# Electronic systems

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

**Department assigned to the subject: Electronic Technology Department**

**Coordinating teacher: PATON ALVAREZ, SUSANA**

**Type: Electives ECTS Credits : 6.0**

**Year : Semester :**

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Linear Systems, Electronic Components and Circuits

## SKILLS AND LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.
CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.
CG4. Solve mathematical, physical, chemical, biological and technological problems that may arise within the framework of the applications of quantum technologies, nanotechnology, biology, micro- and nano-electronics and photonics in various fields of engineering.
CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.
CG6. Develop new products and services based on the use and exploitation of new technologies related to physical engineering.
CG7. Undertake further specialized studies, both in physics and in the various branches of engineering.
CE13. Understand and handle solid state physical principles relevant to engineering and, in particular, semiconductors for application in electronic and photonic components, as well as the fundamentals and applications of analog and digital electronics and microprocessors.
CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.
RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.
RA3. To be able to search for, collect and interpret relevant information and data to back up their conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.

RA4. To be able to successfully manage themselves in the complex situations that might arise in their academic or professional fields of study and that might require the development of novel approaches or solutions.
RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

## OBJECTIVES

The aim of this course is to provide the students with a solid knowledge in a number of key horizontal techniques in electronic systems. During the development of this subject, special emphasis will be placed on the application of these techniques to specific equipment and subsystems commonly used in telecommunications, both for signal processing as well as equipment power supply. To achieve this objective, students will acquire the following specific abilities:
- Understand the operation of electronic circuits with negative feedback and their frequency response
- Analyse and evaluate the most common oscillator circuits
- Understand the functioning of real operational amplifiers and their linear and nonlinear applications
- Understand the operation of the most commonly found electronic subsystems used in signal processing and communications such as timers, VCOs and PLLs
- Understand the operation and applications of power supplies and power equipment for telecommunication systems
In terms of general abilities or skills, the following areas will be worked upon throughout the development of the subject:
- Ability to work cooperatively in a team, knowing how to adapt the requirements and working conditions of the subsystem developed so that they operate correctly within a global system which is not only electronic. This aspect will be covered by means of the development of examples and case studies.
- Ability to identify, formulate and solve problems in Engineering
- Ability to use techniques and tools required in modern engineering to reduce the equipment development time

## DESCRIPTION OF CONTENTS: PROGRAMME

Topic 1. Introduction to Electronic Systems (ES)
- ES in communications, computing, measurement and automation, and other commercial and industrial applications. Analog, digital and mixed systems.
- Circuit integration platforms and associated tools: CMOS, SoC, SiP, PCBs, and others.
- Design cycle and prototype development. Hierarchical design/analysis, from system to circuit.

Topic 2. Circuits for analog signal processing.
-Amplifiers
. Voltage amplifier modeling, and op-amp review as a block
. Non idealities of an amplifier
-Filters
. Active Filters
. The Sallen-Key Filter
-Comparators
. Types of comparators
. Comparators with hysteresis

Topic 3. Feedback and Stability of amplifiers
- Feedback
o Basic Concepts of Feedback Theory in Electronics
o Topologies of Feedback
o Calculation of Gain, Input Impedance, and Output Impedance in a Feedback Circuit According to the Approximate Method
o Basic Feedback networks
- Stability & Compensation
o Frequency Analysis
o Study of the stability using the Bode diagram
o Compensation by dominant pole

Topic 4. Power Systems
- Fundamentals in power supplies
- Primary sources, energy converters, load stabilization and regulation
- Linear voltage regulators
. Operation

. Efficiency
. Protection Circuits
- LDOs
. Operation and efficiency
- Switching voltage regulators
. Fundamentals & Types
. The buck converter
. Operation
. Efficiency
- Photovoltaic systems
- Uninterruptible power supplies or UPSs

Topic 5. Signal Generators

- Sinusoidal oscillators
  - General settings of an oscillator. Starting and Maintaining Condition of an Oscillator
  - RC Oscillators
  - LC Oscillators and Crystal Oscillators
- Pulse Circuits
- PLLs & Applications
  - Basic Circuit
  - Signal Model
  - Applications

## LEARNING ACTIVITIES AND METHODOLOGY

The teaching methodology will include::
- 14 Magisterial Classes, where the students will be presented with the basic knowledge they must acquire. Students will be provided with lecture notes and key reference texts, which will enable them to complete and acquire a more in depth knowledge of the subject.
- 11 Problems Classes these are aimed at the solving of exercises and examples within the context of real case studies. These classes will be complemented with the resolution of practical exercises on behalf of the student, which in some cases may require the use of computer based simulation programs.
- 4 Laboratory Practical Sessions, here the student will design, model and characterise electronic systems within the area of communications and real applications.

Group tutorial session. At least, a group tutorial session will be carried out during the recovery week as revision and final exam preparation. (See the weekly schedule for additional details)

## ASSESSMENT SYSTEM

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| **% end-of-term-examination:** | 40 |
| **% of continuous assessment (assigments, laboratory, practicals…):** | 60 |

A continuous evaluation system will be carried out where the following will be evaluated:
1. Mandatory Laboratory Practical Sessions (20%)

The knowledge acquired by the student will be evaluated by means of the experimental implementation of several of the circuits analysed previously in the Magisterial and Problems classes. The laboratory practices will be carried out in groups and during them a complete electronic system will be developed. The system will be evaluated in a laboratory exam.

2. Problem and/or quiz solving in mid/end-term exams (40%)
3. Mandatory Final exam (40%)

Also, at the end of the course a final exam will be carried out where the global knowledge acquired by the students will be evaluated. A minimum mark will be required (3.5 over 10 points) to fulfil the requirements of continuous evaluation process.

## BASIC BIBLIOGRAPHY

- A. S. SEDRA, K.C. SMITH, T. C. CARUSONE, , V. GALDET Microelectronic Circuits, Oxford University Press, 8th edition

- D. JOHNS, K. MARTIN, T. C. CARUSONE Analog Integrated Circuitt Design, John Wiley and Sons, 2nd edition

- M. H. RASHID Microelectronic Circuits: Analysis and Design, CL-Engineering, 2010

- N. MOHAN First Course on Power Electronics, MN Power Electronics (MNPERE), 2009