Electronic circuit design for communication

Academic Year: (2024 / 2025) **Review date: 26-04-2024**

Department assigned to the subject: Electronic Technology Department

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

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

The subject is divided into three thematic blocks. Lab sessions, the development of a case study and a midterm exam will be carried out. At the end of the course there will be a final exam. The final grade will be made up of the average grade of the case study (15%), the mark of the partial exam (20%), the grade of the lab (15%) and the final exam (50%) as long as the minimum grade of 3.5 is exceeded in the end.

In the extraordinary call, a single final exam will be held with a weight of 100%.

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