Course guide
230652 - ESDC - Electronic System Design for Communications

Last modified: 25/05/2023

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

Degree:	MASTER'S DEGREE IN TELECOMMUNICATIONS ENGINEERING (Syllabus 2013). (Compulsory subject). MASTER'S DEGREE IN ADVANCED TELECOMMUNICATION TECHNOLOGIES (Syllabus 2019). (Optional subject).

Academic year: 2023   **ECTS Credits:** 5.0   **Languages:** English

LECTURER

Coordinating lecturer:	Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/responsables-assignatura
Others:	Consultar aquí / See here: https://telecos.upc.edu/ca/estudis/curs-actual/professorat-responsables-coordinadors/professorat-assignat-idioma

PRIOR SKILLS

Previous knowledge needed to follow all the explanations:
CONCEPTS OF PHYSICS:
- Plate parallel capacitance. Voltage-Charge relation. Dielectrics.
- Magnetic flux. Self-Inductance. Mutual Inductance.
- PN Junctions: forward and reverse biasing.
BASIC CIRCUIT ANALYSIS:
- RC circuits. Time constant. Energy stored in a capacitor.
- LR circuits. Time constant. Energy stored in a inductance.
- Concept of resonance frequency in RLC circuits.
MOS TRANSISTOR
- Identification of terminals, sing of currents and voltages in NMOS and PMOS
devices.
- Large Signal (DC), long channel equations (ID vs VGS, VDS) curves and
regions. Transconductance and gate dimensions. Channel-Length modulation.
Overdrive voltage
- Unified model for PMOS and NMOS.
- Threshold voltage effects: Body Effect. Threshold voltage as a function of bulksource
voltage: linear simplification equation. Drain induced barrier lowering.
- Short channel equations: Mobility degradation and Velocity saturation.
- Parasitic capacitances: Gate capacitance and Diffusion Capacitance
DIGITAL CIRCUITS
- CMOS Logic gates. Extraction of the truth table and logic expression form a
gate transistor schematic.
- Pass Transistor DC characteristics. N, P and CMOS transmission gates.
- Inverter: Static transfer function. Noise Margin definition.
DIGITAL DESIGN
- Digital codes: Signed and unsigned binary codes. Basic binary arithmetic
operations: addition and multiplication. Error Detection Codes: parity codes.
- Combinational circuits. Canonical implementation of logic functions. De
Morgan?s Laws.
- State Machines: state diagram. Canonical structure of sequential systems.
- Basic combinational and seqüential blocks. Truth table. Logic level schematic.

Symbol. (basic logic gates, multiplexer, decoder, half adder, full adder, flip-flop,
latch, register, counter).
- Digital waveform as a function of time interpretation.
- VHDL Hardware Description Language.
- Basic understanding of C programming
- Basic microprocessor experience
DATA COMMUNICATIONS BASICS (*)
- Basics of data flow and digital communication channels
- Types of network connections
- Network topologies
- Network types (LAN, WLAN)
- Switched WAN
- Packet switching Networks
- Internet basics
- Communication protocols
- Protocols layering
- TCP/IP protocol
- Layers communication in networks with switching and routers
- Message encapsulation and decapsulation
- Addressing in TCP/IP protocol suite
- Multiplexing and demultiplexing
- OSI model
- Time Division and Frequency Division Multiplexing
(*) For this part we suggest ?Data Communications and Networking? of B.A.
Forouzan

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Ability to design and manufacture integrated circuits
2. Knowledge of hardware description languages for high-complex circuits.
3. Ability to use programmable logical devices, as well as to design analog and digital advanced electronics systems. Ability to design
communication devices, such as routers, switches, hubs, transmitters and receivers in different bands.

Transversal:
4. 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.

5. 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
- Application classes
- Laboratory activities
- Individual work
- Exercises
- Extended answer test (Final Exam)

LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

To understand the general principles and design methods of integrated electronic computing and communication systems.

Learning results of the subject:

- Ability to assess the possibilities and limitations of CMOS technology.
- Abitlity to design at circuit level the main subsystems of a digital electronic circuit based on given specifications, including communications applications.
- To acquire knowledge on signal integrity, power consumption and test of an electronic system.
- Understanding of communication processor arquitectures.

STUDY LOAD

Type	Hours	Percentage
Hours small group	13,0	10.40
Hours large group	26,0	20.80
Self study	86,0	68.80

Total learning time: 125 h

CONTENTS

Design Methodolgy

Description:
Challenges of a design methodology.
Setting the specifications: what should we include?
Strategies to extract the block diagram of a design.
Synchronization and communication between blocks. Flag and awakening signals.
Design of the algorithm of a block.
Process and control unit design: state diagram and circuit schematic.
Usage of Intellectual Properties.
Application example: design of the main blocks of the design developed in the laboratory.

Related competencies :
CE10. Ability to design and manufacture integrated circuits
CE11. Knowledge of hardware description languages for high-complex circuits.
CE12. Ability to use programmable logical devices, as well as to design analog and digital advanced electronics systems. Ability to design communication devices, such as routers, switches, hubs, transmitters and receivers in different bands.
CT5. 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.

Full-or-part-time: 16h
Theory classes: 8h
Self study : 8h

Specific communication electronic components and architectures

Description:
Motivation, Basics of Digital Communications, Switch
Queues and CRC Checkers/Generators
Design of basic communication systems
State of the art in R&D on Electronics for Communication

Related competencies :
CE10. Ability to design and manufacture integrated circuits
CE12. Ability to use programmable logical devices, as well as to design analog and digital advanced electronics systems. Ability to design communication devices, such as routers, switches, hubs, transmitters and receivers in different bands.
CT4. 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.

CT5. 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.

Full-or-part-time: 16h
Theory classes: 8h
Self study : 8h

Integrated Circuit Design Concepts

Description:
Delay in digital circuits. Timing analysis.
Power and energy in integrated circuits.
Low power design techniques.

Related competencies :
CE10. Ability to design and manufacture integrated circuits
CT4. 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.

CT5. 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.

Full-or-part-time: 16h
Theory classes: 8h
Self study : 8h

ACTIVITIES

EXERCISES

Description:
Exercises to strengthen the theoretical knowledge.

EXTENDED ANSWER TEST (FINAL EXAMINATION):

Description:
Final examination.

LABORATORY

Description:
The laboratory consist in two parts:
Development of the design done in the PART 1 of the theory sessions.
Development of a free design project.
Tools:
Designs are implemented in FPGAs. State of the art software tools and evaluation boards are used.

Related competencies :
CE11. Knowledge of hardware description languages for high-complex circuits.
CE12. Ability to use programmable logical devices, as well as to design analog and digital advanced electronics systems. Ability to design communication devices, such as routers, switches, hubs, transmitters and receivers in different bands.
CT5. 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.

CT4. 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.

Full-or-part-time: 74h
Laboratory classes: 12h
Self study: 62h

GRADING SYSTEM

Final examination: 50%
Partial exams and laboratory: 50%.

BIBLIOGRAPHY

Basic:
- Forouzan, B. A. Data communications and networking with TCP/IP protocol suite. 6th ed. New York: McGraw-Hill, 2022. ISBN 9781260597820.
- Escudero i Costa, F; Altet, J. Design methodology for programming multi task applications on low cost microprocessors. First edition: English version. [Great Britain]: Francesc Escudero, Josep Altet, [2020]. ISBN 9798667923503.
- Weste, N.H.E.; Harris, D.M. CMOS VLSI design: a circuits and systems perspective. 4th ed. Boston: Addison Wesley, 2011. ISBN 9780321547743.
- Franklin, M.A. [et al.]. Network Processor Design, vol. 3, Issues and practices [en línia] [on line]. Morgan Kaufmann, 2005 [Consultation: 21/04/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=232128. ISBN 9780120884766.

Complementary:
- Giladi, R. Network Processors : architecture, programming, and implementation [on line]. Amsterdam: Morgan Kaufmann, 2008 [Consultation: 21/04/2020]. Available on: https://ebookcentral.proquest.com/lib/upcatalunya-ebooks/detail.action?docID=404833. ISBN 9780080919591.