELOR'S DEGREE IN TELECOMMUNICATIONS TECHNOLOGIES AND SERVICES ENGINEERING (Syllabus 2015). (Compulsory subject).  
BACHELOR'S DEGREE IN DATA SCIENCE AND ENGINEERING (Syllabus 2017). (Optional subject).

**Academic year:** 2020    **ECTS Credits:** 6.0    **Languages:** Catalan

#### LECTURER

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**Coordinating lecturer:** Pons Nin, Joan  
Mateo Peña, Diego

**Others:** Altet, Josep  
Bardés, Daniel  
Bermejo, Sandra  
Calderer, Josep  
Chávez, Juan Antonio  
Garcies, Pau  
Martín, Isidro  
Mateo, Diego  
Pons, Joan  
Puigdollers, Joaquim

#### PRIOR SKILLS

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Basic analysis of electronic circuits.  
Basic knowledge of electronic devices and, in particular, the MOS transistor.

#### REQUIREMENTS

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Electronics Fundamentals  
Linear Circuits

#### DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

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**Generical:**

12 CPE N2. They will be able to identify, formulate and solve engineering problems in the ICC field and will know how to develop a method for analysing and solving problems that is systematic, critical and creative.



## TEACHING METHODOLOGY

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Lectures and application classes  
Laboratory classes  
Group work (distance)  
Individual work (distance)  
Exercises  
Short answer tests (Control)  
Long answer tests (Final Exam)  
Laboratory work

## LEARNING OBJECTIVES OF THE SUBJECT

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The student must be able to analyze, design and experimentally verify combinational and sequential digital subsystems. This course introduces and uses the hardware description language VHDL. It also includes an introduction to CMOS logic circuits, an introduction and utilization of programmable logic devices and an introduction to complex digital systems.

## STUDY LOAD

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Type	Hours	Percentage
Self study	85,0	56.67
Hours small group	26,0	17.33
Hours large group	39,0	26.00

**Total learning time:** 150 h

## CONTENTS

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### Module 1. Introduction to digital design

**Description:**

The digital abstraction, systems and digital signals, behavior vs. structure, hierarchical design. Logic functions and Boolean algebra. Number systems and codes. Under the digital abstraction: power, delay, power consumption, logic levels and high impedance.

**Full-or-part-time:** 17h

Theory classes: 7h

Self study : 10h

### Module 2. Combinational design

**Description:**

SdP and PdS canonic design. Simplification of logic functions. Combinational design based on logic gates and on standard combinational modules. Multiplexers, decoders, adders, comparators, etc.

**Full-or-part-time:** 30h

Theory classes: 10h

Laboratory classes: 2h

Self study : 18h



### Module 3. Combinational design with VHDL

**Description:**

History and basic features of HDLs, methodologies and design tools. Basic elements: data types, objects, operators. Units Description: entities, architectures, packages and libraries. Concurrent assignments, conditional assignments and selections. Processes and sequential statements. Declaration and instantiation of components.

**Full-or-part-time:** 24h

Theory classes: 6h

Laboratory classes: 4h

Self study : 14h

### Module 4. Sequential design

**Description:**

Asynchronous and synchronous sequential systems, time behavior. Latches and flip-flops. Analysis and synthesis of synchronous state machines. Sequential modular design, registers and counters. Sequential design with VHDL. Time performance: output delay, hold time, setup time, skews, maximum frequencies, clock and reset signal managing. Algorithmic machines, data unit and control unit.

**Full-or-part-time:** 55h

Theory classes: 15h

Laboratory classes: 10h

Self study : 30h

### Module 5. CMOS digital circuits

**Description:**

Types of digital ICs and logic families. MOS transistors. CMOS inverter and basic logic gates. CMOS features: circuit delays, spurious, static and dynamic power consumption. Programmable logic devices, logic cells, and types of synthesis. Memory structures.

**Full-or-part-time:** 22h

Theory classes: 10h

Self study : 12h

## GRADING SYSTEM

Final grade based on the respective qualifications of the theory (60%) and the laboratory (40%) parts. The theory mark consists of 60% from the final theory exam and 40% from continuous assessment: exams, small works, delivery of problems or other activities done during the course. The laboratory mark is obtained from the laboratory work done during the course and from the final lab exam.

The re-evaluation of the course involves having to do the final exam again, which includes theory and laboratory parts. Grades earned replace the previous ones. Laboratory work and continuous assessment are not re-avaluable.

This course will assess the generic skill:

- Ability to identify, formulate and solve engineering problems (Intermediate Level)

## EXAMINATION RULES.

During the exams it is not allowed to use wireless devices (mobile phones, laptops, tablets, etc..) nor programmable calculators. It is also necessary to provide some identification document (ID card, passport, etc.)



## BIBLIOGRAPHY

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### Basic:

- Harris, S.L; Money, D. Digital design and computer architecture. Waltham, MA: Morgan Kaufmann, 2016. ISBN 9780128000564.
- Pardo Carpio, F.; Boluda Grau, J.A. VHDL: lenguaje para síntesis y modelado de circuitos. 3a ed. act. Madrid: Ra-ma, 2011. ISBN 9788499640402.
- Ercegovac, M.D.; Lang, T.; Moreno, J.H. Introduction to digital systems. Estats Units d'Amèrica: John Wiley & Sons, 1999. ISBN 0471527998.

## RESOURCES

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### Computer material:

- Quartus II Web edition