Microelectronics

Academic Year: (2022 / 2023) **Review date: 10-06-2021**

Department assigned to the subject: Electronic Technology Department

Coordinating teacher:

Type: Electives ECTS Credits : 6.0

Year : 4 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Electronic Engineering Fundamentals
Analog Electronics (I)
Digital Electronics
Integrated Circuit Design (optional)

OBJECTIVES

By the end of this subject, students will be able to have:
1. coherent knowledge of tools and methods for designing microelectronic analog, digital and mixed-signal circuits;
2. the ability to apply their knowledge and understanding to identify, formulate and solve microelectronics problems using advanced techniques for place and route, layout and post-layout simulations;
3. the ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements;
4. an understanding of design methodologies and optimization techniques for analog, digital and mixed-signal integrated circuits with regards to speed, area and power consumption requirements, and the ability to use them.
5. the ability to design integrated circuits at layout level, simulate their behaviour, interpret results and characterize the integrated circuit performance;
6. workshop and laboratory skills.
7. the ability to select and use appropriate equipment, tools and methods;
8. the ability to combine theory and practice to solve problems of optimal design in digital, analog and mixed-signal microelectronic circuits;
9. an understanding of applicable techniques and methods for the new tendencies in nanoelectronics, and of their limitations;

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction to Integrated circuits and microelectronics.
1.1. MOSFET transistor review
1.2. Digital technologies review
1.3. CMOS technology review
2. Integrated circuits manufacturing. Application Specific Integrated Circuits. Packaging.
2.1 Involved processes in circuit manufactuing
2.2. CMOS circuits manufacturing
2.3. Passive components
2.4. Packaging and Mounting
2.5. Application Specific Integrated Circuits. Configurable devices.
3. Analysis and design of basic digital integrated circuits: logic gates, sequential elements, etc.
3.1 Masks and design rules
3.2. Microwind tool
3.3. Layout and Simulation of Digital Integrated Circuits
3.4. Logic gates, sequential elements, tristate buffers.
4. Tecnological aspects on digital integrated circuits: delay, power consumption, noise, etc.
4.1 Delay, clocking and supply
4.2. Latchup, noise and mestastability
5. Basic analog integrated circuits: current source, current mirror, differential pair, casode, etc.
5.1. Current source
5.2. Current mirror
5.3. Differential pair

5.4. Casode
6. Integrated amplifiers: differential and operational amplifiers.
6.1. Common source amplifier (Small-signal model=
6.3. Common drain amplifier
6.4 Cascode Amplifier
6.5. Miller compensation CS Amplifier
6.6 AB Differential Amplifier. Response in DC, AC, CMRR, PSRR, SlewRate, MAtching, Layout. Application Examples.
6.7. Operational Amplifiers. Ideal OA. Circuits with OA. OTA Circuit. Applicaton Examples.
7. Integrated circuits applications: PLLs, D/A y A/D converters
7.1. Digital PLL
7.2. Phase detector. VCO.
7.3. DLL Filter.
7.4. Examples: recovering clock circuits.
7.5. Fundamentals of Data converters.
7.5.1. Sample and Hold.
7.5.2. Commuted capacitances
7.5.3. DA and AD converters
7.6. Mixed signal circuits Layout
7.7. Applications Examples. DA R2R converter. Flash AD and SAR converters.

8. Computer aided tools for integrated circuits design.
8.1 Layout CAD Tools for Digital Integrated Circuits Analysis and Design
8.2 CAD Tools for Analog Integrated Circuits Analysis and Design

LEARNING ACTIVITIES AND METHODOLOGY

1. Theoretical classes: 1,2 ECTS. Intended to reach the specific competences of the course through theory dissertation, audiovisual watching and exercises resolution. Two ongoing evaluations of this part will be done. To facilitate their development, students will receive class notes and can use basic reference texts that allow them to complete and study in depth those units in which they are most interested.
2. Face to face classes: 1,2 ECTS with reduced groups for exercises resolution to fix theoretical and practice knowledge acquisition.
3. Practices: 1,2 ECTS. Design and development of integrated circuits using specific CAD tools with the aid of the professor. Face-to face sessions in laboratory.
4. Project design and development: 2,4 ECTS. A project, developed individually will be proposed and developed in laboratory. Final assessment will be done on this part.
5. Student study: exercises and complementary readings proposed by the teacher. Personal study.
6. Assessment presential tests.

ASSESSMENT SYSTEM

1. Two partial exams along term with a 40% weight in the global qualification (20% each)
2. A design and development project, to be done along laboratory sessions with a 60% weight in the global qualification

Extraordinary Exam:
Assessment can be fitted to continous assessment system (with the same ponderation as in the ordinary exam) or to a Final Exam with the 100% of qualification

% end-of-term-examination:	10
% of continuous assessment (assigments, laboratory, practicals…):	90

BASIC BIBLIOGRAPHY

- A. Rubio, J. Altet, X. Aragonés, J.L. González, D. Mateo, F. Moll Diseño de circuitos y sistemas integrados, UPC, 2003
- M. RABAEY, A. CHANDRAKASAN, B. NIKOLIC Digital Integrated Circuits, Prentice-Hall International, 2003
- NAISH, P., BISHOP, P Designing ASICs, Ellis Horwood Limited, 1988
- WESTE, N., HARRIS, D. Principles of CMOS design - A circuits and systems perspective, Addison-Wesley, 2005

ADDITIONAL BIBLIOGRAPHY

- Razavi, Behzad Design of analog CMOS integrated circuits , McGraw Hill, 2001
- SEDRA, Adel S. Circuitos microelectrónicos , McGraw-Hill Interamericana, 2006