UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Escola Tècnica Superior d'Enginyeria de Telecomunicació de Barcelona

telecos BCN

230736 – INTRODUCTION TO MICROELECTRONIC DESIGN

Credits: 5 ECTS

LECTURER

Coordinating lecturer: Xavier Aragones Cervera

Others:

PRIOR SKILLS

The MOS transistor - Physical structure and Modeling (DC equations). Small-signal model. Concepts of operation point (quiescent point) and response to the small signal. DC and Small-signal analysis of basic analog circuits - the common-source amplifier. Circuit analysis in the Laplace domain.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:

TEAMWORK. Being able to work as a member of an interdisciplinary team, either as a member or carrying out management tasks, in order to contribute to developing projects with pragmatism and a sense of responsibility, assuming commitments taking into account the available resources.

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.
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)
- Exercises
- Extended answer test (Final Exam)

LEARNING OBJECTIVES OF THE SUBJECT

Learning objectives of the subject:

The main objective of the course is to provide basic knowledge and skills related to the design of circuits integrated in microelectronic CMOS technologies. Based on the analysis and design of both basic analog circuit stages (amplifiers) as digital (basic gates), the student will delve into the physical design (layout) of these circuits in CMOS integrated technologies, and will know the physical and functional verification processes of the designed circuits, using EDA design tools. The student will understand the physical

aspects that affect the performance of the circuits (parasitic capacitances, process variability, noise), will know several non-idealities, and will finally be introduced to the particularities of microelectronic design for Radiofrequency signals.

Learning results of the subject:

- Carry out the design of integrated circuits in CMOS technologies, including their physical implementation. Analyze the performance of basic logic gates and simple analog CMOS circuits and perform their microelectronic design.

STUDY LOAD

Hours large group: 13

Hours small group: 26

Hours self study: 86

CONTENTS

Topic 1: CMOS circuits and technology

- Reminder on the MOS transistor: physical structure, qualitative behavior, models.
- DC analysis of circuits with MOS transistors
- A CMOS microelectronic implementation of CMOS circuits: parts of an integrated circuit; twin-well and triple-well technologies; layers; transistors; contacts; metal connections.
- Lab1: Introduction to schematic capture, circuit simulation and layout edition using Cadence Virtuoso.

Time: 9 h.

Topic 2: Basic CMOS digital gates

- Physical structure, DC analysis,
- Delay models and estimation; design for speed
- Power consumption: dynamic, static (leakage).
- Fanout and driving force. Scaled drivers.
- Lab2: Design and analysis of digital CMOS circuits. Sizing digital gates.

Time: 9 h.

Topic 3: Basic CMOS analog amplifiers

- Reminder small-signal concept (operating point, linearity assumption) and small-signal models.
- The common-source amplifier (single-ended).
- Biasing. The current mirror.
- Frequency response. Pole identification. Bandwidth estimation.
- Differential common-source amplifier (fully-differential).
- Differential amplifier with current-mirror load (simple OTA)
- Lab3: Design of basic CMOS amplifier circuits

Time: 12 h.

Topic 4: Introduction to amplifiers for RF: a narrowband LNA

- A receiver for RF communications. Requirements for a LNA.
- The common-source amplifier with inductive degeneration.
- Inductive loads. Quality factor.
- Noise in analog CMOS circuits. Noise metrics in RF amplifiers. Noise metrics in low-frequency amplifiers.
- Non-linearity in analog CMOS amplifiers. Linearity metrics in RF amplifiers. Linearity metrics in low-frequency amplifiers.
- Lab4: Design and analysis of a narrowband RF amplifier

Time: 9 h.

GRADING SYSTEM

- Final exam: 40 %
- Labs: 40%
- Continuous assessment: exercises to at home, mid-term test: 20 %

BIBLIOGRAPHY

Basic:

- Neil H.E. Weste, David M. Harris, *CMOS VLSI Design. A Circuits and Systems Perspective*. 4th Ed. Addison-Wesley, 2011.

- Razavi, B. Fundamentals of microelectronics. Hoboken: John Wiley & Sons, 2008. ISBN 9780471478461.

- Rabaey, J.M.; Chandrakasan, A.P.; Nikolic, B. Digital integrated circuits: a design perspective. 2nd ed. Upper Saddle River: Pearson
Education, 2003. ISBN 0131207644.

Complementary:

- Carusone, T.C.; Johns, D.; Martin, K.W. Analog integrated circuit design. International student version. New York: John Wiley, 2013. ISBN 9781118092330.