Electronic circuit design for communication

Academic Year: (2022 / 2023) **Review date: 20-05-2022**

Department assigned to the subject: Department of Electronic Technology

Coordinating teacher: PATON ALVAREZ, SUSANA

Type: Compulsory ECTS Credits : 6.0

Year : 1 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

(Bachelor) Electronic Systems, Digital electronics, Linear Systems, Communication Theory

OBJECTIVES

The teaching objectives are:
- knowing the circuits of the front-end of commercial communications equipment
- designing and sizing at system level the necessary requirements for the blocks of the front-end, including noise and quantization
- sizing some specific circuits that are part of the front-end

DESCRIPTION OF CONTENTS: PROGRAMME

Block I

Lesson 1. C ommunications systems circuit design
- Processing chain in a communications system
- Introduction to microelectronics in communications systems. System on Chip (SoC). Design flow of a SoC

Lesson 2. Active filters in continuous time
-Review of filter synthesis theory
- Biquadratic filters
- Sallen Key Filters and its derivatives
- State variables filtes wir RC-Opamp circuits
- Filters with gyrators
- Gm-C Filters

Lesson 3. sample and hold circuits
- The CMOS switch
- Sampling circuits and basic sample&hold circuits
- Charge injection phenomenon
- Sampling uncertainty phenomenon
- Integrated Sample & Hold Circuits

Lesson 4. Switched capacitor circuits
- Elements of a switched capacitor circuit
- Basic Integrator
- Discrete Integrator insensitive to parasitic capacitances with delay
- Discrete Integrator insensitive to parasitic capacitances without delay
- Adder and gain stages
- Discrete time Filters of first and second order

Block II:

Lesson 5. Special Communications Amplifiers: hybrid circuits, tuned amplifiers, mixers, AGC
- Single-ended and differential LC tuned amplifiers. Integrated inductances.
- Active mixers of 2 and 4 quadrants
- Variable gain amplifiers VGA
- Amplifiers with Automatic Gain Control (AGC). Logarithmic control law

Lesson 6: Non linear circuits
- Total Harmonic Distortion (THD) Concept
- IP3 point of an amplifier

- SFDR and SNDR concepts
- Differentail amplifiers
- RF power amplifiers

Lesson 7. Noise in electronic systems
- Review of statistical definitions of electrical noise. Noise spectral density
- Equivalent noise bandwidth of a circuit
- Types of circuit noises. Small-signal noise models of semiconductor devices
- Noise in discrete systems. Maximum SNR of an ideal sampler.
- Noise Factor and Friis formula.
- Concept phase noise of an oscillator. Relationship to jitter of a digital clock.

Block III:

Lesson 8. Principles of A/D and D/A. D/A converters
- Noise a uniform quantizer
- Static parameters of an A/D and D/A, static errors, INL and DNL.
- Dynamic parameters. SNR, SNDR, SFDR, ENOB and dynamic range.
- D / A converters with resistance networks
- D / A converters with current sources
- D / A converters with switched capacitors
- Converter with R-2R network

Lesson 9. A/D converters
- Integrating A/D Converters (ramp, dual ramp)
- Succesiva approximation A/D converters (SAR)
- Pipe-line A/D converters
- FLash A/D converters

Lesson 10: Oversampled Circuits
- Concept of oversampled systems
- Principle of noise shaping (Noise Shaping)
- Sigma-delta modulators of 1st and 2nd order
- Implementation of oversampled A/D
- Implementation of oversampled D/A converters

Lesson 11: Frequency Synthesis
- Types of Frequency Synthesizers
- Dynamic Equations of a phase control loop (PLL)
- Elements of a PLL: phase comparators, LC VCO, programmable dividers
- Phase noise in a digital divider
- Double modulus synthesizers
- Synthesizers controlled by sigma-delta modulation
- DDS Synthesizers
- Ring Oscillators. Time to Digital Converters
- Digital PLL Synthesizers

LEARNING ACTIVITIES AND METHODOLOGY

The training activities include:

* Master classes, small group questions resolution classes, student presentations, individual tutorials and student personal work, including study, tests and exams; oriented to the acquisition of theoretical knowledge.
* Classes of problems in small groups, individual tutorials and personal work of the student, including study, tests and exams; oriented to the acquisition of practical skills related to the program of each subject
* Laboratory practices
* Preparation of papers and reports individually or in groups as a result of circuit simulations or experimental work

The teaching methodologies will be:
* Exhibitions in class of the teacher with support of computer and audiovisual media, in which the main concepts of the subject are developed
* Resolution of practical cases and problems raised by the teacher individually or in groups
* Preparation of work and reports individually or in groups as a result of practical work in the laboratory or computer room

ASSESSMENT SYSTEM

The subject is divided into three thematic blocks. The practices and assignments of the subject will be carried out. At the end of the course there will be a final exam. The final mark will be made up of the average mark of the written assignments (40%), the mark of the practices (15%) and the final exam (45%).
Those students who do not pass the minimum mark of the written tests, or for those students who want a reevaluation of their work. For these students, the final grade will be made up of the final exam grade (85%) and the practice grade (15%).
In the extraordinary call, there will be a single final exam weighing 100%.

% end-of-term-examination:	45
% of continuous assessment (assigments, laboratory, practicals…):	55

BASIC BIBLIOGRAPHY

- A. Sedra Microelectronic Circuits, Oxford Publishing, 1991
- B Razavi RF Microelectronics, Prentice Hall, 1998
- D. Johns Analog Integrated Circuit Design, J. Willey & Sons, 1997
- J. Smith Modern Communication Circuits, McGraw-Hill Science, 1997