

# Course guide 230644 - ADS - Advanced Digital Systems

Last modified: 11/05/2022

| Unit in charge:        | Barcelona School of Telecommunications Engineering   |  |  |
|------------------------|--|--|--|
| Teaching unit:         | 710 - EEL - Department of Electronic Engineering.  |  |  |
| Degree:                | MASTER'S DEGREE IN ELECTRONIC ENGINEERING (Syllabus 2013). (Compulsory subject).<br>MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Optional subject).<br>MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional<br>subject). |  |  |
| Academic year: 2022    | ECTS Credits: 5.0 Languages: English   |  |  |
| LECTURER               |  |  |  |
| Coordinating lecturer: | J. MANUEL MORENO ARÓSTEGUI   |  |  |
| Others:                | JOAN CABESTANY MONCUSÍ<br>Moreno Arostegui, Juan Manuel  |  |  |

# **PRIOR SKILLS**

- Digital design based on a hardware description language (VHDL, Verilog, ...)
- Design and simulation of basic digital systems: combinational and sequential logic functions and finite state machines.
- Implementation of basic digital systems on configurable devices.
- Development of software applications based on microprocessor/microcontroller.

- C programming language.

# **DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES**

#### **Specific:**

- 1. Ability to apply synchronization techniques and use standard buses considering electrical aspects and protocols.
- 2. Ability to specify and develop embedded systems using RTOS.
- 3. Ability to design digital systems based on multi-processors, configurable processors and FPGAs with HDL languages and CAE tools.

#### Transversal:

4. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

5. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

6. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

# **TEACHING METHODOLOGY**

- Lectures
- Laboratory classes
- Laboratory practical work
- Individual work (distance)
- Short answer test (Control)
- Extended answer test (Final Exam)



# LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

The aim of this course is to train students in methods of design complete digital system encompassing hardware and software components and also their interconnection. First the system architecture of a complex digital system is reviewed. Then the memory and interconnection models to be used are presented. Thereafter the main features of a real time operating system (RTOS) are considered. Afterwards, physical aspects related to the implementation of the system (synchronisation, clock and data recovery methods) are presented.

Learning results of the subject:

- Ability to specify, design networks, services, processes and applications of telecommunications in both a fixed, mobile, personal, local or long distance, with different bandwidths in multicast networks, including voice and data.

- Ability to apply both traffic engineering tools as planning tools, dimensioning and network analysis.

- Ability to analyse, model and implement new architectures, network protocols and communication interfaces and new network services and applications.

- Ability to analyse, model and apply advanced techniques both security, including cryptographic protocols, firewalls, and collection mechanisms, authentication and content protection.

# **STUDY LOAD**

| Туре              | Hours | Percentage |
|-------------------|-------|------------|
| Hours large group | 26,0  | 20.80      |
| Self study        | 86,0  | 68.80      |
| Hours small group | 13,0  | 10.40      |

Total learning time: 125 h

# CONTENTS

# 1. Introduction

### **Description:**

- Trends in system on chip design

- System components
- Implementation alternatives

### Full-or-part-time: 9h

Theory classes: 2h Laboratory classes: 1h Self study : 6h

### 2. Memory Design

# **Description:**

- Scratchpads and cache memory
- SOC memory systems
- Board-based memory systems

Full-or-part-time: 15h Theory classes: 4h Laboratory classes: 1h Self study : 10h



### 3. Communication architectures

# **Description:**

- Bus-based communication architectures
- Communication architectures standards
- Networks on chip

### Full-or-part-time: 43h

Theory classes: 8h Laboratory classes: 5h Self study : 30h

# 4. Real-time operating systems (RTOS)

#### **Description:**

- Multi-tasking and task scheduling

- Synchronisation of resource access
- Inter-task communication
- Interrupt handling

Full-or-part-time: 34h Theory classes: 6h Laboratory classes: 4h Self study : 24h

# 5. Physical communication mechanisms

#### **Description:**

- Synchronisation
- Clock alignment
- Clock recovery

**Full-or-part-time:** 24h Theory classes: 6h Laboratory classes: 2h Self study : 16h

# ACTIVITIES

# LABORATORY

#### **Description:**

- Use of embedded microprocessors with RTOS in configurable devices.
- System integration for communication applications.

# **EXERCISES**

### **Description:**

Exercises to strengthen the theoretical knowledge.



# SHORT ANSWER TEST (CONTROL)

**Description:** Mid term control.

# EXTENDED ANSWER TEST (FINAL EXAMINATION)

**Description:** Final examination.

# **GRADING SYSTEM**

Final exam: 40% Group assessments: 20% Laboratory assessments: 40%

# **BIBLIOGRAPHY**

### **Basic:**

- Flynn, M.J.; Luk, W. Computer system design: system-on-chip [on line]. Cambridge, MA: Wiley, 2011 [Consultation: 21/04/2020]. Available on: <u>https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=693260</u>. ISBN 9781118009901.

#### **Complementary:**

- Pasricha, S.; Dutt, N. On-chip communication architectures: system on chip interconnect. Amsterdam ; Boston: Elsevier / Morgan Kaufmann Publishers, 2008. ISBN 9780123738929.

- Dally, W.J.; Poulton, J.W. Digital systems engineering. Cambridge: Cambridge University Press, 1998. ISBN 0521592925.

- Moyer, B. (ed.). Real world multicore embedded systems [on line]. Elsevier, 2013 [Consultation: 21/04/2020]. Available on: <a href="https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1138206">https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=1138206</a>. ISBN 9780123914613.