Integrated Heterogenous Systems Design 2013/2014

Code: 42838
ECTS Credits: 6

Degree	Type	Year	Semester
4313797 Enginyeria de Telecomunicacions / Telecommunication Engineering	OB	1	2

Contact

Name: Francesc Serra Graells

Email: Francesc.Serra.Graells@uab.cat

Use of languages

Principal working language: anglès (eng)

Prerequisites

In order to achieve the best understanding of syllabus contents, the following background is needed:

• Signal processing
• Circuit theory
• Electronic devices
• Analog CMOS circuits

Objectives and Contextualisation

The aim of this syllabus can be split into two goals:

• Introduction to the design of A/D and D/A converters in CMOS technologies
• Hands-on experience on the high-level description languages used for the simulation of these mixed integrated circuits.

Skills

Enginyeria de Telecomunicacions / Telecommunication Engineering

- Be capable of using programmable logic as well as designing advanced electronic systems, both analogue and digital.
- Capacity for critical reasoning and thought as means for originality in the generation, development and/or application of ideas in a research or professional context.
- Capacity for designing and manufacturing integrated circuits.
- Capacity for working in interdisciplinary teams
- Knowledge of the hardware description languages for highly complex circuits
- Maintain proactive and dynamic activity for continual improvement
- Students should be capable of integrating knowledge and facing the complexity of making judgements using information that may be incomplete or limited, including reflections on the social and ethical responsibilities linked to that knowledge and those judgements
- Students should know how to apply the knowledge they have acquired and their capacity for problem solving in new or little known fields within wider (or multidisciplinary) contexts related to the area of study

Learning outcomes

1. Be capable of designing heterogeneous electronic systems
2. Capacity for critical reasoning and thought as means for originality in the generation, development

and/or application of ideas in a research or professional context.
3. Capacity for working in interdisciplinary teams
4. Design advanced electronic systems, both digital and analogue
5. Design analogue and mixed integrated circuits
6. Maintain proactive and dynamic activity for continual improvement
7. Students should be capable of integrating knowledge and facing the complexity of making judgements using information that may be incomplete or limited, including reflections on the social and ethical responsibilities linked to that knowledge and those judgements
8. Students should know how to apply the knowledge they have acquired and their capacity for problem solving in new or little known fields within wider (or multidisciplinary) contexts related to the area of study

Content

Chapter 1. Introduction to integrated heterogeneous systems
1.1. Evolution of CMOS technologies
1.2. Trends in analog and mixed IC design
1.3. A/D and D/A conversion principles
1.4. ADC and DAC figures of merit
1.5. Work proposal: design of a Delta-Sigma ADC in 2.5um CMOS technology (CNM25)

Chapter 2. ADC architectures and CMOS circuits
2.1. ADC classification
2.2. Flash techniques
2.3. Sub-ranging, pipelining and time-interleaving techniques
2.4. Successive-approximation techniques
2.5. Integrating techniques
2.6. Delta-Sigma modulation techniques
2.7. Time-domain techniques

Chapter 3. DAC architectures and CMOS circuits
3.1. DAC classification
3.2. Flash techniques
3.3. Integrating techniques
3.4. Delta-Sigma modulation techniques
3.5. Pulse-width modulation techniques

(Seminar about EDA tools for IC design)

Chapter 4. High-level description languages for mixed simulation
4.1. Matlab-like and Simulink
4.2. Verilog-AMS
4.3. VHDL-AMS
4.3. SystemC AMS
4.4. XSpice

Chapter 5. Delta-Sigma Modulators for ADC
5.1. Oversampling and noise shaping principles
5.2. Architecture selection based on quantization error
5.3. Switched-capacitor CMOS implementations
5.4. Modeling circuit second order effects
5.5. Digitally assisted techniques
5.6. Low-power circuit topologies

(Seminar about CNM25 design kit)

Chapter 6. Application to Read-Out ICs for Sensors
7.1. High-reconfigurable SC Delta-Sigma ADC for space applications

7.2. Ultra low-power SC Delta-Sigma ADC for hearing aids
7.3. Compact pixel integrating ADC for infrared and X-ray imagers
7.4. Potentiostatic CT Delta-Sigma ADC for electrochemical integrated sensors

Methodology

• Directed activities: lectures, case studies and exercises, lab sessions and seminars
• Supervised activities: tutorials
• Non-supervised activities: study, lab pre-work

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Case studies and exercises	12	0.48	1, 2, 6, 7, 8
Lab sessions	12	0.48	1, 2, 3, 6, 8
Lectures	26	1.04	1, 4, 5, 8
Type: Supervised			
Tutorials	12	0.48	2, 4, 5, 6
Type: Autonomous			
Lab pre-work	8	0.32	2, 3, 4, 5, 6, 7, 8
Study	68	2.72	1, 2, 4, 5, 6, 7, 8

Evaluation

Progressive evaluation is based on the following weights:

• Two partial exams (25%+25%)
• Team work at lab scheduled in four reports (5%+10%+10%+15%)
• Solved exercises (10%)

Team work, including lab sessions, is mandatory to pass evaluation. The above evaluation scheme is only applicable when marks for first and second items are greater or equal to 5/10. Otherwise, a final exam is needed.

For those students going to the final exam, either due to low marks or for their own improvement, the resulting exam mark will weight 50%, together with the team work (40%) and the solved exercises (10%).

Any change on the above evaluation method will be communicated in advance.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes

Final exam (only when required)	50%	2	0.08	1, 2, 4, 5, 8
Partial exam 1	25%	2	0.08	1, 2, 4, 5, 8
Partial exam 2	25%	2	0.08	1, 2, 4, 5, 8
Solved exercises	10%	2	0.08	1, 4, 5, 7, 8
Working team lab reports	40%	4	0.16	1, 2, 3, 4, 5, 6, 7, 8

Bibliography

Materials supplied during class sessions are almost self-explanatori. For a deeper understanding of both theoretical and practical contents, the following readings are recommended:

• R. van de Plassche, CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters, Kluwer Academic Publishers
• R. Schreier and G. C. Temes, Understanding Delta-Sigma Data Converters, John Wiley & Sons
• V. Peluso, M. Steyaert and W. Sansen, Design of Low-Voltage and Low-Power CMOS Delta-Sigma A/D Converters, Kluwer Academic Publishers
• F. Medeiro, A. Pérez-Verdú and A. Rodríguez-Vázquez, Top-Down Design of High-Performance Sigma-Delta Modulators, Kluwer Academic Publishers
• T. Tuma and A. Burmen, Circuit Simulation with SPICE OPUS: Theory and Practice, Modeling and Simulation Science, Engineering and Technology, Birkhäuser Boston
• A. Hastings, The Art of Analog Layout, Pearson Prentice Hall